

**Short Course 1 – Saturday, June 20 @ 9:00am-4:00pm**  
**Two-dimensional Liquid Chromatography:**  
**Principles, Instrumentation, Method Development, and Applications**

**Instructors: Prof. Dwight R. Stoll, Gustavus Adolphus College**  
**Dr. Mark R. Schure, Kroungold Analytical, Inc.**

In 2DLC, sample components are fractionated by two different columns utilizing different retention mechanisms. To achieve successful 2D resolution of complex sample components, dissimilar (orthogonal) retention mechanisms are required to effectively spread the peaks throughout the available separation space.

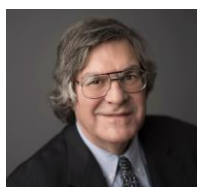
In this course we will discuss in detail:

- Theory of 2DLC, from a practical point of view
- Instrumentation, including commercially available instruments
- Method development across a wide variety of sample types
- Applications to lipids, peptides, proteins, small and large molecule pharmaceuticals, biological extracts, industrial polymers, and surfactants
- Helpful insights that are important for achieving good results in the lab

Students are expected to be familiar with HPLC.

Those who take this course will learn background information essential to understanding the technique and achieve practically useful results with commercial instrumentation. Many aspects of 2DLC are shared with one-dimensional HPLC such as column technologies, pumps, solvent systems, and matching the detector. However, 2DLC has some issues which are not present in one-dimensional HPLC, and these will be explained in detail so that course participants will have this knowledge prior to starting method development. We will also explore the suitable instrumentation for 2DLC, and how to process data external to the acquisition software. Applications of comprehensive 2DLC will be shown for complex industrial and biological samples, as well as simpler applications such as column switching, target peak purity investigation, and biopolymer analysis using commercial two-dimensional chromatographic instruments.

#### **Instructor Bios:**



Mark Schure has worked in separation science for over 40 years in industry and academics. He is presently the Chief Technology Officer at Kroungold Analytical, a consulting firm he started in 2012. Dr. Schure is Adjunct Professor in the department of Chemical and Biomolecular Engineering at the University of Delaware; a position he has had for over 20 years. He has published over 120 papers, 4 patents and recently edited the book "Multidimensional Liquid Chromatography." His scientific interests include the fundamental separation science of complex molecules, polymers and colloids, colloid chemistry, computational materials science and all aspects of solving large-scale chemical and physical problems with computers. He has received many awards including the Arthur Doolittle award from the American Chemical Society, the Northeastern University Distinguished Alumni Lecture award, the Douglas Leng award from The Dow Chemical Company, the Eastern Analytical Symposium award in separation science, the L. S. Palmer award from the Minnesota Chromatography Forum and in 2015 he received the Stephen Dal Nogare award and the Uwe D. Neue award.



Dwight Stoll is Professor at Gustavus Adolphus College, where he teaches quantitative and instrumental analysis courses and is currently co-chair of the Chemistry Department. Active research projects in his laboratory touch upon most aspects of multi-dimensional separation methodologies, including optimization strategies, characterization of selectivity in reversed-phase HPLC, instrument development, and applications in biopharmaceutical analysis. Dwight is the author or co-author of 64 peer-reviewed publications and four book chapters in the area of separation science, is a named co-inventor on five patents, and has instructed numerous short courses in two-dimensional liquid chromatography. In 2011 he was the recipient of *LCGC's Emerging Leader in Chromatography Award*. In 2014 he was named to *The Analytical Scientist's* list of 'Top 40 Under 40' analytical scientists. In 2017 he received the *Georges Guiochon Faculty Fellowship*, and was recognized with an *Agilent Technologies Thought Leader Award*, which will support research in his laboratory on the development of 2D-LC methodologies for biopharmaceutical analysis.

**Short Course 2 – Saturday, June 20 @ 9:00am-4:00pm**  
**Practical LC-MS/MS Method Development for Small Molecules**

**Instructor: Dr. Perry G. Wang, LC-MS Expert**

This course offers practical training for intermediate-level scientists and focus on LCMS/MS method development. It will take the participants step-by-step through the concepts and techniques to develop LC-MS/MS methods. The emphasis is on practical issues associated with developing LC-MS/MS methods for small molecules. It also emphasizes problem-solving skills with examples encountered in the analytical fields. This course will provide the participants with an updated overview and a solid working knowledge of LC-MS/MS. The participants will learn useful theoretical concepts, instrumental fundamentals and operating principles. After this course, the participants will be able to independently develop their own LC-MS/MS methods. New technologies and techniques, such as monolithic chromatography and hydrophilic interaction liquid chromatography (HILIC) will be presented. Some principal validation concepts will be introduced.

**Who Should Attend:** This one-day course is intended for analytical chemists, supervisors, lab managers, and researchers using LC-MS. It will benefit the scientists ranging from college graduates to professionals in the analytical field.

