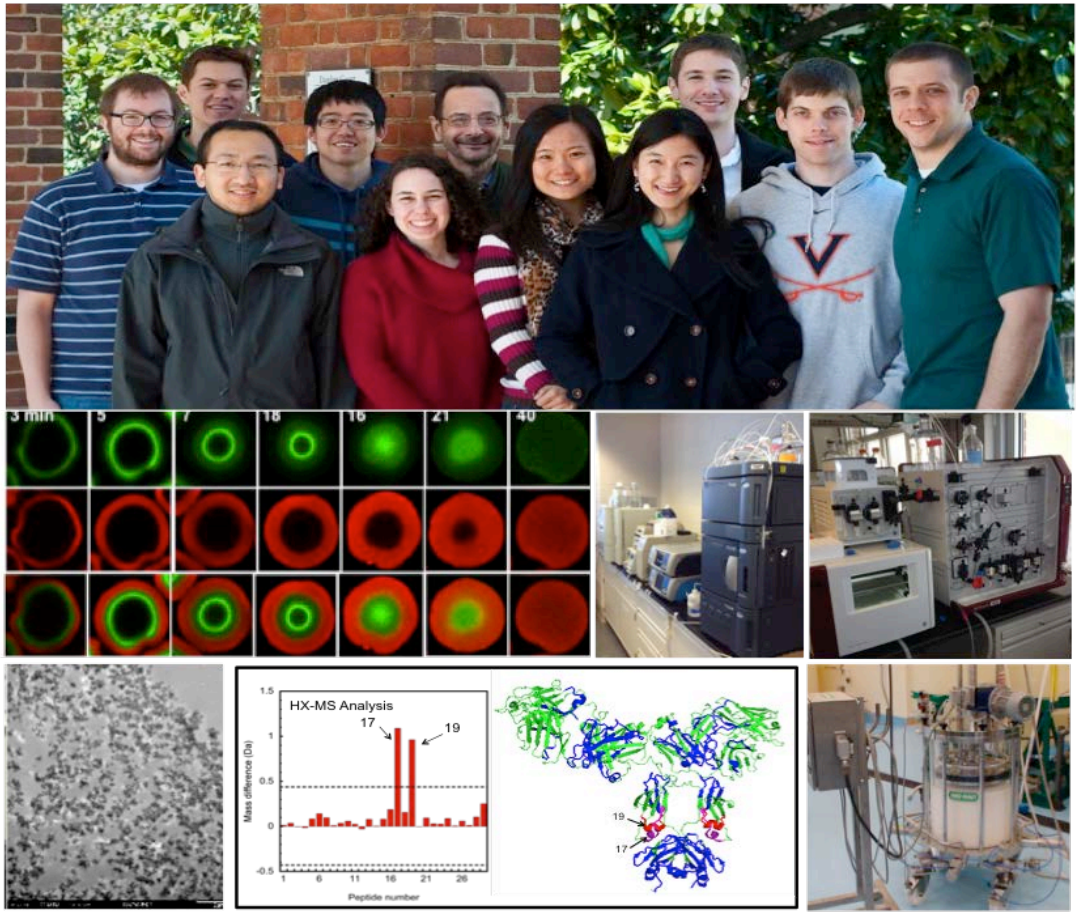
Bioseparations Engineering



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"The goal of our work is to improve biopharmaceutical production by developing the science basis to fundamentally understand chromatographic purification of biomolecules at manufacturing scale and achieve Quality by Design."

Our research group employs experimental and theoretical engineering approaches to investigate chromatographic separation problems and develop new materials and processes for bioseparation applications. We are especially interested in studying the relationship between absorbent characteristics, biomolecular structure, and mass transfer and in the optimization of process chromatography for the recovery, separation, and purification of biomolecules. Our current projects are sponsored by: Ajinomoto, Bio-Rad Laboratories, Bristol-Myers Squibb, MedImmune, Merck & Co., Inc., NSF Pfizer, and the NIH Biotechnology Training Program at the University of Virginia.

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Bioseparations Research

The emphasis on our work is on the downstream processing of biotechnology products. Our efforts are devoted to:

1. The development of physical and mathematical models to describe and optimize chromatographic processes for the recovery, separation, and purification of biopharmaceuticals at manufacturing scale.
2. The development of novel advanced materials for bioseparations including large-pore particles, gel-composite media, and polymer-grafted ion exchangers for high performance and high throughput protein separations. We are especially interested in polymer hydrogels and polymer grafted materials as separation media since these materials can be synthesized with a range of properties desirable for protein chromatography.
3. Studies on protein transport in ion exchangers using a variety of macroscopic and microscopic techniques with the goal of gaining a fundamental understanding of equilibrium and transport processes. We are studying the fundamental relationships between polymer properties and partitioning and diffusion phenomena of proteins in order to develop criteria for optimum design of the separation medium.
4. Understanding protein-surface interactions in chromatographic separations and their effects on protein stability, unfolding and aggregation. We use Hydrogen-deuterium exchange mass spectrometry (HX-MS), CD spectroscopy, confocal laser scanning microscopy (CLSM), infrared spectroscopy, and other biophysical tools to investigate these interactions.
5. Understanding the factors that affect the purification of virus like particles and other large bioparticles such as virus. We are collaborating with Merck & Co., Inc. to understand processes used to purify HPV-VLP for use as vaccines. We focus especially on the relationship between the physical and chemical properties of the chromatographic stationary phase, the biophysical properties of the VLPs, and the process performance. Other work is on the purification of viral vectors for gene therapy applications.

Educational Outreach

Our laboratory offers an annual short course in protein chromatography aimed at downstream processing professionals. The course includes both lectures and laboratory components and provides an invaluable opportunity for our research groups to interact with industry while providing an important educational service to the bioprocessing community.

RECENT RESEARCH DEVELOPMENTS

- Carta, G., Jungbauer, A., "Protein Chromatography - Process Development and Scale-up", Wiley-VCH, 2010.
- Guo, J., Carta, G., "Unfolding and Aggregation of Monoclonal Antibodies on Cation Exchange Columns: Effects of Resin Type, Load Buffer, and Protein Stability", J. Chromatogr. A, 1388 (2015) 184.

RECENT GRANTS

- NSF – Integrated Program for Conformational Effects in Protein Chromatography
- MedImmune – Competitive Binding and Resolution of Native and Deamidated Monoclonal Antibodies
- Merck & Co., Inc. – Understanding the Chromatographic Processing of Recombinant HPV Vaccine
- BMS – Integration of Modeling and HTS for Efficient Design & Optimization of Bioprocess Chromatography

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