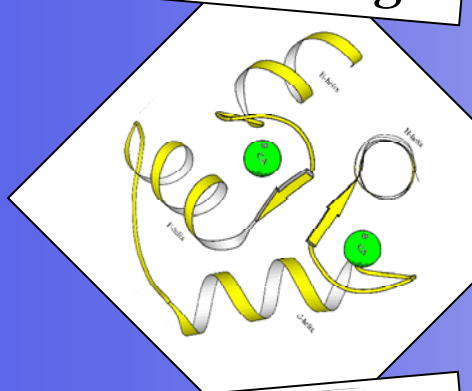
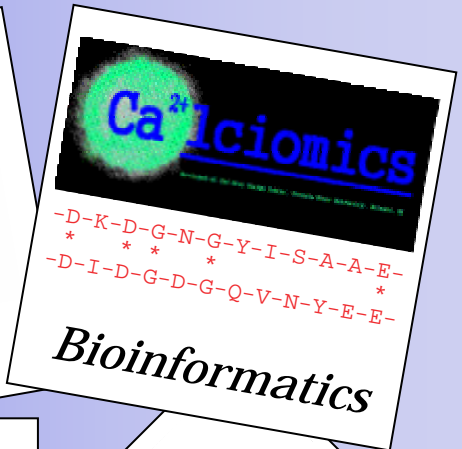
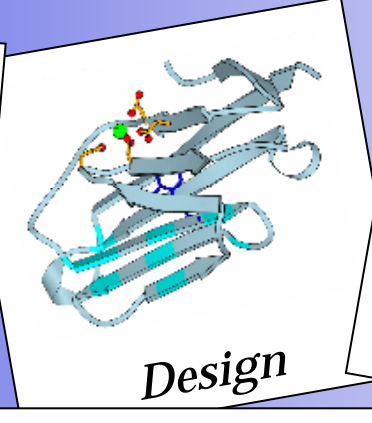
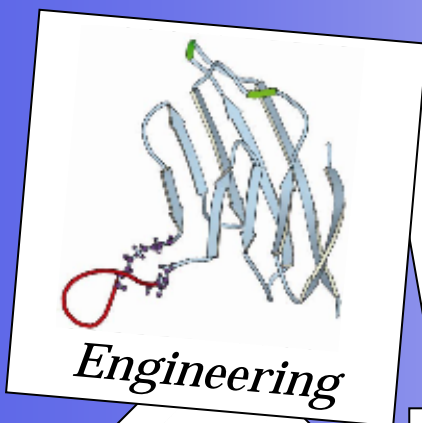


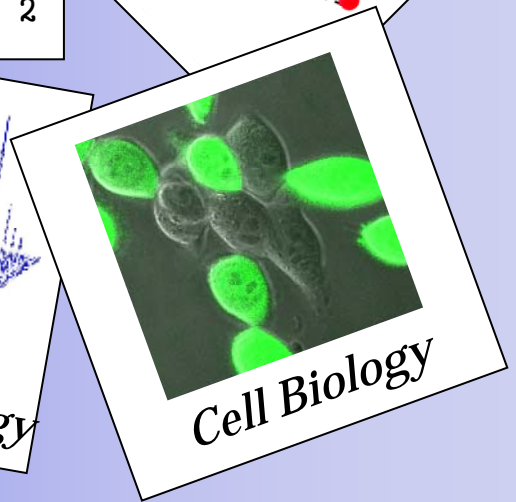
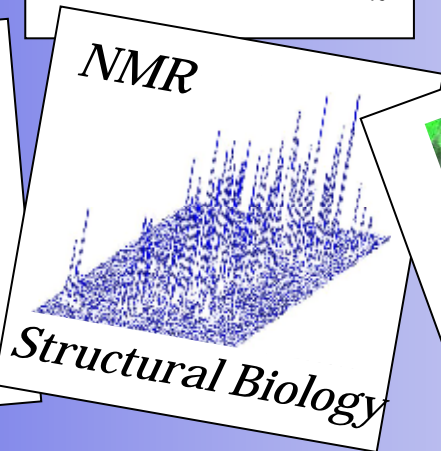
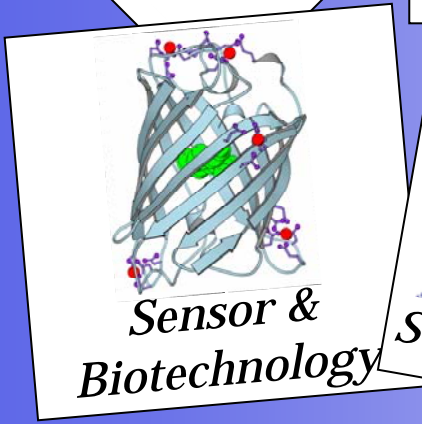
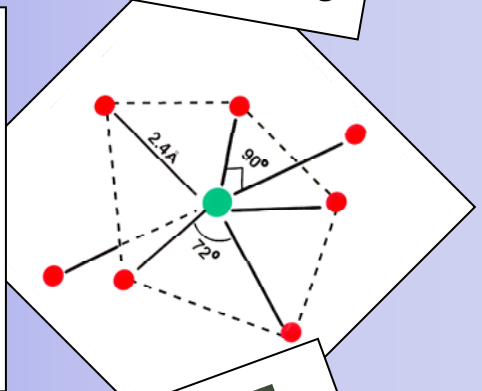


# RESEARCH IN THE YANG GROUP



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Current versions of this brochure and additional information about Dr. Jenny J Yang's Research Group are available on the Web at:

**<http://chemistry.gsu.edu/faculty/Yang/Yang.html>**

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**The research in the Jenny J Yang Laboratory focuses on the role of calcium and the mechanism of molecular recognition, especially the relationship between structure and function of proteins.** Calcium is not only an essential structural component in biomineralization, but also a 'signal of life and death' that controls numerous cellular processes such as cell division and growth, secretion, ion transport and muscle contraction. Through temporal and spatial changes of calcium concentrations and by binding proteins with different affinities, calcium ions mediate calcium-dependent functions by inducing conformational changes, stabilizing their target proteins, protecting from proteolytic degradation, and regulating domain interactions. For example, calmodulin, an intracellular EF-hand calcium binding protein, regulates more than 100 proteins upon calcium-dependent conformational change. Cadherin, an extracellular non-EF-hand calcium binding protein with a structural topology similar to that of the cell adhesion protein, CD2, plays essential roles in controlling the development and maintenance of tissues. Calmodulin and cadherin have been chosen as model systems for our research on intracellular EF-hand proteins and extracellular calcium binding proteins. Our goal is to predict and understand the role of metal ions especially calcium in biological, chemical and environmental systems (**We call it calciomics**), to design novel tools for diagnostics and research, and to create drugs for better health.

**Summary** To provide a platform for controlling biological functions and understanding the factors that contribute to metal-binding affinity and selectivity, the group has successfully developed an approach to automatically create calcium and other metal binding sites in proteins. The Yang laboratory has designed a series of novel calcium binding proteins, for the first time, with strong calcium-binding ability with different conformational properties depending upon calcium binding and desired functional properties such as cell adhesion. In addition, a grafting approach has been developed for obtaining site-specific calcium binding properties, cooperativity, and calcium-induced conformational changes for EF-hand proteins. Furthermore, a novel class of fluorescence metal biosensors has been created that can be targeted to different cellular compartments and organs to study many human diseases associated with deleterious changes in calcium.

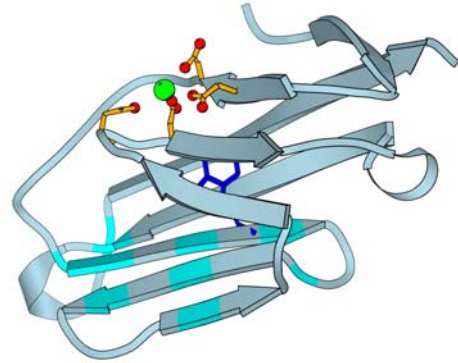
**Next** Since the designed and engineered metal binding proteins exhibit interesting selectivity for lanthanides and other paramagnetic metal ions, they have strong applications in facilitating structure determination of large protein complexes using residual dipolar coupling and creating a new class of contrast reagents for magnetic resonance imaging. Now this exciting stage allows the laboratory to apply these established approaches to predict and understand the role of metal ions especially calcium in biological, chemical and environmental systems and to create novel materials and tools for research, diagnostics and therapeutics.