#### TOPICS

1. Introduction and Overview – History of chromatography · Introduction of high performance liquid chromatography · Introduction of mass spectrometry
2. Key Concepts – Retention time (tR) · Retention factor (k') · Separation factor ( $\alpha$ ) · Column efficiency (N) · Chromatographic resolution (R) · pKa/pKb of analytes · van Deemter Equation · Fundamentals of mass spectrometry · Atmospheric pressure ionization (API) in mass spectrometry · Common ionization modes: ESI, APCI and APPI · Mass analyzers: quadrupole, time of flight, ion trap and orbitrap · Mass resolution and mass accuracy · Matrix effects
3. What you can learn from the course – What kind of columns should be selected? · How column physical property affects the resolution · How column chemical property affects the resolution · How pH affects the separation · How to transfer HPLC methods to UHPLC/UPLC methods · Which mode should be selected – isocratic or gradient · How to select the best solvents for LC-MS · How to optimize a gradient profile · Separation mechanism: reversed-phase or HILIC or normal-phase · Mobile phase selection and organic modifiers · How pKa/pKb affect separation · How to eliminate and compensate matrix effects of MS · Validation consideration
4. Operating Parameters and Column Selection – Flow rate · Gradient time · Column temperature (T) · Packed columns (support type, dimensions, particle size and pore size) · Monolithic columns · HILIC columns
5. Mass spectrometer (MS) – Fundamental – charged species, mass resolution and mass accuracy · What kind of ionization should be selected – ESI, APPI or APCI · Single and triple quadrupole, TOF, Ion trap and Q-exactive · How to develop an MS and MS-MS method · How to perform a qualitative and quantitative analysis
6. Method Development Approaches – Finding or estimating pKa or pKb of the analytes · Defining method type (reversed phase or normal phase or HILIC) · Estimating buffer pH · Scouting gradient to get the first chromatogram · Fine-tuning and optimizing the method – solvent type and strength
7. Method Validation – Accuracy · Precision · Linearity · Weighting factors
8. Special Topics – Monolithic chromatography · Hydrophilic interaction liquid chromatography · Core-shell technology

#### Instructor Bio:



Dr. Perry G. Wang worked in the pharmaceutical and medical-device industry from 2000 to 2008. He received his Ph.D. degree at Oregon State University. Dr. Wang currently works at FDA as a chemist. His expertise in the pharmaceutical field focuses on high throughput drug analysis and validation by LC-MS. He prepares and teaches this course in his own capacity but not as an employee of the FDA. He has been invited to teach this course at HPLC since 2012, at EAS since 2014 and at PittCon since 2006. In addition to over twenty peer-reviewed publications, Dr. Wang has edited and co-edited five books: *High Throughput Analysis for Food Safety* (ISBN-10: 1118396308), John Wiley & Sons Inc., 2014. *Counterfeit Medicines* (ISBN: 978-1-906799-08-3) ILM Publications, 2012. *Hydrophilic Interaction Liquid Chromatography and Advanced Applications* (ISBN: 978-1-4398-0753-8) CRC Press, 2011. *Monolithic Chromatography and Its Modern Applications* (ISBN: 978-1-906799-03-8) ILM Publications, 2010. *High-Throughput Analysis in the Pharmaceutical Industry* (ISBN: 978-1-4200-5953-3) CRC Press, 2008.

**Short Course 3 – Saturday, June 20 @ 9:00am-4:00pm**  
**Analysis and Characterization of Oligonucleotide Therapeutic Drugs**

**Instructor: Dr. Claus Rentel, Ionis Pharmaceuticals**

This course will provide an overview of analytical techniques used for drug development of oligonucleotide therapeutics. Methods used for release and stability testing of recently approved antisense drugs will be presented including their development, validation and use in a quality control laboratory. Characterization tools employed to establish structure and properties of oligonucleotide drugs will be described, and approaches for the structural elucidation of oligonucleotide impurities covered. Expectations of regulatory agencies like FDA and EMA regarding testing and characterization of therapeutic oligonucleotides will be addressed.

**Instructor Bio:**



Claus Rentel has more than 20 years of experience in quality control, analytical development and method validations. He has extensive expertise in the development of oligonucleotide therapeutics in regard to specifications, testing of starting materials and reagents, drug substance intermediates, drug substance, drug product and toxicological samples, as well as validation of IT quality systems. He has been responsible for the CMC drug substance section of IND filings for more than 40 oligonucleotide therapeutics, and participated in the NDA filings for KYNAMRO® (mipomersen), SPINRAZA™ (nusinersen), WAYLIVRA® (volanesorsen), and TEGSEDI™ (inotersen). Claus is currently Executive Director, Analytical Development and Quality Control at Ionis Pharmaceuticals, Inc., Carlsbad, California. Prior to joining Ionis in 2001 he worked in Quality Control and Special Analytics at CarboGen Laboratories AG, Aarau, Switzerland. He received his Ph.D. (summa cum laude) from the University of Tübingen, Germany.

**Short Course 4 – Sunday, June 21 @ 9:00am-12:00pm**

**(u)HPLC Method Development**

(Focusing on Stability-Indicating Assays)

**Instructor: Dr. Michael W. Dong, MWD Consulting**

This 3-hour intermediate course reviews best practices, short cuts, and tricks-of-the-trade to help pharmaceutical and other scientists to become more successful in developing effective HPLC methods (focuses on potency and ICH-compliant stability-indicating assays of pharmaceuticals) using a 3-pronged method template and universal generic gradient method(s) approaches.

**Who Should Attend:** This course is intended for analysts, managers, and researchers using HPLC in the pharmaceutical laboratory and other industries wishing to learn how to develop HPLC methods quickly and more effectively. A fundamental understanding of HPLC is assumed, and some practical hands-on HPLC and method development experience is highly recommended.

**Agenda: (u)HPLC Method Development**

**A. Overview and Back to the Basics**

- Why focus on stability-indicating assays of pharmaceuticals?
- Why gradient RPC with UV detection and acidic mobile phases?
- Some HPLC method development insights...
- The Traditional Approach *according to Snyder, Kirkland and Glajch*  
Steps in traditional method development, Scouting gradient and getting the first chromatogram, method fine-tuning and optimization (Solvent strength/type, pH, buffer/additive, F, T,  $t_R$ ), Case studies for method development of a phase 0 method for a new chemical entity
- General method development strategy, forced degradation studies to demonstrate method specificity, automation screening systems, and software tools.

