Biomimetic Dendrimers and Photonic Laboratory

Principal Investigator: Prof. Ezequiel Perez-Inestrosa, eperezinestrosa@bionand.es

Institutions

BIONAND, Andalusian Centre for Nanomedicine and Biotechnology
University of Málaga
IBIMA, Instituto de Investigación Biomédica de Málaga.
RIRAAF, Red de Investigación de Reacciones Adversas a Alérgenos y Fármacos (Instituto de Salud Carlos III)
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Keywords

Organic Chemistry, molecular and supramolecular chemistry, photoinduced electron transfer, molecular recognition, dendrímeros and dendrones, sensors and bio-sensors, fluorescence systems, multiphoton excitation processes, nanoscience, nanomedicine.

Research Lines

✓Synthesis of dendrimeric structures (dendrimers and dendrons)
✓Synthesis of fluorescent markers
✓Preparation of Solid Particles suitable for supporting dendrimeric structures
✓Molecular Sensors and Molecular Logic Gates for the processing of biomedical information

Scientific Activity

This research group is focused on the development of new molecular and supramolecular chemical entities, at nano- and micro-scale, and their applications in biological medias of medical interest. Particular attention on the design and engineering at molecular level of nanostructured organic compounds and photonic devices is attained. The research deals on the frontiers of nano-chemistry and biomedicine. The main interest is to improve existing diagnostic and therapies, by employing novel nanomaterials - dendrimers.

Research lines:

✓Synthesis of dendrimeric structures (dendrimers and dendrons)

Dendrimers are three-dimensional polymer molecules with highly branched and regular architectures, which are synthesized in a controlled manner to yield monodisperse compounds with specific physical and chemical properties. Because physical and chemical properties of these molecules can be modulated by control and design during synthesis, dendrimers have a high versatility and its applications are studied and multidisciplinary fields such as chemistry, physics, biology, medicine, materials science, etc.. The structural elements that comprise a dendrimer are the core, the monomers or branched repeating units and endgroups. Dendrimeric structure is characterized by "layers" between each focal point called generations. Dendrimers can be formed from virtually any chemical structure that can branch out and can present a wide variety of features depending on which are built and how. Dendrimers are considered the basic units from most versatile synthesis architecture on the nanoscale, in terms of controlled composition and structure are concerned.

✓Synthesis of fluorescent markers

The use of fluorescent molecules in many laboratories is an standard, and its use is increasing steadily due to its versatility, sensitivity and quantitative capabilities. This line of research focuses on the synthesis and photophysical study of molecular fluorescent probes, allowing us to label molecules for specific uses in fluorescent microscopy. The development of fluorescent probes with high stability and quantum yield emission also allows its implementation in more complex systems as can be dendrimers or nanoparticles. These systems allow applications in the development of health sciences and in the field of biology and nanoimagen.

✓Preparation of Solid Particles suitable for supporting dendrimeric structures

We are working in luminescent silica nanoparticles of different sizes and narrow size distribution. As synthetic procedure we employ Stöber methods. This synthesis avoids the use of potentially toxic organic solvents and surfactants, and allows the use of these nanoparticles as new probes for biomedical imaging and carriers for drug delivery. Additionally we are developing hybrid organic-silica materials for biosensing applications. The modified silica nanoparticles are used as a solid supports for in vitro test to determine if a patient is allergic or not to a specifically drug.

✓Molecular Sensors and Molecular Logic Gates for the processing of biomedical information

Molecular electronics is a field of nanotechnology where the chemical design is used to fabricate molecular structures simulating the behavior of electronic components. As the classic electronics, the chemical design has been able to produce molecules covering almost completely the wide variety of electronic devices existing. One of the most interesting devices group is the so-called Logic gates. Logic gates are systems that can give a different response (called output), depending on the stimulus acting over them (called input). The relationship between stimulus and response (inputs and outputs) permits to define a logic behavior that, according to the Boolean logic, permits to perform different operators of different levels of complexity: AND, OR, XOR, NAND, NOR, XNOR, INH, Half-Adder and Subtractor, Full-Adder and Subtractor, etc. In the classic electronics devices, inputs and outputs are voltages and the responses are measured according to the voltage thresholds defined. When we talk about the Molecular Logic Gates, inputs and outputs can be of a different nature: optical, chemical or electrical. The most common devices are designed in a way that the inputs are chemicals (ions, pH differences, etc.) and the output are optical, being possible to measure the response via UV-vis absorption or fluorescence.