**Approach** The multi-disciplinary approach to these research interests includes Structural Biology using NMR and X-ray, Biophysics, Biochemistry, Bioinorganic Chemistry, Cell and Molecular Biology, Biotechnology, Biocomputing (Bioinformatics), Physiology, Neural Sciences and Biomaterial Sciences. Commonly used methods are site-directed mutagenesis, combinatorial methods, molecular modeling, cell cultures, in-cell NMR, various spectroscopic methods (e.g. CD, fluorescence, confocal scanning fluorescence microscopy, and other techniques such as BiaCore (SPR) and Mass spectrometry. There are several main research concentrations in the Yang group that are divided into subgroups.

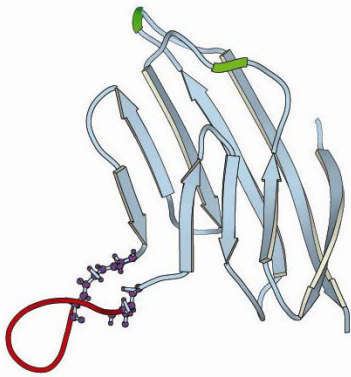
# OUTLINE OF RESEARCH PROJECTS

## Designing Calcium and Metal Binding Sites

The objectives of this project are to 1) develop a general methodology to design metal binding sites, to 2) understand the mechanism of cell adhesion, 3) monitor calcium signaling in vivo, and 4) determine large protein complex using residue dipolar coupling and lanthanide binding. Various biophysical and chemical tools including using high resolution methods are used to characterize the Ca(II) binding sites and to optimize our methods for the design of calcium binding proteins.



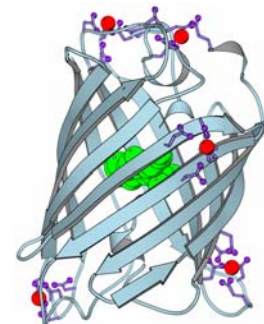
## Engineering EF-hand Calcium Binding Proteins



The objective of this project is to understand calcium signaling via trigger proteins such as calmodulin, troponin C and other EF-hand proteins. A grafting approach has been established to understand site-specific calcium binding affinity and selectivity of individual calcium binding motifs and to estimate the contribution of conformational change and cooperativity between paired EF-hand motifs. How EF-hand proteins regulate gap junction in lens cells and iron transporters in bacteria are investigated.

## Calcium Sensors

The goal of this project is to develop a novel class of Ca<sup>2+</sup> sensor proteins that will have wide applicability in studies of human diseases including various cardiomyopathies, Alzheimer's Disease, cancer, and lens cataract formation that are known to be associated with altered Ca<sup>2+</sup> signaling.



# OUTLINE OF RESEARCH PROJECTS



## **Calciomics and Calcium Banks**

The objective of this research is to develop 1) a calcium bank that contains up-to-date sequence, structure and literature information about calcium and its binding proteins in chemical, biological, material and environmental systems using bioinformatic tools and 2) a web server for predicting calcium binding sites and related information.

## **Virus Infection**

The objectives of this project are to understand the mechanism of viral infections and to develop better prevention, vaccination, and treatment against viral infections. The structural and functional relationship of nonstructural proteins in rubella virus and proteins involved in the immune response of poxvirus are investigated.

## **Against Cancer**

The objectives of this project are to develop better probes, MRI contrast reagents, and tools and sensors and to search biomarkers such as peptides and proteins to diagnose and treat cancers by protein design and engineering.

## **Biotechnology Biomaterial and Biomineralization**

The objectives of this project are to understand the mechanism of calcification and the role of calcium and proteins in biomineralization by bioinformatics and to develop new desired biomaterials and organs by protein engineering.

## **Protein Folding**

The objective of this project is to understand conformational flexibility/change and diseases related to protein folding and misfolding. Conformational change is a common mechanism involved in numerous biological processes such as protein folding, signaling and molecular recognition. We use different proteins as model systems to investigate determinants that contribute to the conformational change of proteins and the mechanism of fibril formation.

## SELECTED RECENT PUBLICATIONS

- (1) Wei Yang, Lisa M. Jones, Leanne Isley, Yiming Ye, Hsiau-Wei Lee, Anna Wilkins, Zhi-Ren Liu, Homme Hellenga, Russell Malchow, Mohammed Ghazi, Jenny J Yang. Rational Design of a Calcium-binding Protein. *JACS* (2003), **125**(20), 6165-6171.

Ca<sup>2+</sup> ions play key roles as structural components in biomineralization and as a 2nd messenger in signaling pathways. Here, the authors introduced a de novo designed Ca<sup>2+</sup>-binding site into the framework of a non-Ca<sup>2+</sup>-binding protein, domain 1 of cell surface adhesion receptor CD2. The resulting protein, CD2.Ca1, selectively bound Ca<sup>2+</sup> over Mg<sup>2+</sup> with a Ca<sup>2+</sup>-binding affinity comparable to that of natural extracellular Ca<sup>2+</sup>-binding proteins (K<sub>d</sub> = 50 nM). This experiment is the 1st successful metalloprotein design that has a high coordination no. (7) metal-binding site constructed into a  $\beta$ -sheet protein. The results demonstrate the feasibility of designing a single Ca<sup>2+</sup>-binding site into a host protein, taking into account only local properties of a Ca<sup>2+</sup>-binding site obtained by a survey of natural Ca<sup>2+</sup>-binding proteins and chelators. The resulting site exhibits strong metal selectivity, suggesting that it should now be feasible to understand and manipulate signaling processes by designing novel Ca<sup>2+</sup>-modulated proteins with specifically desired functions and to affect their stability.

- (2) Yiming Ye, Sarah J. Shealy, Hsiau-Wei Lee, Ivan Torshin, Robert Harrison, and Jenny J. Yang "A Grafting Approach for Site Specific Metal Binding Affinity of EF-hand Proteins." *Protein Engineering* (2003), **16**(6), 429-34.

The EF-hand calcium-binding loop III from calmodulin was inserted with glycine linkers into the scaffold protein CD2.D1 at three locations to study site-specific calcium binding properties of EF-hand motifs. After insertion, the host protein retains its native structure and forms a 1:1 metal-protein complex for calcium and its analog, lanthanum. Tyrosine-sensitized Tb<sup>3+</sup> energy transfer exhibits metal binding and La<sup>3+</sup> and Ca<sup>2+</sup> compete for the metal binding site. The grafted EF-loop III in different environments has similar La<sup>3+</sup> binding affinities, suggesting that it is largely solvated and functions independently from the host protein.

- (3) Jenny J. Yang, Amy Gawthrop, and Yiming Ye "Calcium binding Affinity and Selectivity of calmodulin" *Protein and peptide Letter* (2003), **10** (4).

Calmodulin (CaM) is an EF-hand Ca(II)-binding protein involved in the regulation of many important biol. processes. To date, there is a wealth of information available concerning studies to obtain site-specific calcium binding affinities of CaM, and further to est. the cooperativity of calcium binding using mutational studies, peptide models, and proteolytic fragmentation. In this paper, we will discuss the energetics of calcium binding and the strong relationship between calcium binding cooperativity and conformational change. We then explain the difficulty of studying key determinants of calcium binding affinity of CaM due to the large change of calcium binding affinity upon mutation. Subsequently, we will introduce "grafting" as a novel approach to obtain the site-specific metal binding properties of calmodulin.

- (4) Jenny J. Yang, Calcium Binding Proteins *Encyclopedia of Inorganic Chemistry*, Bruce King (Eds.) 2nd Edition, John Wiley & Sons, Ltd (2003).

## SELECTED RECENT PUBLICATIONS

- (5) Hsiau-wei Lee, Wei Yang, Yiming Ye, Zhi-ren Liu, John Glushka and Jenny J. Yang. Isolated EF-loop of Calmodulin in a Scaffold Protein Remains Monomeric in Solution. *BBA* (2002), **56**, 1099-1107.

