

Carlos Alberto Ortega Zuñiga

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EDUCATION

January 2014 – June 2019
University of Puerto Rico,
Mayagüez Campus
PhD. in Applied Chemistry

**August 2011 – Program
completed in December 2013
(Degree awarded in June 2014)**
University of Puerto Rico,
Mayagüez Campus
M.S. in Chemistry

August 2002 – April 2008
University of Cartagena,
Colombia
B.S. in Chemistry

EXPERIENCE

September 2023 – Present

- Rutgers, The State University of New Jersey

Assistant Research Professor (Process Analytical Technology)

Department: Chemical & Biochemical Engineering, School of Engineering

Duties:

- *Conducting advanced scientific research in pharmaceutical engineering and science.*
- *Publishing original findings in esteemed peer-reviewed journals.*
- *Crafting and submitting research proposals guided by the Center's academic vision.*
- *Preparing internal research reports and ensuring clear, timely communication with external partners, collaborators, and sponsors.*
- *Actively participating in and presenting at scientific and technical conferences.*
- *Providing mentorship and academic guidance to undergraduate and graduate students in collaboration with Professor Muzzio.*

December 2019 – August 2023

- Rutgers, The State University of New Jersey

Post-Doctoral Associate (Process Analytical Technology)

Department: Chemical & Biochemical Engineering, School of Engineering

Duties:

- *Perform PAT-related work for funding activities by industrial collaborators and the FDA.*
- *Develop experiments using NIR, Raman, UV, NMR, AAS, and other analytical techniques to monitor the pharmaceutical process in a continuous manufacturing line and batch processes.*
- *Communicate with instrument vendors to test their instruments for pharma projects.*
- *Write technical reports for industry pharma collaborators.*
- *Prepare scientific proposals for the pharmaceutical industry.*
- *Develop a teaching portfolio for industry and academics for knowledge of PAT to new users.*
- *Test new methods for RTRt.*

August 2019 – December 2019

- University of Puerto Rico, Mayagüez Campus

Assistant Professor (Fundamental Organic Chemistry Laboratory)

Department: Chemistry Department.

Duties:

- Led the course QUIM3450L: Fundamental Organic Chemistry Laboratory, aimed at engineering, chemistry, and biotechnology students.
- Developed and implemented innovative teaching methodologies for experimental techniques in Organic Chemistry, including preparing, separating, and purifying organic compounds and spectroscopic methods for compound analysis and identification.
- Collaborated closely with Dr. Luis Morell, course professor for the theoretical component QUIM3450, ensuring an integrated approach to practical and theoretical learning.
- Managed laboratory coordination, which encompassed syllabus design, experiment scheduling, preparation of reagents and waste management for each experiment, supervision of class instructors, and creation of laboratory exams.

September 2019 – November 2019

- IBS Caribe, Inc.

IBS Technical Director-Services, Marketing and Projects Management

Duties: IBS Technical Director-Services, Marketing, and Projects Management employment provide the opportunity to work with selected scientists and engineers in industry and academia to develop selected innovative technologies consonant with company strategies. Keep abreast of new technologies chosen by reading, searching, seminars, and group discussions. Prepares and conducts workshops in spectroscopy and IBS analyzer suppliers. This employment offers an environment to work closely with customers to identify business opportunities in Process Analytical Technology (PAT) for the pharmaceutical industry. Skills that the activities of the work can develop are gaining experience in Total Quality tools, FDA regulations, and Project management skills (ASANA).

June 2017 – April 2018

- Johnson & Johnson - Janssen Ortho LLC – Gurabo, Puerto Rico

Doctoral Practicum (NIR Spectroscopy - Chemometrics)

Department: Process Science and Advanced Analytics.

Duties: The Doctoral Practicum student will perform research, execute process studies related to chemometric analysis, design experiments and technical assessment of spectrophotometric analytical methods, perform analytical investigations, and chemometrics-related duties. Will apply theory and professional concepts to resolve high complexity problems, requiring judgment and decision making. May execute activities in support of product and analytical methods transfer. Determine corrective and preventive actions using the appropriate root cause analysis tools with the team and his supervisor. Develop metrics and trending reports, initiate change controls, execute data analysis, participate in audits and manage projects of medium to high complexity supporting site chemometrics analytical methods transfers in the continuous manufacturing line and the laboratory. Work with other teams to resolve technical issues using sound scientific reasoning and technical expertise.