**B. The 3-Pronged Template Approach for Rapid Method Development**

- Fast LC isocratic methods for potency or performance assessment, generic broad-gradient methods, Multi-segment gradient methods for ICH compliant stability-indicating assays of complex molecules, case studies of multi-chiral drugs and complex products with multiple APIs, references

**C. A Modern Universal Generic Gradient Method(s):**

- Introduction of a universal generic gradient method(s), method is capable of peak capacities of 100-300 in 2 to 6 minutes, Rationales of selection of column and operating conditions (CSH, SPP,  $t_R$ ), method adjustments, Case studies for cleaning verification of multiple NCEs, purity assays including compounds with multiple chiral centers.

**Instructor Bio:**



Dr. Michael W. Dong is a principal consultant in MWD Consulting, focusing on consulting and training services on HPLC, pharmaceutical analysis, and drug quality. He was formerly Senior Scientist in Analytical Chemistry and Quality Control at Genentech, Research Director at Synomics Pharma, Research Fellow at Purdue Pharma, and Senior Staff Scientist at Applied Biosystems/Perkin-Elmer. He holds a Ph.D. in Analytical Chemistry from the City University of New York and has 120+ publications, including a bestselling book on chromatography (HPLC and UHPLC for Practicing Scientists, 2<sup>nd</sup> Ed., Wiley, 2019). He is an advisory board member of LCGC magazine, American Pharmaceutical Review, and Chinese American Chromatography Association. He has been a columnist of "Perspectives of Modern HPLC" for LCGC North America since 2013. Recommended Textbook: M. W. Dong, HPLC and UHPLC for Practicing Scientists, 2<sup>nd</sup> Ed., Wiley, Hoboken, New Jersey, 2019.

**Short Course 5 – Sunday, June 21 @ 9:00am-12:00pm**  
**Contributions of LC and LC/MS to Characterize Protein Glycosylation**

**Instructor: Prof. Ron Orlando, University of Georgia, Athens, GA and GlycoScientific, LLC**

Glycosylation is one of the most common post-translational protein modifications in eukaryotic systems, with estimates that 60-90% of all mammalian proteins are glycosylated at some point during their existence and virtually all membrane and secreted proteins are glycosylated. For many years, observations of abnormal glycosylation in virtually all types of human cancers have identified the potential of using glycan markers in either a diagnostic or a prognostic manner. The glycosylation on recombinant protein therapeutics is also known to have significant effects on pharmacokinetics, impact on pathways of immune stimulation, and to have direct effects on glycoprotein structure and biophysical properties. Hence, quantification of glycoprotein glycans plays important roles from the discovery of new diagnostic/prognostic markers to the development of therapeutic agents, to basic understanding of cellular physiological controls. High resolution separations methods are central to the analysis of glycoproteins and their glycans. This workshop will focus on biochemical and analytical approaches to define glycan structures, and to measure the quantities of such glycans. Emphasis will be placed on the use of liquid phase methods, particularly HPLC methods, which have emerged as popular tools for analysis of glycoproteins, at the levels of intact glycoproteins, proteolytic fragments (glycopeptides), and released glycans. The Lecturer will share examples from the literature and from his personal experience on the use of the variety of methods required to address glycan changes on both native and recombinant glycoproteins.

**Instructor Bio:**



Professor Orlando is a leading expert in the analysis of glycoproteins by liquid chromatography-mass spectrometry. Ron has over 35 years of experience with mass spectrometry, 30 of these years focused on the identification/characterization of proteins and their post-translational modifications with MS. He has co-authored over 150 publications in peer-reviewed journals, has given over 100 invited lectures at various conferences, and has served on over 40 NIH review panels. Ron has organized and taught short courses on the Analysis of Glycoproteins by Mass Spectrometry at meetings of the American Society for Mass Spectrometry (ASMS), HPLC, and the International Symposium and Exhibit on the Separation of Proteins, Peptides & Polynucleotides (ISPPP). He is the

Editor-in-chief of the Journal of Biomolecular Techniques (JBT). He founded the ABRF Glycoprotein Research Group and am frequently invited to give lectures on my mass spectrometry-based research. He directs the Mass Spectrometry Laboratory at the Complex Carbohydrate Research Center.

**Short Course 6 – Sunday, June 21 @ 9:00am-12:00pm**  
**Introduction to Capillary Liquid Chromatography**

**Instructors: Dr. Justin Godinho, Advanced Materials Technology, Inc.**  
**Prof. James Grinias, Rowan University**

This course is designed to introduce those familiar with analytical scale HPLC to capillary (or “nano”) liquid chromatography. Although both techniques are based on the same fundamental principles, capillary LC has a number of distinct advantages and challenges that will be detailed. Commercial instrument options, as well as the basics of preparing your own capillary LC columns, will be described. Because one of the most prominent uses of capillary LC is its coupling to mass spectrometry for complex biological sample analysis, special attention will be given to this important area. Both academic and industrial researchers will be able to apply the information gained through this course to overcome the challenges faced when using this essential technique. Course Highlights: After completing this course, participants will be able to: Understand the differences between analytical and capillary scale LC. Describe the fundamentals of capillary LC column preparation. Determine the best detection modes for a given application. Explain the advantages of coupling capillary LC with mass spectrometry and how to approach method development using capillary LC-MS. Identify best practices for the use of capillary LC to solve analytical challenges.

**Instructor Bios:**



James Grinias is Assistant Professor in the Department of Chemistry & Biochemistry at Rowan University in Glassboro, NJ. Dr. Grinias has a number of research interests focused on chemical separations and microfluidics, both at the fundamental level and for the analysis of biological systems. He was previously granted fellowships from the National Science Foundation for his graduate work at the University of North Carolina at Chapel Hill (where he was also a member of the Royster Society of Fellows) and from the National Institutes of Health for his postdoctoral research at the University of Michigan. Dr. Grinias' graduate research on liquid chromatography also led to him being named a Csaba Horváth Young Scientist award winner at the 2013 HPLC Conference, a top award for young researchers in the field. At Rowan, he teaches courses in general, analytical, and bioanalytical chemistry while also conducting research on UHPLC column performance and instrument miniaturization.