Calmodulin (CaM) is a trigger calcium-dependent protein that regulates many biological processes. We have successfully engineered a series of model proteins, each contains a single EF-hand loop but with increasing nos. of Gly residues linking the EF-hand loop to a scaffold protein, cluster of differentiation 2 (CD2), to obtain the site-specific calcium-binding ability of a protein with EF-hand motifs without the interference of cooperativity. Loop III of calmodulin with two Gly linkers in CD2 (CaM-CD2-III-5G) has metal affinities with  $K_d$  values of  $1.86 \times 10^{-4}$  and  $5.8 \times 10^{-5}$  M for calcium and lanthanum, respectively. The oligomeric states of the CD2 variants were examined by pulsed-field-gradient NMR (PFG NMR). The diffusion coefficient values of CD2 variants are about  $11.1 \times 10^{-7}$  cm<sup>2</sup>/s both in the presence and absence of metal ions, which are the same as that of wild-type CD2. This suggests that the isolated EF-loop III of calmodulin inserted in the scaffold protein is able to bind calcium and lanthanum as a monomer, which is in contrast to the previous observation of the EF-hand motif. Our results imply that additional factors that reside outside of the EF-loop III may contribute to the pairing of EF-hand motifs of calmodulin. This result is of interest as it opens up the way for studying the ion-binding properties of isolated EF-hands, which in turn can answer important questions about the properties of EF-hands, the large and important group of calcium-binding signaling proteins.

- (6) Anna L. Wilkins, Yiming Ye, Wei Yang, Zhi-ren Liu, Sarah Shealy, Hsiau-wei Lee, and Jenny J. Yang. Metal-binding studies for a de novo designed calcium-binding protein. *Protein Engineering* (2002), **15**(7), 571-4.

To understand the key determinants in calcium-binding affinity, a calcium-binding site with pentagonal bipyramid geometry was designed into a non-calcium-binding protein, domain 1 of CD2. This metal-binding protein has five mutations with a net charge in the coordination sphere of -5 and is termed DEEEE. Fluorescence resonance energy transfer was used to determine the metal-binding affinity of DEEEE to the calcium analog terbium. The additional of protein concentration to Tb(III) solution results in a large enhancement of Tb(III) fluorescence due to energy transfer between terbium ions and aromatic residues in CD2-D1. In addition, both calcium and lanthanum compete with terbium for the same desired metal binding pocket. Our designed protein exhibits a stronger affinity for Tb(III), with a  $K_d$  of 21 mM, than natural calcium-binding proteins with a similar Greek key scaffold.

- (7) April L. Ellis, J. Christian Mason, Hsiau-wei Lee, Lucjan Strekowski, Gabor Patonay, Hoseob Choi, Jenny J. Yang. Design, Synthesis, and Characterization of a Calcium-Sensitive Near Infrared Dye. *Talanta* (2002), **56**, 1099-1107.

Intracellular calcium concentration in biological cells varies from 0.1 to 10 mM depending upon cell signaling and disease states. A direct estimate of calcium concentration in cell tissues within this range is possible with a novel calcium-selective reagent 15C5-774. The mol. of 15C5-774 consists of a near-IR (NIR) chromophore ( $\lambda_{max}=774$  nm) and a metal complexing moiety of benzo-15-crown-5. The reagent shows a strong calcium binding affinity in a 1:1 ratio and metal selectivity in the order  $Ca^{2+} > Mg^{2+} > Sr^{2+} \gg K^+ \gg Na^+ > Zn^{2+} > Li^+$ . The high sensitivity is achieved by conducting absorption measurements in the NIR region where background interference from the biol. matrix is low.

## SELECTED RECENT PUBLICATIONS

- (8) Wei Yang, Hsiau-wei Lee, Homme Hellinga and Jenny J. Yang. Structural analysis, identification, and design of calcium-binding sites in proteins. *Proteins* (2002), **47**, 344-356.

Assigning proteins with functions based on the 3-D structure requires high-speed techniques to make a systematic survey of protein structures. Calcium regulates many biological systems by binding numerous proteins in different biological environments. Despite the great diversity in the composition of ligand residues and bond angles and lengths of calcium-binding sites, our structural analysis of 11 calcium-binding sites in different classes of proteins has shown that common local structural parameters can be used to identify and design calcium-binding proteins. Natural calcium-binding sites in both EF-hand proteins and non-EF-hand proteins can be described with the smallest deviation from the geometry of an ideal pentagonal bipyramid. Further, two different magnesium-binding sites in parvalbumin and calbindin(D9K) can also be identified using an octahedral geometry. Using the established method, we have designed de novo calcium-binding sites into the scaffold of non-calcium-binding proteins CD2 and Rop. Our results suggest that it is possible to identify calcium- and magnesium-binding sites in proteins and design de novo metal-binding sites.

- (9) Jenny Jie Yang, Haidong Yang, Yiming Ye, Harry Hopkins & Gary Hastings. Temperature-induced formation of a non-native intermediate state of the all  $\beta$ -sheet protein CD2. *Cell Biochemistry and Biophysics* (2002), **36**, 1-18.

Domain 1 of the cell adhesion protein CD2 (CD2-1) has an all  $\beta$ -structure typical of proteins belonging to the immunoglobulin superfamily. It has a remarkable ability to fold as a native monomer or a metastable intertwined dimer. To understand the origin of structural rearrangements of CD2-1, we have studied equilibrium unfolding of the protein using various biophysical spectroscopic techniques. At temps. above approx. 68°, a partially folded state of CD2-1 (H state) with a distinct secondary structure, involving largely exposed aromatic and hydrophobic residues and a substantially perturbed tertiary structure, is observed. In contrast, an unfolded state (D state) of CD2-1 with random-coil-like secondary and tertiary structures is observed. in 6 M GuHCl. This partially folded high-temp. state has increased neg. molar ellipticity at 222 nm in far-UV CD spectra, implying formation of a non-native helical conformation. The existence of this non-native high-temp. intermediate is consistent with relatively high intrinsic helical propensities in the primary sequence of CD2-1. This conformational flexibility may be important in the observed. domain swapping of CD2-1.

- (10) Yiming Ye, Hsiau-Wei Lee, Wei Yang, Sarah J. Shealy, Anna L. Wilkins, Zhi-ren Liu, Ivan Torshin, Robert Harrison, Robert Wohlhueter and Jenny J. Yang. Metal Binding Affinity and Structural Properties of an Isolated EF-loop in a Scaffold Protein. *Protein Engineering* (2001), **14**(12), 1001-1013.

To establish an approach to obtain the site-specific calcium binding affinity of EF-hand proteins, we have successfully designed a series of model proteins, each containing the EF-hand calcium-binding loop 3 of calmodulin, but with increasing numbers of Gly residues linking the loop to domain 1 of CD2. Structural analyses, using different spectroscopic methods, have shown that the host protein is able to retain its native structure after insertion of the 12-residue calcium-binding loop and retains a native thermal stability and thermal unfolding behavior. In addition, calcium binding to the engineered CD2 variants does not result in a significant change from native CD2 conformation. The CD2 variant with two Gly linkers has been shown to have the strongest metal binding affinity to Ca(II) and La(III). These experimental results are consistent with our molecular modeling studies, which suggest that this protein with the engineered EF-loop has a calmodulin-like calcium binding geometry and backbone conformation. The addition of two Gly linkers increases the flexibility of the inserted EF-loop 3 from calmodulin, which is essential for the proper binding of metal ions.

## SELECTED RECENT PUBLICATIONS

- (11) Jenny J. Yang, Yiming Ye, Amy Carroll, Wei Yang, and Hsiau-wei Lee. Structural Biology of the Cell Adhesion Protein CD2: Alternatively Folded States and Structure-function Relation. *Current Protein and Peptide Science* (2001), **2** (1), 1-17.