January 2014 – December 2019

- University of Puerto Rico, Mayagüez Campus

Research Assistant (NIR Spectroscopy - Chemometrics)

Department: Chemistry Department.

Duties: Developed a NIR calibration model for real-time determination of low drug concentration of powder blends within a feed frame. Evaluated the impact on NIR calibration models of physical properties

(powder density and porosity) of powder materials within the feed frame. Developed experiments to assess the effects of spectral preprocessing, spectral region, and the number of samples in calibration and validation sets on NIR calibration models. Evaluated sources of errors in NIR calibration models due to light scattering reducing the material heterogeneity using polymer films and estimated the optical sampling depth of NIR radiation into the polymer materials based on PCA analysis.

August 2011 – June 2019

- University of Puerto Rico, Mayagüez Campus

Teaching Assistant (graduate-level chemometrics course)

Department: Chemistry Department.

Duties: Developed MLR, CLS, PCA, PCR, and PLS experiments. Taught students to use SIMCA, Modde, Pirouette, Unscrambler, and Statgraphics. Taught students to evaluate calibration models, the number of factors, and validation methods.

- University of Puerto Rico, Mayagüez Campus

Teaching Assistant (undergraduate level organic chemistry course)

Department: Chemistry Department.

Duties: Prepared and monitored laboratories for organic chemistry class in experimental techniques: separation, purification, reactions of non-aromatics hydrocarbons and alkyl halides, identification and preparation of organic compounds, spectroscopy.

January 2012 – December 2013

- University of Puerto Rico, Mayagüez Campus

Research Assistant (Physical-Spectroscopic properties of Highly Energetic Materials)

Department: Chemistry Department.

Duties: Developed a standoff detection method of Highly Energetic Materials (HEM) using FTIR spectroscopy. Performed a determination of thermodynamic properties of HEM by DSC, TGA, Raman, FTIR, and computational chemistry.

March 2009 – August 2011

- University of Cartagena, Colombia

Young Researcher, COLCIENCIAS (Computational and Medicinal Chemistry)

Department: Environmental and Computational Chemistry Group, Pharmaceutical Chemistry

Duties: Developed a model for quantitative structure-activity relationships (QSAR) in analytical chemistry and toxicology and developed In silico design of small molecules and macromolecules using molecular modeling. Performed a virtual screening and inverse virtual screening of large databases to find potential targets for proteins related to dengue, diabetes, and antibiotic properties.

February 2007 – August 2007

- ECOPETROL S.A., oil refinery, Cartagena, Colombia

College Apprentice

Department: Quality Inspection Laboratory. Internal registry: Z-4112

Duties: Developed analytical techniques: Measurement of mercaptans in gasoline with potentiometric titration based on ASTM D3227. Measurement of water in crude oils by potentiometric Karl Fischer titration based on ASTM D4377. Measurement of salt in crude oil with an electrometric method based on ASTM D3230. Measurement of caustic soda in water treatment with colorimetric titration analysis.

COURSES RELEVANT TO THE PROCESS ANALYTICAL TECHNOLOGY

- **QUIM 6994 – Chemometrics.** 4 credits hour, 3 hours of lecture, 4 hours of laboratory. Application of statistical methods to chemometrics. Quality analysis for the improvement of industrial processes. Design of experiments that optimize the information needed to understand and analyze chemical systems. Develop plans to extract chemical information from multivariate techniques through appropriate experimental design and chemometric methods.
- **QUIM 8995 – Solid State Vibrational Spectroscopy.** 4 credits hour, 3 hours of lecture, 4 hours of laboratory. Analysis of solids through diffuse reflectance near-infrared spectroscopy and chemical imaging as well as Raman spectroscopy. Theoretical understanding of NIR and Raman spectroscopy. Theoretical knowledge of diffuse reflectance NIR spectroscopy and learn how to extract both chemical and physical information available in NIR spectra. Obtain information on material properties using NIR and Raman spectroscopy. Advantages and disadvantages of the different chemical imaging methods.
- **QUIM 6007 – Environmental and pharmaceutical applications of the theory of sampling (TOS).** One credit hour. A course dedicated to the study of the Theory of Sampling. Quality Control efforts in every industry depend on the samples obtained from the process, and environmental studies also rely on the samples obtained. Importance of sampling, correct vs. incorrect sampling, homogeneity vs. heterogeneity, 0-D and 1-D sampling, possible errors in 1-D sampling, mass reduction, variographic analysis.
- **QUIM 5205 – Pharmaceutical Analytical Chemistry.** Three credit hours. Application of analytical methods and validation requirements oriented to pharmaceutical processes, materials, and regulations that apply to the pharmaceutical industry. Drug development process and the role of pharmaceutical sciences in each of the phases in this process. Analytical methods are used for these formulations. Process analytical technology in the pharmaceutical industry. Quality, quality control, quality systems, quality assurance, and role of analytical chemists in proving key information.