Justin Godinho is a research scientist at Advanced Materials Technology, Inc. in Wilmington, Delaware. Dr. Godinho's research interests largely focus on the fundamentals of chromatographic separations in capillary ultrahigh pressure liquid chromatography columns. His research has explored methods of capillary column packing, column characterization and column implementation. He has been involved in collaborations studying the microstructure of the packed bed and how it relates to column performance. During his postdoctoral research at the University of North Carolina at Chapel Hill he studied electrophoretic separations in microfluidic devices. These devices were coupled with mass spectrometry for analyte detection. Currently, Dr. Godinho is researching chromatographic materials and methods at Advanced Materials Technology.

**Short Course 7 – Sunday, June 21 @ 9:00am-12:00pm**  
**Field-Flow Fractionation (FFF) with Light Scattering Detection**

**Instructor: Prof. Kim R. Williams, Colorado School of Mines (CSM)**

This short course covers the fundamentals of field-flow fractionation (FFF) including the basic theory, instrumentation, and practical aspects as well as the recent applications in macromolecules and particulate materials. *The primary focus is on asymmetrical flow field-flow fractionation (AF4) with light scattering detection.* Sedimentation and thermal FFF will be introduced. Specific topics include the following:

- Introduction to FFF
  - Basic theory
  - Different fields in FFF and instrumentation
  - Different modes of FFF (normal and steric)
- FFF capabilities (polymers, proteins, nanoparticles, bioparticles, cells)  
When to use sedimentation, thermal, or asymmetrical flow FFF ?
- On-line detection methods (UV, MALS-dRI, -DLS)  
Basic light scattering and considerations for on-line use
- Applications of AF4-MALS-dRI, -DLS
- Method development
  - Selecting starting FFF conditions/sample preparation
  - Considerations in selecting carrier liquid
  - Membranes
  - Measuring sample overloading and sample recovery
- Trouble shooting (most likely problems and how to resolve)

Target audience: Analytical chemists and all others working in separation science.

**Instructor Bio:**



Kim R. Williams (aka S. Kim Ratanathanawongs Williams) is a Professor of Chemistry at the Colorado School of Mines (CSM). Before joining the faculty at CSM in 1997, she worked with the late Professor J. Calvin Giddings as a postdoctoral and subsequently as the Assistant Director of the Field-Flow Fractionation Research Center at the University of Utah. She holds a B.Sc. in Chemistry from McGill University and a Ph.D. in Analytical Chemistry from Michigan State University. Dr. Williams' research area can be broadly classified as separation science of nanometer to beyond micrometer-size analytes. This includes a focus on developing field-flow fractionation-based approaches with light scattering and mass spectrometry as a platform to simultaneously separate and characterize complex macromolecular, colloidal, and particulate systems. Her research group works with complex polymers, protein aggregation relevant to biotherapeutics, nanoparticle systems associated with renewable energies, and bioparticle systems. Dr. Williams has published numerous FFF papers and book chapters and is the editor of a book titled *Field-Flow Fractionation in Biopolymer Analysis* (2013). She has taught FFF workshops worldwide and currently serves as the co-chair of the International Field-Flow Fractionation Steering Board. Website: <https://chemistry.mines.edu/project/williams-kim/>

**Short Course 8 – Sunday, June 21 @ 9:00am-12:00pm**  
**Chiral Liquid Chromatography**

**Instructor: Prof. Bezhan Chankvetadze, Tbilisi State University**

In this course, after a short introduction to the basics of stereochemistry, the analytical and preparative scale separation of enantiomers and the currently available technologies for achieving this goal will be reviewed. After comparing different synthetic and separation strategies, the latter will be discussed in more detail with emphases on liquid phase techniques, such as high-performance liquid chromatography (HPLC) and super-/sub-critical fluid chromatography (SFC). All currently available modalities of liquid-phase separation techniques for analytical and preparative scale separation of enantiomers will be reviewed with focus on various chiral selectors and stationary phases and their performance from the viewpoint of analyte coverage, applicability in various separation mode(s) and their suitability for analytical and preparative purposes, respectively. The most widely used chiral selectors will be discussed, such as polysaccharide derivatives, along with the strategy of developing and selecting a promising CS, in combination with the optimal silica support. Modalities of attachment of a chiral selector to the silica surface will be also discussed. CSP preparation will be linked to the chromatographic performance of these materials. Significant attention will be paid to analytical and preparative method development with polysaccharide-based CSPs, enantiomer elution order, kinetics and thermodynamics of separation. Unusual observations will be discussed along with their significance for analytical and preparative-scale method development. Current trends in the field of enantioseparations, such as ultrafast separations, separation of chiral molecules with multiple chiral centers, etc. will be also reviewed [1]. Reference: [1] B. Chankvetadze, Recent trends in preparation, investigation and application of polysaccharide-based chiral stationary phases for separation of enantiomers in high-performance liquid chromatography, Trends in Analytical Chemistry (TrAC), 122 (2020) 115709.

