



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DICUS

DIPARTIMENTO DI CHIMICA
"UGO SCHIFF"

ECCELLENZA 2023-2027



UNIVERSITÀ
DEGLI STUDI
FIRENZE

PhD
Chemical Sciences

Da un secolo, oltre.

Prof Dr THIMMAIAH GOVINDARAJU

Bioorganic Chemistry Laboratory, New Chemistry Unit and School of Advanced Materials (SAMat), Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur P.O., Bengaluru 560064, India

2-4 September 2024

Protein and Peptide-Based Biomaterials

LECTURE TOPICS

Monday 02.09.2024 - Lesson 1 Introduction to amino acids, peptides, and proteins; structure and function. Introduction to biomaterials, biocompatibility, and other related aspects. Noncovalent interactions, self-assembly, molecular and material architectures

2 pm – 6 pm Aula A1, plesso E. Calabresi, via E. Detti, 3, 50019 Sesto Fiorentino

Join online: <https://meet.google.com/brv-texg-hsm>

Tuesday 03.09.2024 - Lesson 2 Protein-, amino acid-, peptide-based (bio)materials

2 pm – 6 pm Aula A1, plesso E. Calabresi, via E. Detti, 3, 50019 Sesto Fiorentino

Join online: <https://meet.google.com/hxo-scav-qxh>

Prof.ssa Anna Maria Papini
Coordinatore del Dottorato

Prof.ssa Anna Maria Papini
Organizzatore



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2-4 September 2024

Protein and Peptide-Based Biomaterials

LECTURE TOPICS

Wednesday 04.09.2024 – Lesson 3 Amino acid and peptide-guided molecular architectonics. Amino acid, peptide and their mimetics as auxiliaries. Upcycling of cyclic dipeptides

9 am – 1pm Aula A1, plesso E. Calabresi, via E. Detti, 3, 50019 Sesto Fiorentino

Join online: <https://meet.google.com/yxs-rbjo-qim>

Please note: All lectures deal with design, structure, properties, function, and applications

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2-4 September 2024

Course program and objectives

Nature showcases its elegant functional design through marvelous materials made up of proteins. In fact, these protein-based materials and formulations are useful in a range of biomedical applications. An ideal biomaterial should be biocompatible, biodegradable, and easily processable into various scaffold formats, preferably under situations similar to physiological conditions. This course briefly covers protein-based biomaterials for various biomedical applications such as drug delivery, wound healing, tissue engineering, and regenerative medicine. A number of lectures cover reductionistic approaches of employing natural amino acids, peptides, and their designer mimics to produce (bio)materials with a range of properties and functions. The course also introduces a novel research theme and an umbrella concept "molecular architectonics" to develop molecular and nanoarchitectures with novel properties and applications. This concept of designing noncovalent systems enables us to focus on distinct functional aspects of designer molecules for biological and non-biological applications, which also strengthens our efforts in understanding the art of controlled molecular assemblies. In this context, biomolecules with in-built information for molecular recognition can guide the scheme of molecular architectonics.

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The tailorability of molecular assemblies can be accomplished by employing biomolecules like amino acids and peptides as auxiliaries with functional cores. Molecular architectonics of modular functional building blocks, and the derived molecular and material architectures that are developed led to understanding homochirality, protein folding, organic (bio)electronics, high-mechanical strength (bio)organic materials, self-cleaning, (bio)sensors, and tissue engineering applications among others.

Objectives:

- Protein based biomaterials and their structure and function.
- Reductionistic strategies to biomaterials: Amino acids, peptides, and their mimics-based materials.
- Molecular architectonics: amino acids, peptides, and mimics as auxiliaries to guide the controlled molecular assembly of functional molecules.
- Design, structure, function, and applications in each category.
- Applications: Health, Energy and Environment.