SOFT SKILLS

Excellent interpersonal skills, teamwork and collaboration, work-alone orientation as needed, ethical behavior in teamwork, skills with a national and international perspective, analytical skills for problem-solving, critical observation.

PUBLICATIONS

- **Ortega-Zúñiga, C. A.**, Román-Ospino, A. D., Gupta, S., Omar, T., Baranwal, Y., Sanchez-Paternina, A., ... & Muzzio, F. J. (2025). Real-time monitoring of small changes in powder blends and ejected tablets in a low-dose formulation with 1% w/w of active pharmaceutical ingredient using Raman and near-infrared spatially resolved spectroscopy within a tablet press. *International Journal of Pharmaceutics*, 670, 125165. <https://doi.org/10.1016/j.ijpharm.2025.125165>
- Aldama, J., Shi, Z., **Ortega-Zúñiga, C.**, Románach, R. J., & Lysenko, S. (2021). Fractal and Polarization Properties of Light Scattering Using Microcrystalline Pharmaceutical Aggregates. *Applied Spectroscopy*, 75(1), 94-106. <https://doi.org/10.1177/0003702820949272>

- B.B. Alvarado-Hernandez, J. Scicolone, **C. Ortega-Zuñiga**, A.D Roman-Ospino, Y. Colon, E. Aymat, E. Sanchez, F. Muzzio, R. Romanach; Method transfer of a near-infrared spectroscopic method for blend uniformity in a poorly flowing and hygroscopic blend. *Journal of Pharmaceutical and Biomedical Analysis* Volume 180, 20 February 2020, 113054. <https://doi.org/10.1016/j.jpba.2019.113054>
- **C. Ortega-Zuñiga**, R. Navarro-Dent, D. Vargas-Mejia, and R. J. Romañach; A study of prediction errors in PLS calibration models with low heterogeneity films. the role of optical sampling, spectral region, and preprocessing on the reproducibility of two FT-NIR instruments, Submitted in *Journal of Near Infrared Spectroscopy* in 17-Jul-2019 in review.
- **C. Ortega-Zuñiga**, C. Pinzón-De la Rosa, A.D. Román-Ospino, A. Serrano-Vargas, R.J. Romañach, R. Méndez, Development of Near Infrared Spectroscopic Calibration Models for In-line Determination of Low Drug Concentration, Bulk Density, and Relative Specific Void Volume within a Feed Frame. *Journal of Pharmaceutical and Biomedical Analysis* 164 (2019) 211–222. <https://doi.org/10.1016/j.jpba.2018.10.046>
- A. Román-Ospino, V. Cárdenas, **C. Ortega-Zuñiga**, & R. Singh, PAT for pharmaceutical manufacturing process involving solid dosages forms. *Computer Aided Chemical Engineering*, (2018) 41, 293-315. <https://doi.org/10.1016/B978-0-444-63963-9.00012-9>
- J. Güette-Fernández, E. Meléndez, W. Maldonado-Rojas, **C. Ortega-Zuñiga**, J. Olivero-Verbel, & E. Parés-Matos, A molecular docking study of the interactions between human transferrin and seven metallocene dichlorides. *Journal of Molecular Graphics and Modelling*, (2017) 75, 250-265. <https://doi.org/10.1016/j.jmgm.2017.05.005>
- **C. Ortega-Zuñiga**, K. Reyes-Maldonado, and R.J. Romañach, Study of near infrared chemometric models with low heterogeneity films. The role of optical sampling and spectral preprocessing on partial least squares errors. *Journal of Near Infrared Spectroscopy*, 2017, Volume: 25, Issue: 2, page(s): 103-115. <https://doi.org/10.1177/0967033516686653>
- A. Román-Ospino, R. Singh, M. Ierapetritou, R. Ramachandran, R. Méndez, **C. Ortega-Zuñiga**, F. Muzzio, R. Romañach, Near infrared spectroscopic calibration models for real time monitoring of powder density. *International journal of pharmaceutics*, 2016, Volume 512, Issue 1, pages 61-74. <https://doi.org/10.1016/j.ijpharm.2016.08.029>