A review and discussion with 79 refs. Cluster of differentiation 2 (CD2) is a cell surface glycoprotein expressed on most human T cells and natural killer (NK) cells and plays an important role in mediating cell adhesion in both T-lymphocytes and in signal transduction. The understanding of the biochemical basis of molecule recognition by the cell adhesion molecule CD2 has been advanced greatly through the determination of structures and the dynamic properties of the complexes and their individual components and through site-directed mutagenesis. A numbers of general principles can be derived from the structural and functional studies of the extracellular domains of CD2 and CD58 and their complex. Significant electrostatic interactions within the protein-protein interfaces contribute directly to the formation of macromolecule complexes of CD2 and CD58. Also, residues located on the protein-protein interface demonstrate a certain degree of conformational change upon the formation of a complex. Structural anal. of CD2 has revealed that this adhesion mol. exhibits strong conformational flexibility with a partial non-native helical conformation at high temps. and in the presence of an org. solvent. In addition, it can be converted into a domain swapped dimer, or trimer and tetramer through hinge deletion. Thus, the conformational status of the adhesive proteins contributes to the regulation of cell adhesion and the folding of CD2.

- (12) Wei Yang, Hsiau-wei Lee, Zhi-ren Liu, Homme Hellinga and Jenny J. Yang. Analysis and evaluation of rational designed calcium binding sites in CD2. *Peptides: The Wave of the Future*, R. A. Houghten & M. Lebl. (Eds.), Escom Leiden (2001), 811-813.

Detailed surveys of known calcium-binding proteins have shown that almost all of the ligands involved in calcium binding in proteins use oxygen atoms. The most common calcium-binding site has pentagonal bipyramidal or distorted octahedral geometry with 6 or 7 coordination positions. The structural parameters for designing calcium-binding proteins have been established with the popular pentagonal bipyramidal geometry using EF-hand and non-EF-hand proteins as controls with a computational program. The designed calcium-binding sites in CD2-D1 are filtered for mol. engineering based on their side chain clashes, locations, charge nos., and dynamic properties. All mutations for a chosen site are not located at the hydrophobic core of the protein. The side chains of the ligand residues for the chosen site have little conflict with the pre-existing atoms. The mutations of a chosen site do not cause any significant conformational change of the host protein.

- (13) Yiming Ye and Jenny J. Yang. Site specificity metal binding affinity in C-terminal of calmodulin. *Peptides: The Wave of the Future*, R. A. Houghten & M. Lebl. (Eds.), Escom Leiden (2001), 450-451.

Isolated EF-hand motifs were engineered with Gly linkers in a scaffold protein, domain 1 of DC2-D1, designated as calmodulin-CD2-III-5G and CAM-CD2-IV-5G, to evaluate the intrinsic calcium binding affinity of C-terminal calcium-binding site III and IV. The metal binding affinity in a protein was monitored using the fluorescence from the lanthanide ion Tb<sup>3+</sup>. Fluorescence spectra of CAM-CD2-III-5G and CAM-CD2-IV-5G for La(III) showed that the fluorescence intensity of proteins were gradually decreasing with increasing La(III) concn. without changing the emission max. greatly. In high La(III) concn., the addn. of La(III) did not change the emission max. from 327 to 340 nm and the 340 was close to the free Trp amino acid emission max., indicating that high La(III) concn. could expose the buried Trp of the proteins. Under the same conditions, CAM-CD2-III-5G displayed stronger metal binding affinities for both La(III) and Tb(III) than that of CAM-CD2-IV-5G.

## SELECTED RECENT PUBLICATIONS

- (14) Jenny Jie Yang, Amy R. Carroll, Wei Yang, Yiming Ye, and, Christina Nguyen. An Alternated Folded Acid-stable Beta-sheet Protein. *Cell Biochemistry and Biophysics* (2000) **33**, 253-273.

Cell adhesion mol., CD2, from the Ig superfamily, is comprised of antibodies and Ig-like domains and plays a fundamental role, not only in the immune system, but also in the interactions between cells, specifically in cell-cell adhesion. This study examines the N-terminal domain 1 of CD2 (CD2-1) at different pHs, and in 2,2,2-trifluoroethanol (TFE), using nears- and far-UV CD (CD), fluorescence, and <sup>1</sup>H NMR to elucidate factors contributing to the Ig  $\beta$ -structure. Contrary to the complete unfolding induced by guanidine hydrochloride, CD2-1 retains its native tertiary structure at pHs from 1.0 to 10.0. Like the effects of high temps. that have previously been observed, TFE reduces the integrity of the tertiary structure, while reorganizing the secondary structure from a native all- $\beta$ -sheet to a significantly  $\alpha$ -helical conformation. The induced helicity of CD2-1 correlates with the helicity inherent in its primary sequence. Our results suggest that electrostatic interactions are less important for the formation of the native secondary and tertiary structure of CD2-1, although they are crucial for CD2's adhesion function. Interference with the protein's hydrophobic interactions and hydrogen-bonding networks, however, causes significant changes in its conformation. Residues of CD2-1, with high conformational flexibility, may contribute for the formation of a metastable dimer by domain-swapping.

- (15) Wei Yang, Hsiauwei Lee, Homme Hellinga, Michelle Pu and Jenny Jie Yang. Identifying and designing of calcium binding sites in proteins by computational algorithm. *Computational Studies, Nanotechnology, and Solution Thermodynamics of Polymer Systems*. Kluwer Academic/Plenum Publishers. 127-138, 2000

Structural parameters were established for identifying and designing Ca-binding proteins by the computer algorithm Dezymer. Three evolutionary related intracellular Ca-binding proteins (EF-hand proteins), calmodulin, parvalbumin, and calbindinD9K, were used as model systems to test if the computer program can accommodate the intrinsic variability of ligand geometry and length of Ca(II)-ligand O atom. Natural Ca-binding sites were accurately relocated with Dezymer using a set of geometric descriptions of an ideal pentagonal bipyramid. The success of each constructed site could be ranked by the relative pseudo-energy  $U(p)$  values. The investigated native-like sites in 3 EF-hand proteins had the smallest deviation from the target geometry. The results indicate a useful method for searching Ca-binding sites in proteins. It is possible to use established parameters to design novel Ca-binding proteins.

- (16) Wei Yang, Tom Tsai, Mark Kats, & Jenny Jie Yang. Peptide Analogs from E-Cadherin with Different Calcium Binding Affinity. *Journal of Peptide Research* (2000) **55**, 203-215.

Cadherins are a family of calcium-dependent cell-surface proteins that are fundamental in controlling the development and maintenance of tissues. Motif B of E-cadherin seems to be a crucial calcium-binding site as single point mutations (D134A and D134K) completely inactivate its adhesion activity. We analyzed peptide models corresponding to motif B (amino acids 128–144) as well as selected mutations of this motif. Our NMR studies showed that this motif B sequence is actually an active calcium-binding region, even in the absence of the rest of the cadherin molecule. We found that the binding affinity of this motif is very sensitive to mutations. For example, our peptide P128-144 with the native calcium-binding sequence has an affinity of  $K_d$  0.4 mM, whereas the mutants P128-144/D134A and P128-144/D134K containing the replacement of Asp<sup>134</sup> by Ala and Lys, have  $K_d$  values of only 1.5 and 11 mM, respectively. Removing Asp at position 134, which correlates with the loss of adhesion activity, decreases calcium-binding affinity 20-fold. Ala<sup>132</sup>, along with residues Asp<sup>134</sup>, Asp<sup>136</sup> and Asn<sup>143</sup>, is involved in calcium binding in solution. We also demonstrated that the calcium-binding affinity can be increased ~3-fold when an additional Asp is introduced at position 132. In 50% organic solvent, this binding affinity of peptide P128-144/A132D (17-mer) from E-cadherin is similar to that of peptide P72–100/C73–77–91A (29-mer) from  $\alpha$ -lactalbumin.

## SELECTED RECENT PUBLICATIONS

- (17) Xin Liu, Jenny J. Yang, Mohamad Ghazi & Teryl Frey. Characterization of the Zinc Binding Activity of the Rubella Virus Nonstructural Protease. *Journal of Virology* (2000) **74**, 5949-5956.