**Instructor Bio:**



Bezhan Chankvetadze is Full Professor for Physical Chemistry and director of the Institute of Physical and Analytical Chemistry at the Tbilisi State University in Tbilisi, Georgia. Between 1991-2005 B. Chankvetadze held research and teaching positions at the Institute of Pharmaceutical and Medicinal Chemistry, University of Münster, Germany and at the Department of Applied Chemistry, Graduate School of Engineering, Nagoya University, Japan. B. Chankvetadze has published over 250 research papers in peer reviewed journals, over 30 review papers and book chapters and holds several patents of the former Soviet Union, USA, Germany and Japan. B. Chankvetadze has published one monograph (Capillary Electrophoresis in Chiral Analysis, Wiley&Sons, Chichester, UK, 1997), co-authored one book (Quantitative Determination of Antiepileptic Drugs in Biological Fluids, Tbilisi University Press, Tbilisi, Georgia, 1993) and edited one multiautored book (Chiral Separations, Elsevier Science, 2001). He has edited and co-edited many special issues of the journals J. Chromatogr. A, Electrophoresis, J. Pharm. Biomed. Anal., and Journal Separation Science on various topics of separation science. B. Chankvetadze has given over 300 presentations as plenary, invited or oral speaker on the international conferences, as well as in industry and academia in fields of chirality, electromigration techniques and separation science. B. Chankvetadze has developed and commercialized in co-operation various companies more than 10 polysaccharide-based chiral stationary phase for liquid-phase separation of enantiomers. He is the Editor of the Journal of Pharmaceutical and Biomedical Analysis (Elsevier, Amsterdam, Netherlands) and a member of the editorial boards of Electrophoresis (Wiley-VCH), Journal of Chromatography A (Elsevier), Journal of Separation Science (Wiley-VCH), Chirality (Wiley), Acta Chromatographica and several other international journals. B. Chankvetadze is the recipient of “Journal of Chromatography Top Cited Article Awards” in 2005, 2006 and 2010, “2006 Belgian Society of Pharmaceutical Science Award of Recognition”, “The Scientist of the Year 2016” award of the Shota Rustaveli National Science Foundation (Georgia), and Csaba Horvath Memorial Award of the Hungarian Chemical Society and Connecticut Separation Science Council (USA) (2017). Prof. B. Chankvetadze is Full Member of the Georgian National Academy of Sciences.



**Short Course 9 – Sunday, June 21 @ 9:00am-12:00pm**  
**Cannabis Analysis**

**Instructor: Mr. Craig Young, Shimadzu Scientific Instruments**

Cannabis products for medical and recreational use are enjoying an unprecedented surge in popularity. Accurate cannabis analysis is required for accurate product labeling in the market place. Since cannabis is often used as medicine, additional analysis is required to protect consumers from potentially harmful microbiological contamination, and chemical residues such as pesticides. This course will cover the basics of cannabis and the industry, as well as the state-of-the-art testing methods currently available.

**Part I. Cannabis and cannabis industry background.**

The cannabis plant and its use and cultivation will be presented. The plant's medical use, growing techniques, and final product formulation will be briefly introduced. The history and current legal status of cannabis will be summarized. As part of this framework, cannabis will be distinguished from hemp. The testing lab industry and the problems which have led to the need for testing will be emphasized.

**Part II. Basic testing for potency, moisture, and microbiology.**

Accurate cannabis potency testing is of the utmost importance for establishing safe and effective dosages, optimizing growing conditions, and preventing fraud in the cannabis industry. High accuracy and high precision methods of cannabinoid determination will be discussed, including HPLC-UV analysis. Since poor moisture control of cannabis often leads to mold and bacteria growth, testing for moisture and microbes are essential, and will be briefly discussed as well.

**Part III. Advanced testing**

Terpenes are responsible for the unique aroma of each cannabis strain. Both gas and liquid chromatographic techniques are available for terpene analysis, and the basic techniques will be described. Pesticide and chemical residue analysis is one of the more challenging requirements for cannabis labs, and relies on liquid and gas chromatography with mass spectrometry. High speed and robust methods for analysis of these substances will be discussed in detail.

**Instructor Bio:**



Craig S. Young received a Master's Degree in Organometallic Chemistry from the University of Utah Department of Chemistry, where he then held a position as organic chemistry lecturer for ten years. He has spent many years as a field-based LC/LCMS Product Specialist for several companies and now serves as HPLC Product Manager for Shimadzu Scientific Instruments in Columbia, Maryland. He has authored numerous papers and technical notes in the field of analytical HPLC and LCMS.

**Short Course 10 – Sunday, June 21 @ 1:00pm-4:00pm**  
**Capillary Electrophoresis with Mass Spectrometry Detection,  
More Than Just a Complementary Tool for LC-MS**

**Instructor: Prof. David D. Y. Chen, University of British Columbia, Vancouver**

LC-MS is currently the most important analytical techniques for many applications in biomedical research and pharmaceutical industry. CE-MS, on the other hand, hasn't seemed to live up to its potential and has only been successfully used by a relatively small number of scientists. The reality though, is not always as it seems. CE technology has quietly been used in the application processes of the majority of the new drugs approved by the US FDA in recent years. With the improvement in the interface technology between CE and MS, the sensitivity and robustness of have been significantly improved, and CE-MS technology is poised to become an increasingly more important tool to be used to push the frontiers of biomedical and pharmaceutical research. The application of CE-MS, including capillary isoelectric focusing directly coupled to mass spectrometry (cIEF-MS) for the analysis of monoclonal antibodies, peptides, and small molecules will be discussed. New development in protein conformer analysis, characterization of in-solution protein structural differences, protein aggregation, and proton activity analysis by hydrogen-deuterium exchange analysis in conjunction with CE based separation, will also be demonstrated.