Collaborations

- **Institut des Sciences Moléculaires-CNRS, Université Bordeaux** I (France). Dr. Dario Bassani. Organic Nanostructures Group.
- **Universidad de Málaga** (Spain). Prof. José Becerra Ratia. Laboratorio de Bioingeniería y Regeneración Tisular.
- **Servicio de Alergología y Laboratorio de Investigación, Hospital Carlos Haya** - Fundación IMABIS, (Málaga, Spain). Dr. Miguel Blanca Gómez.
- **DTU Veterinary-National Veterinary Institute**, Technical University of Denmark (Denmark). Prof. Ulrik Boas.
- **CIN2-Barcelona** (Spain). Dr. Laura M. Lechuga. NanoBiosensors and Bioanalytical Applications Group
- **Universidad de Huelva** (Spain). Prof. Uwe Pischel. Departamento de Ingeniería Química, Química Física, Química Orgánica.
- **Instituto de Investigaciones Químicas**-C.S.I.C.-Sevilla (Spain). Dr. Francisco Javier Rojo Marcos. Grupo de Carbohidratos.
- **Central Michigan University** (U.S.A). Prof. Donald A. Tomalia. Department of Chemistry
- **Universidad Pablo de Olavide** (Spain). Prof. Ana Paula Zaderenko. Departamento de Sistemas Físicos, Químicos y Naturales.
- **Universidad de Málaga** (Spain). Prof. Juan T. López Navarrete. Espectroscopía Molecular de Materiales para Electrónica Orgánica.
- **Philipps-Universität-Marburg** (Germany). Prof. Wolfgang Parak. Biophotonics Group.
- **Université de Strasbourg**, (France). Prof. Luisa De Cola. Laboratoire de Chimie et des Biomatériaux Supramoléculaires.

Research Projects in the last 5 years

- Nanoestructuras dendriméricas soportadas sobre superficies sólidas aplicadas al desarrollo de un test in vitro para el diagnóstico de hipersensibilidad inmediata a antibióticos beta-lactámicos, PI-0551/2009, Consejería de Salud (2010-2012). PI: Ezequiel Pérez-Inestrosa
- Diseño y síntesis de nuevos dendrímeros y dendrones para aplicaciones biomédicas, CTQ2010-20303, Ministerio de Economía y Competitividad (2011-2014). PI: Ezequiel Pérez-Inestrosa
- Ayudas para el subprograma RETICs (Redes Temáticas de Investigación Cooperativa en Salud), de la línea de articulación del sistema de la Acción Estratégica en Salud, en el marco del PN de I+D+i 2008-2011. Red de Investigación de Reacciones Adversas a Fármacos (RIRAAF). RD12/0013/0003.
- Nanopartículas de sílice funcionalizadas con antígenos dendriméricos (DeAn@SiO2NP) para un diagnóstico múltiple de hipersensibilidad inmediata a medicamentos, PI-0159-2013, Consejería de Igualdad, Salud y Políticas Sociales (2014-2016). PI: Ezequiel Pérez-Inestrosa
- Sintesis y funcionalizacion de estructuras dendrimericas BAPAD solubles y fijadas en superfices sólidas. Aplicaciones en diagnóstico y biotecnología. (CTQ2013-41339-P). Ministerio de Economia y Competitividad (2015-2017). PI: Ezequiel Pérez-Inestrosa.
- Procesamiento Molecular de Información - Desarrollo de Sondas Fluorescentes "Inteligentes" para Aplicaciones Biomédicas. Proyecto de Excelencia (FQM 2140). Consejería de Economía, Innovación, Ciencia y Empresa-Junta de Andalucía (2014-2016). PI Grupo UMA: E Perez-Inestrosa (Coordinator Dr Uwe Pischel).
- Búsqueda y Caracterización de nuevos fármacos antiangiogénicos, CTS 1507. Consejería de Economía y Conocimiento (2014-2016). PI: Ana Rodríguez Quesada
- Nanopatterned Cell Carriers for Improved Architectural Communication Networks in Chondrogenesis towards Osteoarthritic Joint Repair, ChondroNanoNet. Instituto de Salud Carlos III (2014-2015). PI: Josep Samitier

Publications in the last 5 years

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Patents

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- Nanoconjugated dendrimeric antigens, preparation method and use thereof. Yolanda Vida, Maria I. Montañez, Daniel Collado, Francisco Najera, Adriana Ariza, Miguel Blanca, Maria Jose Torres, Cristobalina Mayorga and Ezequiel Perez-Inestrosa. Priority Number: P201400333. Priority Date: 2014-04-14. Owner: University of Malaga and Servicio Andaluz de Salud

- Estructuras dendríticas BAPAD, basadas en la conexión repetitiva de 2,2'-Bis(aminoalquil)carboxiamidas; procedimiento de obtención y aplicaciones. Perez-Inestrosa, E.; Ruiz, A.J.; Najera, F.; Vida, Y.; Collado, D.; Mesa, P. Priority Number: P201100553. Date: 2011-05-14. Patent Number: PCT/ES2012/000136. Publication Date: 2012-12-12. Date of grant: 2013-10-08. Owner: University of Málaga

- Compuestos útiles en la detección de anticuerpos IgE contra cefalosporinas. Blanca, M.; Torres, MJ; Mayorga, C; Montañez, MI; Perez-Inestrosa, E. Priority Number: P201130469. Priority Date: 2011-03-22. Owner: Servicio Andaluz de Salud, Instituto Mediterráneo para el Avance de la Biotecnología y la Investigación Sanitaria (Fundación IMABIS) and University of Malaga

- COMPLEJOS MULTIVALENTES HAPTENO-PORTADOR CON DENDRIMEROS COMO EMULADORES DE LA PROTEINA PORTADORA. Perez-Inestrosa, E.; Suau, R.; Blanca, M.; Montañez, M.I.; Mayorga, C.; Torres, M.J. Patent Number: ES2297955. Publication Date: 2008-05-01. Date of grant: 2009-02-24. Owner: University of Málaga