The rubella virus (RUB) nonstructural (NS) protein (NSP) ORF encodes a protease that cleaves the NSP precursor (240 kDa) at a single site to produce two products. A cleavage site mutation was introduced into a RUB infectious cDNA clone and found to be lethal, demonstrating that cleavage of the NSP precursor is necessary for RUB replication. Based on computer alignments, the RUB NS protease was predicted to be a papain-like cysteine protease (PCP) with the residues Cys1152 and His1273 as the catalytic dyad; however, the RUB NS protease was recently found to require divalent cations such as Zn, Co, and Cd for activity (X. Liu, S. L. Ropp, R. J. Jackson, and T. K. Frey, *J. Virol.* 72:4463-4466, 1998). To analyze the function of metal cation binding in protease activity, Zn binding studies were performed using the minimal NS protease domain within the NSP ORF. When expressed as a maltose binding protein (MBP) fusion protein by bacteria, the NS protease exhibited activity both in the bacteria and in vitro following purification when denatured and refolded in the presence of Zn. Atomic absorption analysis detected 1.6 mol of Zn bound per mol of protein refolded in this manner. Expression of individual domains within the protease as MBP fusions and analysis by a Zn65 binding assay revealed two Zn binding domains: one located at a predicted metal binding motif beginning at Cys1175 and the other one close to the cleavage site. Mutagenesis studies showed that Cys1175 and Cys1178 in the first domain and Cys1227 and His1273, the His in the predicted catalytic site, in the second domain are essential for zinc binding. All of these residues are also necessary for the protease activity, as were several other Cys residues not involved in Zn binding. Far-UV circular dichroism (CD) analysis of the MBP-NS protease fusion protein showed that the protease domain contained a large amount of alpha-helical structure, which is consistent with the results of secondary-structural prediction. Both far-UV-CD and fluorescence studies suggested that Zn did not exert a major effect on the overall structure of the fusion protein. Finally, protease inhibitor assays found that the protease activity can be blocked by both metal ion chelators and the metalloprotease inhibitor captopril. In conjunction with the finding that the previously predicted catalytic site, His1273, is essential for zinc binding, this suggests that the RUB NS protease is actually a novel virus metalloprotease rather than a PCP.

- (18) Wei Yang, Yiming Ye and Jenny Jie Yang. A Sensitive Method for Selecting Calcium-binding Proteins. *Luminescence Forum*, (1999) **5**, 4-8.

- (19) Wei Yang and Jenny Jie Yang Investigation of Conformational Properties of Ca(II)-binding Peptides in Cell Adhesion Molecules. *Peptides: Frontiers of Peptide Science*, J. Tam & Kaumaya, P.T.P., R.S. (Eds.), Escom Leiden (1997), 112-113.

## CURRENT RESEARCH GROUP MEMBERS



### **Dr. Wei Yang**

*Research Scientist*

Research: NMR spectroscopy and Proteomics

2001, Ph.D. Biochemistry, Georgia State University  
1996, M.S. Biophysics, Qinghua University , China  
1993, B.S. Biochemistry, Qinghua University , China  
Email: yang\_wei88@hotmail.com

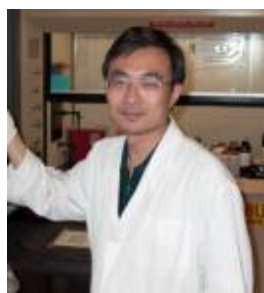


### **Dr. Yiming Ye**

*Research Scientist*

Research: Protein Engineering and Virus Infection

2001, Ph.D. Biochemistry, Georgia State University  
1990, M.S. Microbiology, Jinan University , China  
1980, B.S. Biology, Jinan University , China  
Email: cheyy@langate.gsu.edu

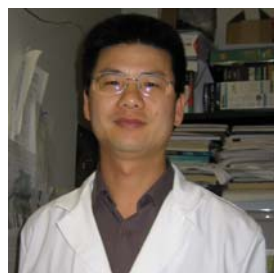


### **Dr. Jin Zou**

*Research Scientist*

Research: Design Biosensors and Biotechnology

2001, Ph.D. Biochemistry, Konan University, Japan  
1985, M.S. Chem. Engineering, Hebei Institute of Tech, China  
1982, B.S. Chemistry, Xuzhou Teacher's College, China  
Email: chejz@langate.gsu.edu



### **Dr. Shunyi (Shawn) Li**

*Postdoctoral Research Associate*

Research: Separation of Biomolecule

1997, Ph.D. Zoology, Chinese Academy of Sciences, China  
1994, M.S. Biochemistry, Hunan Normal University , China  
Email: sli@gsu.edu



### **Dr. Jianhua Yang**

*Postdoctoral Research Associate*

Research: Cancer Research

1999, Ph.D. Biochemistry and Toxicology, Hong Kong Baptist University.  
1990, M.S. Occupational Diseases, West China University of Medical  
Sciences, China  
1985, B.S. Sanitary Technology, West China University of Medical  
Sciences, China  
Email: jianhuayang@hotmail.com

## CURRENT RESEARCH GROUP MEMBERS



### **Anna Wilkins**

*Ph.D. Candidate, NIH Pre-Doctoral Fellow*

Research: Design Calcium Binding Protein

2000, M.S. Biochemistry, Georgia State University

1998, B.S. Biology, Georgia State University

1997, A.S. Biology, Clayton State College

Email: alwmanicca@yahoo.com



### **Hsiau-Wei (Jacques) Lee**

*Ph.D. Candidate, MBD Fellow*

Research: Structural Biology

2001, M.S. Biochemistry, Georgia State University

1991, B.S. Chemistry, Georgia State University

Email: hlee1@student.gsu.edu



### **Lisa M. Jones**

*Ph.D. Candidate, GANN Fellow*

Research: Design Calcium Binding Protein

1999, B.S. Biochemistry, Syracuse University

Email: ljones12@student.gsu.edu



### **April L Ellis**

*Ph.D. Candidate, AHA Pre-Doctoral Fellow*

Research: Design Biosensor

1999, B.S. Chemistry, Georgia State University

Email: alustry1@hotmail.com



### **Yubin (Rubin) Zhou**

*Ph.D. Student*

Research: Virus Infection and Biotechnology

2003, B.M. Basic Medical Sciences, Zhejiang University, China

Email: yzhou7@student.gsu.edu

## CURRENT RESEARCH GROUP MEMBERS



### **Xuezheng (Susan) Fu**

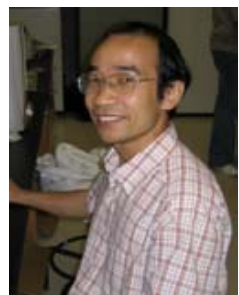
*Ph.D. Student (Computer Science)*

Research: Bioinformatics and Biocomputing

2003, M.S. CS, Beijing Institute of Technology, China

2000, B.S. CS, Beijing Institute of Technology, China

Email: xuezhengfu@yahoo.com



### **Ning (Nick) Chen**

*Ph.D. Student*

Research: Design Biosensor

1997, M.S. Sports Medicine, Wuhan Institute of Physical Education ,  
China

1994, B.M. Pharmaceutical Science, Hubei Institute of Traditional  
Chinese Medicine , China

Email: nchen1@student.gsu.edu



### **Gayatri Ayalasomayajula**

*Master Student*

Research: Proteomics and Bioinformatics

2001, M.S. Microbiology, Orissa University , India

1998, B.S. Zoology, B. J. B. College , India

Email: dokkagayatri@yahoo.com



### **Michael P. Kirberger**

*Master Student*

Research: Proteomics and Bioinformatics

1988, B.A. Journalism/Communications, Penn State University

Email: mkirbeger@comcast.net



### **Angela Holder**

*Master Student*

Research: Biotechnology and Virus Infection

2002, B.S. Chemistry, Georgia State University

Email: kittykane76667@aol.com

## CURRENT RESEARCH GROUP MEMBERS



**Medina Jackson**

*Master Student*

Research: Design Calcium Binding Protein

B.S.