**Instructor Bio:**



Prof. David Da Yong Chen received his Ph.D. in Chemistry in 1993 from the University of Alberta, where he also received postdoctoral training in Chemistry and the Department of Medical Microbiology and Infectious Diseases. In July 1994, he joined the faculty of the Chemistry Department at the University of British Columbia, where he is currently a Full Professor in the Faculty of Science, as well as an Associate Member of the Department of Anesthesiology, Pharmacology & Therapeutics in the Faculty of Medicine. In December 2013, he was appointed Distinguished Guest Professor at the Jiangsu Collaborative Innovation Center of Biomedical Functional Materials, Nanjing Normal University. Dr. Chen's research interests include

investigation of principles of fluid migration and chemical separation, development of novel separation methods and purification systems, and coupling micro separation systems to mass spectrometry. Dr. Chen was given the 2002 Royal Society of Chemistry (RSC) Award in Analytical Separation Methods, and the 2003 Charles McDowell Award for Excellence in Research, a gold medal given to the most outstanding young scientist at UBC. For his contribution in analytical chemistry, Dr. Chen received the W. A. E. McBryde Medal and the Maxxam Award from the Canadian Society for Chemistry in 2008 and 2015, respectively.

**Short Course 11 – Sunday, June 21 @ 1:00pm-4:00pm**  
**Analytical Characterization of Protein Biopharmaceuticals**

**Instructors: Prof. Davy Guillarme, University of Geneva**  
**Dr. Cinzia Stella, Genentech**

The characterization of therapeutic proteins such as monoclonal antibodies (mAbs) represents a tremendous challenge. This short course will highlight the possibilities offered by all the different modes of chromatography (i.e. RPLC, SEC, IEX, HIC, HILIC) to rapidly and accurately characterize the most important critical quality attributes of protein biopharmaceuticals (e.g., glycosylation, oxidation, deamidation, aggregation, glycation, lysine truncation...). The hyphenation of chromatographic approaches with mass spectrometry as well as the use of 2D-LC approaches will also be covered during the short course. Last but not least, the different levels of analysis of biopharmaceuticals will be discussed, including bottom-up analysis (2-5kDa), middle-up (25-100 kDa), and intact proteins analysis (150 kDa). Finally, some industrial cases studies will be presented.

**Instructor Bios:**



Davy Guillarme holds a Ph.D. degree in analytical chemistry from the University of Lyon, France. He is now senior lecturer at the University of Geneva in Switzerland. He authored more than 230 journal articles related to pharmaceutical analysis. His expertise includes HPLC, UHPLC, HILIC, LC-MS, SFC, SFC-MS, analysis of proteins and mAbs. He is an associate editor of Journal of chromatography B and editorial advisory board member of several journals including Analytical chemistry, Journal of Chromatography A, Journal of Separation Science, LC-GC North America, and others.



Cinzia Stella received her PhD in Pharmaceutical Analytical Chemistry from the University of Geneva (Switzerland), after her Master's Degree in Pharmaceutical Sciences from the University of Pavia (Italy). Following a post-doctoral fellowship at Imperial College London (UK) on Metabolomics funded by Unilever, she held a position at the University of Geneva in the School of Pharmacy, where she was responsible for the development and optimization of protein based pharmaceutical formulations in collaboration with industrial partners. She currently is a Sr Scientist and Team leader at Genentech and she is responsible for the analytical development and control strategy of Early Stage programs in the context of CMC development.

## Short Course 12 – Sunday, June 21 @ 1:00pm-4:00pm Solid-phase Microextraction

Instructor: Prof. Janusz Pawliszyn, University of Waterloo, Ontario

Sample preparation is an often overlooked but extremely important aspect of any analytical method. Solid-phase microextraction (SPME) is a simple, fast, sensitive, and environmentally-friendly equilibrium-based sample preparation technique that allows the integration of sampling and sample preparation steps. Due to these unique features, SPME is considered one of the six “Great Ideas of a Decade” by ACS Analytical Chemistry journal. This course will cover both basic and advanced SPME topics with the focus on the main principles of SPME including thermodynamic and kinetic theory, calibration methods and coupling strategies of SPME to GC-MS and LC-MS. A complete method development strategy will be described and illustrated in detail by real-life examples. A variety of SPME applications in the fields such as forensic, environmental, food and beverage, industrial hygiene and clinical analysis will be presented. The discussion will include the comparison of the performance of SPME to various established methods relevant for particular application. Recent advances in SPME will be highlighted including (1) on-site sampling with thin film SPME (2) the use of SPME for ligand-receptor binding and plasma protein binding studies (3) the use of SPME to perform *in vivo* sampling of freely moving animals (4) automation of SPME in 96-well plate format for applications requiring high-throughput (5) the use of SPME for direct tissue sampling and medical applications and (5) direct coupling to mass spectrometry.

**Target Audience:** The course is targeted at both new and current SPME users. The primary goal of the course is to provide the users of the technique with deeper insight into the main principles of this technique and thus increase their productivity and the quality of analytical results. This course will be of interest to analytical chemists, laboratory supervisors, scientists and industry regulators in the environmental, food and beverage, pharmaceutical, clinical, cosmetic, industrial hygiene and many other fields. The unique features of *in vivo* SPME sampling will be of particular interest to researchers in life sciences.