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2-4 September 2024

Suggested reading

- 1) L. P. Datta, S Manchineella and T Govindaraju, Biomolecules-derived biomaterials, Biomaterials 2020, 230, 119633.
- 2) Protein-Based Biological Materials: Molecular Design and Artificial Production, A. Miserez, J. Yu and P. Mohammadi, Chem. Rev. 2023, 123, 2049-2111.
- 3) S.M. Choi, P. Chaudhry, S.M. Zo and S.S. Han, Advances in protein-based materials: from origin to novel biomaterials, in cutting-edge enabling technologies for regenerative medicine. Advances in experimental medicine and biology, H. Chun, C. Park, I. Kwon and G. Khang, (eds), vol 1078. Springer, Singapore, 2018.
- 4) Peptide-based Biomaterials in Soft Matter Series, The Royal Society of Chemistry, London, M. O. Guler (Ed.), 2021.
- 5) B. Roy and T. Govindaraju, Amino acids and peptides as functional components in arylenediimide-based molecular architectonics, Bull. Chem. Soc. Jpn., 2019, 92, 1883-1901.
- 6) Molecular Architectonics and Nanoarchitectonics In the series of Nanostructure Science and Technology, Springer Nature, Singapore, T. Govindaraju and Katsuhiko Ariga (Eds.), 2021.
- 7) C. Balachandra, D. Padhi, and T. Govindaraju, Cyclic dipeptide: a privileged molecular scaffold to derive structural diversity and functional utility, ChemMedChem 2021, 16, 2558-2587.
- 8) S. Manchineella and T. Govindaraju, Molecular self-assembly of cyclic dipeptide derivatives and their applications, ChemPlusChem 2017, 82, 88-106.

(Note: A number of other references will be covered in lectures)

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Organizzatore



T. Govindaraju is Professor for Bioorganic chemistry at the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) Jakkur P.O, India

Research interests

Govindaraju's research focuses on the intersection of chemistry, biology, and material science, with a particular emphasis on the chemical biology of 'functional and disease amyloids'.

Utilizing his expertise in organic synthesis, peptide chemistry, bioconjugate chemistry, biophysical techniques, and chemical biology, Govindaraju has tackled complex problems related to human health and society. His work has led to a deeper understanding of disease mechanisms and the development of innovative diagnostic and therapeutic tools.

EDUCATION AND DEGREES

2006 PhD (Chemistry), National Chemical Laboratory and University of Pune, Pune, India.

2000 Master of Science (Chemistry), Bangalore University, Bengaluru, India

1998 Bachelor of Science, Govt. Science College, Bangalore University, Tumkuru, India

PROFESSIONAL CAREER

2020-present Professor, Bioorganic Chemistry Laboratory, New Chemistry Unit and School of Advanced Materials (SAMat), Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru.

2020-2023 Chair, Education Technology Unit, JNCASR, Bengaluru.

2014 - 2020 Associate Professor, Bioorganic Chemistry Laboratory, New Chemistry Unit, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru.

2008-2014 Assistant Professor, Bioorganic Chemistry Laboratory, New Chemistry Unit, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru.

2018 (April-May) Visiting Professorship, University of Paris-Sud, University of Paris-Saclay

2015 (Apr-May) Visiting Professor, RMIT University, Australia

2011 (Jun-July) Visiting Scientist, Sam Stupp's Laboratory, Northwestern University, USA.

2006-2008 Alexander von Humboldt Research Fellow, Department of Chemical Biology, Max Planck Institute of Molecular Physiology, Dortmund, Germany

2005-2006 Postdoctoral Fellow, Departments of Biochemistry, and Chemical and Biological Engineering, University of Wisconsin-Madison, Madison, USA

2001-2005 Research Fellow, National Chemical Laboratory, Pune.

2000-2001 Research trainee (Campus selection), Cadila Pharmaceuticals, Dholka, Ahmadabad, Gujarat.