Email: [mjackson5@student.gsu.edu](mailto:mjackson5@student.gsu.edu)



**Yan Xiao**

*Non-Degree Research Assistant*

Research: Biotechnology

1983, B.S. Precision Instrument Engineering, Hebei University of Technology, China

Email: [yxiao1962@yahoo.com](mailto:yxiao1962@yahoo.com)



**Julian Johnson**

*Undergraduate Research Assistant*

Research: Design Calcium Binding Protein

2004, Ronald E. McNair Scholar

B.S. Biology, Georgia State University , In progress

Email: [jjohnson65@student.gsu.edu](mailto:jjohnson65@student.gsu.edu)



**Kendra Hubbard**

*Undergraduate Research Assistant*

Research: Design Calcium Binding Protein

University Scholar, 2002-2006

B.S. Chemistry, Georgia State University , In progress

Email: [khubbard1@student.gsu.edu](mailto:khubbard1@student.gsu.edu)



**Dorinda Nelson,**

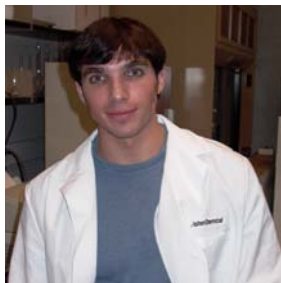
*Undergraduate Research Assistant*

Research: Design of Calcium Sensor

B.S. Biology, Georgia State University , In progress

Email: [dorindan@bellsouth.net](mailto:dorindan@bellsouth.net)

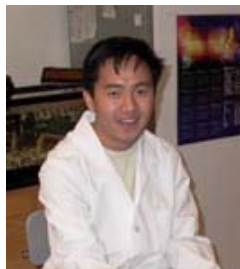
## **CURRENT RESEARCH GROUP MEMBERS**



### **Dan Spratt**

Undergraduate Research Assistant  
Research: Design Calcium Binding Protein

B.S. Chemistry and Kinesiology, Georgia State University, In Progress  
Email: dspratt@ziplip.com



### **Thanh Quach**

*Undergraduate Research Assistant*  
Research: Design Biosensor

2004, Ronald E. McNair Scholar  
B.S. Biology, Georgia State University, In progress  
Email: tqquach1@student.gsu.edu



### **Alice Luo**

*Undergraduate Research Assistant, AURA Fellow*  
Research: Biotechnology

B.S. in progress in Biomedical Engineering/International  
Affairs/Modern Languages(French), Georgia Institute of Technology  
Email: aliceluo517@yahoo.com

## CURRENT RESEARCH FUNDING

### **1. Proposal Title: Rational Design and Analysis of Calcium Binding Proteins**

Source: National Institute of Health

PI: Dr. Jenny J. Yang

Dates: 07/01/01 – 06/30/06

Direct costs: \$1,272,500

### **2. Proposal Title: Design of Calcium Sensors to Monitor Calcium Signaling in ER**

Source: National Institutes of Health-1R21GM070555-01

Dates: 06/01/04 - 5/31/05

PI: Dr. Jenny J. Yang

Co-PI: Dr. Charles Louis

Direct costs: \$363,750

### **3. Proposal Title: Key Determinants of Calcium-Binding Affinity of EF-hand Proteins**

Source: National Science Foundation

PI: Dr. Jenny J. Yang

Dates: 04/01/01 - 03/31/05

Award: \$300,000

### **4. Proposal Title: Regulation of Lens Gap Junctions**

Source: National Institutes of Health-Eye Institute

PI: Dr. Charles Louis

Co-PI: Dr. Jenny J. Yang

Dates: 09/01/04- 08/31/09

Direct costs: \$1,250,000

### **5. Proposal Title: Molecular Biology of Rubella Virus**

Source: NIH

Dates: 07/01/03 - 06/30/08

PI: Dr. Teryl K. Frey

Co-PI: Dr. Jenny J. Yang

Direct costs: \$1,150,000

### **6. Proposal Title: Molecular Recognition of the TNF Receptor Encoded by Variola Virus**

Source: The Southeastern Center for Emerging Biological Threats

Dates: 9/1/03– 8/31/05

PI: Dr. Jenny J. Yang

Direct costs: \$50,000

### **7. Proposal Title: Developing Protein-Based Sensor for diagnosing Poxviruses**

Source: Southeast Research Center for Emerging Diseases and  
Biodefense (SERCEB)

PI: Dr. Jenny J. Yang

Dates: 01/01/05- 12/31/05

Direct costs: \$50,000

### **8. Proposal Title: Supplemental award for Undergraduate Research**

Source: Natural Science Foundation

PI: Dr. Jenny J. Yang

Dates: 04/01/01 - 05/31/05

Total costs: \$7,500

## CURRENT RESEARCH FUNDING

### **9. Proposal Title: Conformational change of EF-hand Proteins by Grafting**

Source: NSF for Minority Graduate Student  
Dates: 10/01/02 - 3/30/05  
PI: Dr. Jenny J. Yang  
Direct costs: \$33,000

### **10. Proposal Title: Supplemental Award for Minority Student Research**

Source: National Institute of Health  
PI: Dr. Jenny J. Yang  
Dates: 07/01/01 – 06/30/06  
Total costs: \$37,500

### **11. Proposal Title: Supplemental Award for Minority Student Research**

Source: National Institute of Health  
PI: Dr. Jenny J. Yang  
Dates: 03/01/04 – 06/30/06  
Total costs: \$114,385

### **12. Proposal Title: NIH Pre-doctoral Fellowship for Graduate Research (Sponsor)**

Source: National Institute of Health  
PI: Ms. Anna Wilkins  
Dates: 01/01/03-09/30/05  
Direct costs: \$72,000

### **13. Proposal Title: AHA Pre-doctoral Fellowship for Graduate Research (Sponsor)**

Source: American Heart Association  
PI: Ms. April Ellis  
Dates: 07/01/03-06/30/05  
Direct costs: \$36,000

### **14. Proposal Title: GANN Minority Pre-doctoral Fellowship for Graduate Research (Sponsor)**

Source: Grants in Areas of National Need  
Awardee: Ms. Lisa Jones (PI: Devon Kennedy)  
Dates: 07/01/04-06/30/07

### **15. Proposal Title: Southeast Collaboratory for High-Field Biomolecular NMR (900 MHz)**

Source: National Institutes of Health  
Dates: 07/01/02-06/30/07  
PI: James Prestegard (The University of Georgia)  
Direct costs: \$5,045,000.00

### **16. Proposal Title: NSF-Atlanta Undergraduate Research Alliance (Sponsor)**

Source: AURA  
Dates: 09/01/04-06/30/05  
PI: Alice Luo (Georgia Institute of Technology)  
Direct costs: \$2500

**POSITIONS HELD:**

- 2002-Present **Georgia State University**, Department of Chemistry, Atlanta, GA  
Associate Professor of Biochemistry and Biophysics (Tenured)  
Research Focus: Design of Calcium Binding Proteins with Medical Applications  
**University of Georgia**, Adjunct Professor at the Center for Metalloenzyme Studies  
**Centers for Disease Control and Prevention: Guest Researcher**  
**Journal of Calcium Binding Protein**: Associate Editor
- 1997-2001 Assistant Professor of Biochemistry and Biophysics, Georgia State University  
1995-1997 Postdoctoral Research Associate, Yale University  
1993-1995 Postdoctoral Research Fellow, University of Oxford  
1992-1993 Postdoctoral Research Fellow, Syntex Discovery Research  
1982-1987 Faculty of Analytical Chemistry, Xiangtan University

**EDUCATION:**

- 1992 **Ph.D.** Biochemistry (**Distinguished**), Florida State University, Tallahassee, Florida  
Graduate Research Advisor: Dr. Harold Van Wart  
Dissertation Title: Kinetic Studies of the Catalytic Pathway of Thermolysin
- 1985 **M.S.** Analytical Chemistry (**Honors**), Xiangtan University, Xiangtan, Hunan, China  
Graduate Research Advisor: Professor Shiling Tang  
Thesis Title: Analysis of Zn and Copper by Electro-Analytic Methods
- 1982 **B.S.** Chemistry with **High Honors**, Xiangtan University, Xiangtan, Hunan, China  
Undergraduate Research Advisor: Professor Weikuan Yiao  
Research Project: Detection and Analysis of Biological Elements