- A. Roman-Ospino, **C. Ortega-Zuñiga**, A. Sanchez-Paternina, S. Ortiz, K. Esbensen and R. Romañach, "Estimating total sampling error for near infrared spectroscopic analysis of pharmaceutical blends—theory of sampling to the rescue", 5(5), 71–75 (2015). doi: 10.1255/tosf.66
- A. Sánchez-Paternina, A. Román-Ospino, **C. Ortega-Zuñiga**, B. Alvarado, K. Esbensen and R. Romañach, "When "homogeneity" is expected—Theory of Sampling in pharmaceutical manufacturing", 5(5), 67–70 (2015). <http://dx.doi.org/10.1255/tosf.61>
- X. Narváez-Pita, **C. Ortega-Zuñiga**, C.Y. Acevedo-Morantes, B. Pastrana, J. Olivero-Verbel, W. Maldonado-Rojas, J.E. Ramírez-Vick, E. Meléndez, Water soluble molybdenocene complexes: Synthesis, cytotoxic activity and binding studies to ubiquitin by fluorescence spectroscopy, circular dichroism and molecular modeling, *Journal of Inorganic Biochemistry*, Volume 132, March 2014, Pages 77-91, ISSN 0162-0134, <http://dx.doi.org/10.1016/j.jinorgbio.2013.10.014>
- G.M. Herrera-Sandoval, H. Félix-Rivera, A.C. Padilla-Jimenez, M. Balaguera-Gelves, **C.A. Ortega-Zuñiga**, L.C. Pacheco-Londoño, O.M. Primera-Pedrozo, P.M. Fierro, C. Ríos-Velázquez, S.P. Hernández-Rivera. Synthesis and Characterization of Silver Nanoparticles and Nanostructures for SERS Applications. Chapter 4. Nova Science Publishers. 2013/10, pages 59-100
- S.P. Hernandez-Rivera, L.C. Pacheco-Londoño, N.Y. Galán-Freyte, J.R. Castro-Suarez, **C.A. Ortega-Zuñiga**, W. Ortiz, and A. Figueroa, "Vibrational Spectroscopy Standoff Detection of Explosives," in *Advanced Photonics 2013*, K. Ewing and M. Ferreira, eds., OSA Technical Digest (online) (Optical Society of America, 2013), paper SW1B.1
- **C.A. Ortega-Zuñiga**; N.Y. Galán-Freyte; J.R. Castro-Suarez; J. Aparicio-Bolaño; L.C. Pacheco-Londoño; S. P. Hernández-Rivera; Dependence of detection limits on angular alignment, substrate type and surface concentration in active mode standoff IR. *Proc. SPIE 8734, Active and Passive Signatures IV*, 87340R (May 23, 2013); <http://dx.doi.org/10.1117/12.2016196>
- M. Domínguez-García, **C. Ortega-Zuñiga**, E. Meléndez. New tungstenocenes containing 3-hydroxy-4-pyrone ligands: antiproliferative activity on HT-29 and MCF-7 cell lines and binding to human serum albumin studied by fluorescence spectroscopy and molecular modeling methods. *JBIC Journal of Biological Inorganic Chemistry*. February 2013, Volume 18, Issue 2, pp 195-209; <http://dx.doi.org/10.1007/s00775-012-0964-2>
- W. Maldonado-Rojas, J. Olivero-Verbel, and **C. Ortega-Zuñiga**. (2011). Searching of protein targets for alpha lipoic acid. *Journal of the Brazilian Chemical Society*, 22(12), 2250-2259; <http://dx.doi.org/10.1590/S0103-50532011001200003>

- J. Olivero-Verbel, M. Cabarcas-Montalvo, **C. Ortega-Zúñiga**, Theoretical targets for TCDD: A bioinformatics approach, Chemosphere, Volume 80, Issue 10, August 2010, Pages 1160-1166, ISSN 0045-6535, <http://dx.doi.org/10.1016/j.chemosphere.2010.06.020>

AWARDS

- Young Researchers and Innovative National Program, **2008**, Administrative Department of Science, Technology and Innovation. COLCIENCIAS.
- Young Researchers and Innovative National Program, **2009**, Administrative Department of Science, Technology and Innovation. COLCIENCIAS.