PhD student position at the Institute of Natural Resources and Agrobiology of Seville (IRNAS-CSIC)

Position: 4-year PhD contract

Location: Seville, Spain

Title: Lignin valorization in lignocellulose biorefineries

Summary: Plant biomass, composed primarily of cellulose, hemicelluloses, and lignin, is the predominant source of renewable materials on Earth. This biomass, abundantly available at a low cost, particularly from agricultural and forestry residues, holds immense potential as a cost-effective resource for producing biofuels and bioproducts. Traditionally, biomass conversion industries have focused on converting the carbohydrate fraction into chemicals and biofuels. However, to establish a robust global bio-based circular economy utilizing plant biomass as feedstock, it is crucial to extract value from all its components. In this sense, lignin, as the second most prevalent biomass component and the only constituent based on aromatic units, emerges as a promising renewable source for producing high-value products. However, despite its wide availability, industrial applications of lignin have been limited, mainly due to its inherent structural variability. To overcome this limitation, it is imperative to understand the detailed structures, types, sources, and reactivity of lignins. This project is committed to advancing the understanding and utilization of lignin from underutilized lignocellulosic sources, aiming at producing value-added bioproducts within the framework of a sustainable Bioeconomy. For this, this project aims to develop different lignin deconstruction and depolymerization procedures to obtain monomeric intermediates for further upgrading toward high-value chemicals.

Requisite: Bachelor's and Master's degree in Chemistry or similar.

How to apply?

1. Send your application to Jorge Rencoret (jrencoret@irnase.csic.es) or to José Carlos del Río (delrio@irnase.csic.es)

2. Include CV and letter of motivation.

Selected publications:

1. Lignin monomers from beyond the canonical monolignol biosynthetic pathway: another brick in the wall. *ACS Sustainable Chemistry & Engineering* **2020**, 13, 4997-5012. https://pubs.acs.org/doi/full/10.1021/acssuschemeng.0c01109

2. Variations in the composition and structure of the lignins of oat (*Avena sativa* L.) straws according to variety and planting season. *International Journal of Biological Macromolecules* **2023**, 242, 124811.

3. Tritordeum, a hybrid cereal with a highly tricin-enriched lignin. *International Journal of Biological Macromolecules* **2024**, 261, 129694.

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CV Summary of Jorge Rencoret (IP-1):

Jorge Rencoret is a Tenured Scientist and head of the Department of Agrobiotechnology, Plant Chemistry, and Biodiversity at the Institute of Natural Resources and Agrobiology of Seville (IRNAS-CSIC). He is an integral member of the "Plant Biomass - Uses and Valorization" Research Group. His PhD thesis (2005-2008) aimed to characterize the lipids and lignins of different agricultural and forest crops and study the biodegradation of these plant components by fungal enzymes. He completed predoctoral stays at the Biological Research Center (CIB-CSIC, Spain) and the Royal Institute of Technology (KTH, Stockholm, Sweden) to learn the most advanced analytical techniques on plant cell-wall characterization. Moreover, he developed a revolutionary gel-state 2D NMR method that allows the "in situ" analysis of whole plant cell wall components without the need for tedious and time-consuming lignin isolation procedures. In 2009, he moved to UW-Madison (USA), joining Prof. John Ralph's group, internationally recognized for their work in lignin chemistry and biosynthesis. After completing his postdoc stay, he rejoined the IRNAS and became the PI of the project "Characterization and valorization of native and technical lignins for their improved industrial use". Throughout his research career, he has been cooperating with other national and international research groups, including leader companies in the Forest, Pulp and Paper, Biofuel and Biotechnological sectors in the course of 18 research projects (including 9 European, 8 National, and 1 U.S. DOE). A highly relevant contribution of Jorge Rencoret in the lignin field has been the discovery of several new lignin monomers from outside the canonical monolignol biosynthetic pathway that behave as authentic lignin monomers, challenging the traditional definition of lignin. Currently, he is PI of the project "Lignin and lipids: renewable resources for new bioproducts, PID2020-118968RB-I00", which focuses on the valorization of lignin and lipids from different underused lignocellulosic materials as renewable resources of new value-added bioproducts in the context of a sustainable Bioeconomy. His achievements include 116 publications (112 Q1) in highly reputed SCI journals, 5 Book Chapters, 152 communications to Congresses, and 2 patents. According to the Scopus database, his h-index is 46, and his works have 7360 citations. During his career, he has supervised 4 Doctoral Theses (2 of them in progress). His editorial contributions include serving as an Associate Editor for the 3 SCI journals: BioEnergy Research, International Journal of Molecular Sciences, and Frontiers in Plant Science. He was a member of the Organizing Committee of the 13th European Workshop on Lignocellulosics and Pulp (2014) and edited the Proceedings book. Currently, he is also a member of the Executive Committee of the CSIC-Hub "WheatNet" and a professor in 2 University of Seville PhD programs. His outstanding contributions have garnered recognition from prestigious institutions, including the Royal Academy of Sciences of Seville (Distinguished Young Researcher, 2013), the University of Seville (US-Bruker prizes in 2013, 2015, and 2019), and CSIC (recognition awards in 2013 and 2016). Notably, his continuous presence in the prestigious Stanford University ranking of the "World's Top 2% Scientists" since 2020 underscores the impact of his research work.