**AWARDS AND HONORS:**

- 2004-present Associate Editor of Journal of Calcium Binding Protein  
2001-2004 Panel Grant Reviewer of National Science Foundation (MCB)  
2004 Panel Grant Reviewer of the Study Session of National Institute of Health (SBDD)  
2003 Honor from McNair Program for outstanding achievement in training minority undergraduate research
- 2002-present Panel Grant Reviewer of the Study Session of National Institute of Health for Predoctoral Fellowship (F31)
- 2003 Outstanding Faculty Achievement Award, Georgia State University  
2003 Featuring Recognition for Outstanding Contribution to McNair Minority Undergraduate Research Program
- 2001 Nominee of Henry Dreyfus Teaching Award  
2001 Nominee of the Pfizer Award, American Chemical Society  
2001 Outstanding Junior Faculty Award, Georgia State University, Art and Science
- 2001 National Science Foundation Research Grant Awarded

# ABBREVIATED CURRICULUM VITAE

1996	Donahue Foundation Research Award
1995 –1996	Hartford Research Award
1993 –1995	Oxford Center for Molecular Sciences Fellowship
1992	Distinguished Graduate Student at Florida State University
1992	Best Presentation at the Florida American Chemistry Society meeting
1992	Sigma Xi
1986	Outstanding Instruction Award, Xiangtan University
1985	Outstanding Graduate Student Award, Xiangtan University
1982	Outstanding Undergraduate Student Award, Xiangtan University

## PROFESSIONAL AFFILIATIONS:

European Calcium Society  
The Royal Society of Chemistry  
The American Chemical Society  
The American Peptide Society  
The Biophysical Society  
The Chinese American in Academia Society  
The Atlanta Calcium Club  
The Atlanta NMR User Club

## OUTSIDE SERVICE:

Associate Editor of Journal of Calcium Binding Protein (2004-present)

Reviewer of Grant Proposals:

National Science Foundation (Panel Grant Reviewer of SBDD,2004)  
National Science Foundation (Panel of MCB, 2001-2004)  
National Institute of Health (Study Session for Predoctoral Fellowship 2002-present)  
National Science Foundation (Ad Hoc Instrumentation)  
Research Cooperation (Ad Hoc)  
Hong Kong Research Grants Council (Ad Hoc)  
The Wellcome Trust-International Research fellowship (Ad Hoc)

Ad Hoc Reviewer of Scientific Articles:

Journal of the American Chemical Society, BBA, Biological Inorganic Chemistry,  
Biochemistry, FEBS Letter, Protein Science, Current Opinions for Structural Biology,  
Talanta, Biomacromolecules, Archives of Biochemistry and Biophysics, Protein  
Engineering, Journal of Inorganic Biochemistry, Journal of Bacteriology

Grant Review Consultant of MORE Program at California State University

Lectured in NSF-sponsored Workshop of Molecular Genetics and Protein Engineering 2001

Lectured in NSF-sponsored Workshop of Molecular Genetics and Protein Engineering 2002

Participated in obtaining Mass spectrometry instruments for Georgia State University and Georgia Institute of Technology from National Institute of Health (Direct costs: \$400,000)

Participated in obtaining high-field biomolecular NMR (900 MHz) for Southeast Collaboratory from National Institute of Health (Direct costs: \$5,045,000.00)

Section Chair of Calcium Signaling at SERMACS, GA, November, 03.

Organizer of Atlanta Calcium Club

# ABBREVIATED CURRICULUM VITAE

## INVITED TALKS (Selected):

1. School of Chemistry and Biochemistry, Georgia Institute of Technology, Atlanta, GA, June, 1997.
2. Department of Biochemistry, University of Berlin, Germany, August, 1998.
3. Department of Molecular Science, University of Frankfurt, Germany, August, 1998.
4. Departments of Chemistry and Biology, Georgia State University, Atlanta, GA, September, 1998.
5. Department of Biochemistry, Hong Kong Polytechnic University, October, 1998.
6. Department of Chemistry, Hong Kong University of Science and Technology, October, 1998.
7. Department of Chemistry, Xiangtan University, Hunan, P.R. China, Oct., 1998.
8. American Chemistry Society Southeastern Regional Meeting, Research Triangle Park, NC, Nov, 1998.
9. Program of Physical, Materials and Computational Sciences (PMACS), Emory University, Atlanta, Georgia, March 23, 1999.
10. Department of Chemistry, University of South Carolina, Columbia, SC, April 27, 1999.
11. American Chemistry Society Southeastern Regional Meeting, Knoxville, TN, October 17, 1999.
12. American Chemistry Society Southeastern Regional Meeting, Knoxville, TN, October 20, 1999.
13. Department of Biology, Georgia State University, Atlanta, September 3, 1999.
14. Department of Chemistry, University of Memphis, Memphis, TN, May 8, 2000.
15. Molecular and Cellular Bioscience, National Science Foundation, Arlington, VA, June 2000.
16. 2nd International peptide Symposium and 17th American Peptide Symposium, San Diego, June, 2001.
17. American Chemistry Society Southeastern Regional Meeting, GA, September 22, 2001.
18. University of California at Santa Barbara, CA, June, 2001.
19. American Chemistry Society Southeastern Regional Meeting, GA, September 24, 01.
20. Department of Chemistry, Peking University, P. R. China, September, 2001.
21. Institute of Biophysics, Science Academy in China, Peking, September, 2001.
22. National Conference of Biochemistry and Biophysics, Shanghai, September, 2001.
23. University of Chinese Science and Technology, Department of Chemistry, Hebei, 24. September, 2001.
24. University of Chinese Science and Technology, College of Life Sciences, Hebei, September, 2001.
25. Institute of Biochemistry, Science Academy in China, Shanghai, September, 2001.
26. Department of Chemistry, University of Illinois, Chicago, IL, November 15, 01.
27. American Chemistry Society Southeastern Regional Meeting, GA, September 25, 01.
28. Department of Chemistry, Northwestern University, Chicago, IL, November 2, 01.
29. Department of Chemistry, University of Urbana-Champaign, IL, November 13, 01.
30. Interdisciplinary Research Center, K.U. Leuven Compus Kortrijk, Kortrijk, B-8500, Belgium, June, 2002
31. 7th International peptide Symposium, Darlian, China, July, 2002.
32. Department of Chemistry, TsingHua University, Beijing, July, 2002
33. Institute of Neuron Science, Chinese Academy of Sciences, Shanghai, July, 2002
34. Institute of Cell Biology and Development, Chinese Academy of Sciences, Beijing, July, 2002
35. Institute of Biophysics, Chinese Academy of Sciences, Beijing, June, 2002.
36. 3rd International Conference on High Resolution Sector Field ICPMS, Atlanta, GA, October, 2002
37. Department of Chemistry and Biochemistry, Florida State University, Tallahassee, FL, November, 2002.
38. The Biophysical Society 47th Annual Meeting, San Antonio, TX, March 2-5, 2003.

## ***ABBREVIATED CURRICULUM VITAE***

39. The National American Chemical Society, New York, NY, September 8, 2003.
40. Symposium Chair of Calcium Signaling at American Chemistry Society Southeastern Regional Meeting, GA, November, 03.
41. Department of Biochemistry, University of Virginia Technology, Blacksburg VA, Oct., 2003
42. Department of Pharmacy, Emory University, School of Medicine, Atlanta, GA, Oct.20, 2003.
43. Department of Pharmacology and Toxicology, Medical College of Georgia, Augusta, GA. 2003.
44. Gordon Conference on Biomineralization, NH, July 8-15, 2004.
45. Harvard medical School, Boston, August 16, 2004
46. Department of Pharmacology, John Hopkins University, Baltimore, October 13, 2004.

### **Student and Postdoctoral Associates, Past and Present:**

- 6 Postdoctoral Research Associates
- 10 Current Ph.D. Graduate Students and Ph.D. Graduates
- 17 Master Graduate Students
- 3 Non-degree/Postgraduate
- 24 Undergraduate Research Assistants
- 3 Technicians

## Atlanta High Field NMR Facility

Varian Inova 600 MHz

$^1\text{H}\{^{15}\text{N}-^{31}\text{P}\}$  PFG indirect detection triple resonance 5 mm probe.