**Course Outline:** Introduction to SPME · Theoretical principles of SPME · SPME interfaces to analytical instrumentation including MS · Needle trap and thin film microextraction and on-site sampling · Calibration of SPME · SPME method development · Automation of SPME · *In vivo* sampling using SPME · Pharmaceutical, clinical and medical applications of SPME · Food, flavor and fragrance applications of SPME

### Instructor Bio:



The primary focus of Professor Pawliszyn's research program is the design of highly automated and integrated instrumentation for the isolation of analytes from complex matrices and the subsequent separation, identification and determination of these species. The primary separation tools used by his group are Gas Chromatography, Liquid Chromatography and Capillary Electrophoresis coupled to variety of detections systems, including range of mass spectrometry techniques. Currently his research is focusing on elimination of organic solvents from the sample preparation step to facilitate on-site monitoring and *in-vivo* analysis. Several alternative techniques to solvent extraction are investigated including use of coated fibers, packed needles, membranes and supercritical fluids. Dr. Pawliszyn is exploring application of the computational and modeling techniques to enhance performance of sample preparation, chromatographic separations and detection. The major area of his interest involves the development and application of imaging detection techniques for microcolumn chromatography, capillary electrophoresis and micro chip separation devices. Professor Pawliszyn has supervised 50 Ph.D. and 65 MS students and he is an author of over 600 scientific publications and a book on Solid Phase Microextraction. His Hirsch Index (H-index) is 96. He is a Fellow of Royal Society of Canada and Chemical Institute of Canada, editor of *Analytica Chimica Acta*, *Trends in Analytical Chemistry* and a member of the Editorial Boards of *Journal of Separation Science* and *Journal of Pharmaceutical Analysis*. He initiated a conference, “ExTech”, focusing on new advances in sample preparation and disseminates new scientific developments in the area, which meets every year in different part of the world. He received the 1995 McBryde Medal, the 1996 Tswett Medal, the 1996 Hyphenated Techniques in Chromatography Award, the 1996 Caledon Award, the Jubilee Medal 1998 from the Chromatographic Society, U.K., the 2000 Maxxam Award from Canadian Society for Chemistry, the 2000 Varian Lecture Award from Carleton University, the Alumni Achievement Award for 2000 from Southern Illinois University, the Humboldt Research Award for 2001, 2002 COLACRO Medal, 2003 Canada Research Chair, in 2006 he has been elected to the most cited chemists by ISI, in 2008 he received A.A. Benedetti-Pichler Award from Eastern Analytical Symposium, 2008 Andrzej Waksmundzki Medal from Polish Academy of Sciences, 2008 Manning Principal Award, 2010 Torbern Bergman Medal from the Swedish Chemical Society, 2010 Ontario Premier's Innovation Award, 2010 Marcel Golay Award, 2010 ACS Award in Separation Science and Technology, 2011 PittCon Dal Nogare Award, 2012 E.W.R. Steacie Award, 2013 CIC Environmental Research and Development Award, 2013 CIC LeSueur Memorial Award, 2015 Maria Skłodowska-Curie Medal from Polish Chemical Society, 2015 Halász Medal Award from the Hungarian Society for Separation Sciences, 2017 Pittsburgh Conference Analytical Chemistry Award, the 2017 Eastern Analytical Symposium Award for Outstanding Achievements in the Fields of Analytical Chemistry, 2018 ACS Award in Chromatography, 2018 North American Chemical Residue Workshop Excellence Award and 2019 Talanta medal. He presently holds the University Professor, Canada Research Chair and Natural Sciences and Engineering Research Council of Canada Industrial Research Chair in New Analytical Methods and Technologies. B.Sc./Chem.Eng., 1977, Technical University of Gdansk; M.Sc., 1978, Technical University of Gdansk; Ph.D., 1982, Southern Illinois University; PDF., 1984, University of Toronto.

**Short Course 13 – Sunday, June 21 @ 1:00pm-4:00pm**  
**3D Printing in Separation Science**

**Instructor: Prof. Simone Dimartino, The University of Edinburgh**

This short course aims to offer an overview of how 3D printing is impacting the separation sciences in general, and chromatography in particular. 3D printing can seamlessly create bespoke models with complex shapes, using a range of materials, and with resolutions that can reach the submicron-scale. This capability opened a new way to fabricate stationary phases, column housings, filtration elements, extraction units and other devices of relevance to the separation science. This short course will open with an introduction on 3D printing and the main printing techniques of relevance to us. Then, a selection of original research pieces will be presented, demonstrating how separation science is benefitting from 3D printers. Finally, current challenges as well as future opportunities will be discussed. This course should spur additional interest in the area and promote new ideas on how to employ 3D printers in our research.

**Instructor Bio:**



Dr. Dimartino is a Senior Lecturer at the Institute for Bioengineering at the University of Edinburgh, UK. He received his PhD from the University of Bologna (Italy, 2009) followed by a Post Doc at the University of Canterbury (New Zealand). He has been always working on the development of new stationary phases for chromatography, spanning from membranes to monoliths to fibre-based media. He now employs 3D printing methods for the fabrication of chromatography media with perfectly ordered morphology, with specific focus on the design of novel three-dimensional lattices and the development of materials compatible with both 3D printers and chromatographic operations. Dr.

Dimartino's research group is currently transferring methods developed in chromatography to other relevant operations in the biotechnology industry (e.g. biocatalysis and bioreactors) and in chemical engineering (e.g. recovery of heavy metals and CO<sub>2</sub> capture). To date, Dr. Dimartino raised a total of £ 1.5 million research income with projects bridging the industry and government sectors. His research has granted him a number of international awards, including 3 best poster awards in 3 continuous years at the PREP conference series, and the Csaba Horvath Young Scientist Award at HPLC 2016.

To know more about his research please watch:

- Fun Science Communication video ([here](#)), awarded 1st prize at HPLC 2019.
- Interview on the future of 3D printing and chromatography [here](#).

**Short Course 14 – Sunday, June 21 @ 12:00pm-4:00pm**  
**HPLC Operation and Troubleshooting**

**Instructor: Dr. Michael W. Dong, MWD Consulting**

This half-day workshop provides the attendees with an overview of the best practices (standard operating procedures) in HPLC/UHPLC operation including mobile phase and sample preparation for pharmaceutical analysis. Common HPLC and UHPLC maintenance procedures are described together with HPLC troubleshooting strategies illustrated with practical case studies.