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CV Summary of José Carlos del Río (IP-2):

José C. del Río is a Research Professor at IRNAS-CSIC where he leads the Research Group "*Plant Biomass - Uses and Valorization*". He obtained his PhD in Chemistry from the University of Seville (1989), and after several postdoctoral stays at the Universities of Oklahoma and Pennsylvania (USA) and Bristol (UK), he acceded to a Researcher position in CSIC (1993). His achievements include 234 publications in SCI journals (131 D1, 208 Q1), with a total of 13028 citations (5235 in the last five years) and an *h*-Index of 65 (in Scopus, 78 in Google Scholar). He also contributed with 17 Book Chapters, 284 communications to Congresses, and 8 invention patents, some of which are licensed. He has also been the director of 12 Doctoral Theses and 14 Master Theses. He was awarded with 5 sexennials of research and 1 sexennial of technological transfer. He has been the National Representative and member of the Management Committee of various COST Actions. He is a member of the Editorial Board of the journals *Holzforschung - International Journal of Biology, Chemistry, Physics, and Technology of Wood* (ISSN: 1437-434X) since 2016, and *The Open Agriculture Journal* (ISSN: 1874-3315) from 2007 to 2022. He was also the Chairman of the "*13th European Workshop on Lignocellulosics and Pulp – EWLP2014"*, and edited the Proceedings Book. He participates in the technological platform "PTI *Horizonte Verde*" focused on ensuring the sustainability of agricultural and forestry systems in the face of the Climate Change, as well as in the "*WheatNet*" CSIC Connection aimed at promoting scientific and technical research for wheat crops.

During his career, he has been collaborating with national and foreign research groups, including the R+D+i centers of leading companies in the Agricultural, Forestry and Paper sectors (i.e. ENCE-Spain, CELESA-Spain, UPM-Kymenee-Finland, Borregaard-Norway, Suzano-Brazil), as well as in the Biotechnology sector (i.e. Novozymes-Denmark), through numerous National and European projects. It is worth highlighting his uninterrupted participation in EU projects since 1995 (from FP4 to H2020). During the course of these projects, his research focused on exploring the valorization of lignocellulosic biomass derived from crops and agroforestry residues for the production of biofuels, biomaterials and high-value chemicals within the framework of the "Lignocellulose Biorefinery". Due to this expertise, he was invited in 2020 to contribute to the CSIC White Book on *Clean, Safe and Efficient Energy* with a chapter on *Valorization of Biomass as Energy Source*. His research on the structure of plant lignins is internationally recognized, and in particular his discoveries of polyphenols derived from other biosynthetic pathways (i.e. flavonoids, hydroxystilbenes, hydroxycinnamides), which act as true lignin monomers incorporated into the lignin polymer, prompted for the reevaluation of the established paradigms for lignin structure and biosynthesis. This advance allowed other researchers to genetically manipulate lignin structure, paving the way to engineer plants with more easily degradable lignins or with lignin enriched in valuable phenolic compounds.
Finally, it is worth highlighting that his achievements are recognized by his continuous presence on the Stanford University's prestigious ranking list of the "*World's Top 2% Scientists*" since the first edition in 2017.

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