$^1\text{H}\{^{13}\text{C}/^{15}\text{N}\}$  PFG triple resonance 5 mm probe.

Varian Inova 500 MHz (NSF BIR-9214443)

$^1\text{H}\{^{13}\text{C}/^{15}\text{N}\}$  PFG triple resonance 5 mm probe.

$^{15}\text{N}-^{31}\text{P}$  (50-202 MHz) broadband 5 mm probe.

$^1\text{H}$  5 mm probe.

Varian Unity+ 300 MHz

$^1\text{H}/^{19}\text{F}/^{13}\text{C}/^{31}\text{P}$  quadruple tuned 5 mm probe.

Varian VRX400 (1986) with a Sun workstation; software matches that of the Unity+ series

$^1\text{H}/^{19}\text{F}$  5 mm probe.

$^{15}\text{N} - ^{13}\text{C}$  broadband 10 mm probe.

( $^{15}\text{N} - ^{13}\text{C}$ ) switchable 5 mm probe.

## Optical Spectrometers

Cary 2200, 3E and 4 ultraviolet-visible spectrometers.

Shimadzu 3101PC ultraviolet-visible-near infrared spectrophotometer.

One Shimadzu 2401PC and three Shimadzu 1601PC ultraviolet-visible spectrophotometers.

Perkin-Elmer SpectrumONE, 2000 and Paragon 1000 PC Fourier-transform infrared spectrophotometers.

Hitachi-Perkin Elmer MPF44a and SLM-8000C spectrofluorimeters.

Photon Technology International QM1 fluorescence spectrophotometer.

JASCO J-600 and J-710 circular dichroism spectrophotometers.

## Microscopy Facility

Leica s420, LEO 1450vp SEMS, and LEO 906e TEM electron microscopes.

Zeiss 510 Laser Scanning Microscope with Ti-Sapphire laser for multiphoton excitation.

Zeiss 510 Laser Scanning Microscope with ultraviolet laser.

## Other Analytical

Microcal Inc. batch and scanning microcalorimeters.

Perkin-Elmer 2400 Series II C,H,N organic elemental analyzer.

# Major Equipment Inventory

## Preparative Biology

Three Beckman L8-80 ultracentrifuges with rotors (Type 35, 45Ti, two 70Ti, 80Ti, VTi50, two VTi80, SW25-1, three SW28, SW50 and SW41).  
lyophilizers.

## DNA and Protein Facility

### *DNA*

Applied Biosystems 381A DNA Synthesizer, single column, 0.2 mmole.  
Applied Biosystems 392 DNA Synthesizer, dual column, 40 nmole.  
MilliGen/Biosearch Cyclone+ DNA Synthesizer.  
Beckman DNA Synthesizer Oligo 1000M.  
LKB-Pharmacia Gene Assembler+ DNA Synthesizer with an LKB FPLC.  
Li-COR 400L DNA Sequencer.  
Applied Biosystems 373A DNA Sequencer.  
FUGI Phosphorimager.  
Photodyne shortwave UV automatic X-ray film developer.  
ABI Catalyst 800 Molecular Biology Lab Station.

### *Peptides/Proteins*

Applied Biosystems 431A and 432A Peptide Synthesizers.  
Beckman LF3200 Protein Sequencer single cart with a Beckman HPLC 125S solvent molecule and 166 UV detector and an IBM P/ACE 5500 Series Capillary Electrophoresis.  
Biosys 2000 Protein Purification System.  
Beckman Amino Acid Analyzer with a Beckman HPLC 125S solvent module and a 166 detector.

## Fermentation Facility

130-1 Brunswick fermentator.  
New Brunswick Scientific Mobile Plant Fermentator with a NESLAB Coolflow CFT-7S Refrigerated Recirculator continuous centrifuge.  
The Center for Metalloenzyme Studies fermentation plant at the University of Georgia is also available.

## **STUDENTS AND POSTDOCTORAL ASSOCIATES, PAST AND PRESENT**

### **Research Scientists and Postdoctoral Fellows**

Dr. Wei Yang	2001 – present	Research Scientist
Dr. Yiming Ye	2001 – present	Research Scientist
Dr. Jin Zou	2002 – present	Research Scientist
Dr. Jianhua Yang	2003 – present	
Dr. Shunyi Li	2004 – present	
Dr. Mingshen Wang	2002 – 2003	

### **Ph.D. Graduate Students**

Anna Wilkins	1999 – present	Ph.D. Candidate	Biochemistry, NIH Predoctoral Fellowship
April Ellis	2000 – present	Ph.D. Candidate	Biochemistry, AHA Predoctoral Fellowship
Hsiau-wei Lee	2000 – present	Ph.D. Candidate	Structural Biology, MBD Predoctoral Fellowship
Lisa Jones	2001 – present	Ph.D. Candidate	Biochemistry, GANN Predoctoral Fellowship
Yubin Zhou	2004 – present	Ph.D. Student	Biochemistry
Susan Fu	2004 – present	Ph.D. Student	Biocomputer Science, P20 Fellowship
Ning Chen	2004 – present	Ph.D. Student	Biochemistry
Wei Yang	1997 – 2001	Ph.D. (Biology)	
Yiming Ye	1998 – 2001	Ph.D. (Biochemistry)	
Michelle Pu	1998 – 1999		

### **M.S. Graduate Students**

Ning Chen	2003 – present	
Michael Kirberger	2003 – present	
Angela Holder	2004 – present	
Medina S. Jackson	2004 – present	
Yan Xiao	2004 – present	
Aayala Gayatri	2003 – 2004	M.S.
Meredith Pyle	2003 – 2004	M.S.
Sarah Shealy	2000 – 2003	M.S.
Amy Carroll	2000 – 2001	M.S.
Leanne Isely	2000 – 2001	M.S.
Hsiau-wei Lee	1999 – 2000	M.S. (Awarded for best poster presentation)
Anna Wilkins	1998 – 1999	M.S. (Awarded for best poster presentation) (Awarded for excellence in teaching)
EL-Hadji Sarr	1998 – 1999	M.S.
Haidong Yang	1996 – 1998	M.S.
Curt Coman	2000 – 2001	
Tom Tsai	1997 – 1998	
Gordon Bivens	1999 – 2000	

## **STUDENTS AND POSTDOCTORAL ASSOCIATES, PAST AND PRESENT**

### **Undergraduate Students**

Julian Johnson	2004 – present (Minority Student supported by the Bridge Program)
Thanh K. Quach	2004 – present (Minority Student supported by the Bridge Program)
Daniel Spratt	2004 – present
Kendra Hubbard	2004 – present (University Fellowship, minority)
Alice Luo	2004 – present (AURA Fellow, Institute of Georgia Technology)
Dorinda Nelson	2003 – present (Minority Student supported by the Bridge Program)
Cedrick Daphney	2003 – 2004
Roy Ayiteyfi	2002 – 2003 (McNair Fellowship for minority student)
Shealey Basse	2002 – 2003 (McNair Fellowship for minority student from UGA)
Michael Kirberger	2001 – 2003
Angela Holder	2001 – 2003
Shane Johnson	2001 – 2003
Onome Swader	2001 – 2003 (McNair Fellowship for minority student)
Timethia Bonner	2001 (NSF-sponsored minority research for Tuskegee Univ.)
Amy Carroll	1998 – 00 (honors and distinction in research, 2nd Prize awarded for oral presentation at Regional ACS meeting)
Annie Lin	1998 – 00
April Ellis	1999 – 00 (distinction in research)
Payal Shah	1999 – 00
Hsiau-wei Lee	1998 – 99 (distinction in research)
Mark Kats	1997 – 98 (Georgia Institute of Technology)
Christina Nguyen	1997 - 98 (honors and distinction in research)
Anna Wilkins	1998
Chris Morley	1998
Trung Tran	1997

### **Non-Degree/postgraduates**

Annie Lin	2000
Amy Gawthrop	2002
Sangeeta Dave	2002

### **Technicians**

Xiu-qin Zhou	2001
Qian Li	2002
Cedrick Daphney	2003