**Who Should Attend:** This course is intended for analysts, managers, and researchers using HPLC in the pharmaceutical laboratory and other industries wishing to learn the best practice of HPLC operation, maintenance and troubleshooting. A fundamental understanding of HPLC is assumed, and some practical hands-on HPLC experience is highly recommended.

**Agenda: HPLC Operation and Troubleshooting**

- A. HPLC Operation
  - Safety and Environmental concerns
  - Mobile Phase and Sample Preparation
  - Best Practice in HPLC Operation: Modules, columns and fittings
- B. HPLC Maintenance and Troubleshooting
  - Common (u)HPLC Maintenance Procedures
  - Problem Diagnosis and Troubleshooting Guide
  - Diagnosing and Solving Problems (pressure, baseline, peak, data performance)
  - Case studies

**Instructor Bio:**



Dr. Michael W. Dong is a principal consultant in MWD Consulting, focusing on consulting and training services on HPLC, pharmaceutical analysis, and drug quality. He was formerly Senior Scientist in Analytical Chemistry and Quality Control at Genentech, Research Director at Synomics Pharma, Research Fellow at Purdue Pharma, and Senior Staff Scientist at Applied Biosystems/Perkin-Elmer. He holds a Ph.D. in Analytical Chemistry from the City University of New York and has 120+ publications, including a bestselling book on chromatography (HPLC and UHPLC for Practicing Scientists, 2<sup>nd</sup> Ed., Wiley, 2019). He is an advisory board member of LCGC magazine, American Pharmaceutical Review, and Chinese American Chromatography Association. He has been a columnist of "Perspectives of Modern HPLC" for LCGC North America since 2013. Recommended Textbook: M. W. Dong, HPLC and UHPLC for Practicing Scientists, 2<sup>nd</sup> Ed., Wiley, Hoboken, New Jersey, 2019.

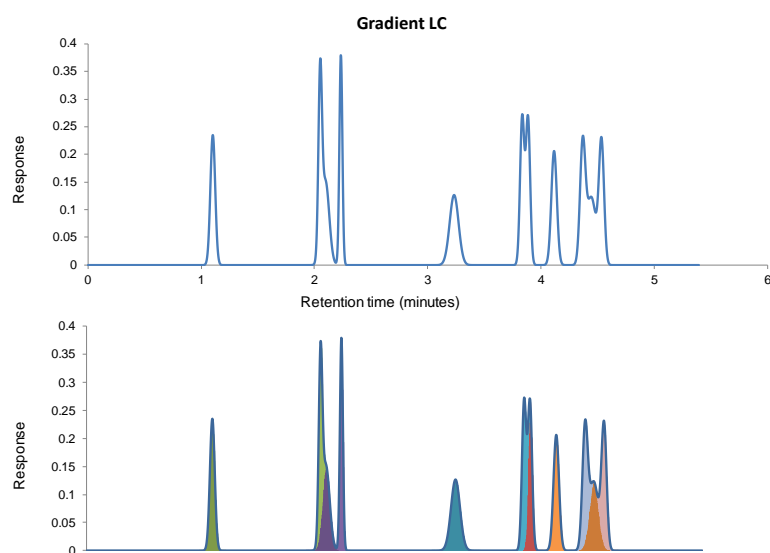
## Short Course 15 – Sunday, June 21 @ 12:00pm-4:00pm Learning Chromatography in Chromatograms

Instructor: Dr. Martin Gilar, Waters Corporation

The course is targeted to medium-to-advanced level students with knowledge of basic chromatographic theory. Attendees should bring a laptop with installed MS Excel (version Excel 2010 or more recent, recommended version Excel 2016, Office 365).

The course attendees will learn about principles of chromatographic modes including reversed-phase, hydrophilic interaction, ion-exchange and size exclusion chromatography. Special emphasis will be given to reversed phase mode. Course attendees will use MS Excel spreadsheets prepared to visualize chromatograms. Attendees will be able to change parameters such as particle size, column length, separation condition, extra column dispersion and others and instantly observe the effects in chromatographic separation. We will cover:

1. Principles of chromatographic separation, isocratic versus gradient elution modes
2. Retention, resolution, peak capacity, band broadening, extra column dispersion
3. Chromatographic behavior of small molecules versus biopolymers
4. Approaches to method development and method transfer.
5. SPE versus LC
6. Chromatographic artifacts of large volume injection, incompatible solvents, etc.



The chromatographic simulators will be able to perform instructor-guided or independent in-silico experiments with real-time generated chromatograms. The students will experiment with parameters such as mobile phase strength, gradient slope, particle size and extra-column band broadening and observe changes in chromatograms: peak widths, heights, and resolution. We will cover simple (2-5 components), moderate (5-12 analytes) and complex (100 peaks – “metabolomic” sample) separation scenarios. Students will learn basic method development strategies.

**Who Should Attend:** Chromatography practitioners, lab personal, students, and LC users who are interested in deeper understanding of chromatographic principles. The course is targeted to medium-advanced students with knowledge of basic chromatographic theory and basic knowledge of MS Excel. We will perform in-silico chromatographic experiments using provided excel spreadsheets.

### Instructor Bio:



Dr. Martin Gilar (\*1966) received his Ph.D. in analytical chemistry from Institute of Chemical Technology in Prague (1996). He spent postdoc years in Hybridon Inc. (1996-1998) and Northeastern University in Boston (1998) developing separation methods for antisense oligonucleotides and fraction collector for DNA molecules. Since 1998 he has worked at Waters Corp. in Milford, Massachusetts, participating in column, sample preparation and instrument research. Dr. Martin Gilar is a Scientific Fellow in the Separation Science Research group at Waters Corporation. He has more than 25 years of experience in the separation sciences, including chromatography, electrophoresis, and mass spectrometry. His research interest is the analysis of biopolymers, and 2D LC. He has published over 55 peer reviewed papers.