HONOURS (SELECTION of the most recent)

2023 National Technology Award (Translational Research), Govt. of India

2023 Fellow, Indian Academy of Sciences, Bengaluru

2022 (1) Sun Pharma Science Foundation Research Award in Pharmaceutical Sciences. (2) Featured in THE ASIAN SCIENTIST 100. (3) Bhagyatara Award, Punjab University (4) SASTRA-CNR Rao Award 2022 for excellence in Chemistry & Materials Science. (5) Dr. Shoba Ramakrishnan Endowment lecture, WCC, Chennai.

2021 Shanti Swarup Bhatnagar (SSB) Prize for the year 2021 in Chemical Sciences. Fellow of Royal Society of Chemistry (FRSC), Royal Society of Chemistry (London), (invited) under "Leader in the Field" Category in the field of Bioorganic Chemistry.

2020 (1) Health & Wellbeing Winner, Commonwealth Chemistry Posters – Building the Partnership, Commonwealth Chemistry, Federation of Chemical Sciences Societies (2) 2020 National Prize for Research in Chemistry of Peptides and Nucleic Acids, CNR Rao Education Foundation and JNCASR, Bengaluru

2019 Special Lecture Award of the Pharmaceutical Society of Japan, Kyoto University, Japan

2019 CDRI Award for Excellence in Drug Research, CSIR-Central Drug Research Institute, Lucknow, India

2018 Visiting Professorship, University of Paris-Sud, University of Paris-Saclay, France

2017 (1) IPS-Young Scientist Award (2017), Indian Peptide Society. (2) R.A. Mashelkar Endowment Lecture, CSIR-National Chemical Laboratory (NCL), NCL-Research Foundation, Pune. (3) 2017 MRSI Medal (2017), Materials Research Society of India

2016 SwarnaJayanti Fellowship (2015-2016), the Department of Science and Technology (DST), Govt. of India

2016 AVRA Young Scientist Award (2015), AV Rama Rao Research Foundation, Avra Laboratories Private Limited, Hyderabad

2015 (1) Sir C V Raman Young Scientist Award (2014), by Government of Karnataka (2) RSI Bronze Medal (2016) of Chemical Research Society of India (3) Founding member of Indian National Young Academy of Science (INYAS). Selected by INSA council. (4) Prof. CNR Rao Award 2014/2015, Royal Melbourne Institute of Technology (RMIT) University, Australia. (5) Selected for "Emerging Young Investigator issue 2015" of ChemComm, RSC Publications

BIBLIOMETRIC DATA

Total number of research papers published: 162+

Patents (sanctioned/filed): >35 (Granted: 6 US patents; 5 Indian patents; many are at PCT and various stages of national phase in several countries). Most of the patents have been licensed/commercialized through startup for the benefit of society.

Citation analysis: h-index: 53 & i10-index: 118 with over 7801 citations (Google Scholar)

BOOKS: 4

SELECTION OF THE 10 MOST RECENT PUBLICATIONS

1. B. Roy and T. Govindaraju, Enzyme-mimetic catalyst architectures: the role of second coordination sphere in catalytic activity, *Bull. Chem. Soc. Jpn.* <https://www.journal.csj.jp/doi/abs/10.1246/bcsj.20230224>.
2. B. Maity and T. Govindaraju, Intrinsically disordered Ku proteins-derived cell-penetrating peptides, *ACS Bio Med Chem Au*, <https://doi.org/10.1021/acsbiomedchemau.3c00032>.
3. M. Ramesh, C. Balachandra, P. Baruah and T. Govindaraju, Cyclic dipeptide-based small molecules modulate zinc-mediated liquid-liquid phase separation of tau, *J. Pept. Sci.*, 2023, 29, e3465. <https://doi.org/10.1002/psc.3465>
4. S. Pratihar, K. Bhagavath, T. Govindaraju, Small molecules and conjugates as theranostic agents, *RSC Chem. Biol.*, 2023, 4, 826-849.
5. P. Baruah, H. Moorthy, M. Ramesh, D. Padhi, T. Govindaraju, A natural polyphenol activates and enhances GPX4 to mitigate amyloid- β induced ferroptosis in Alzheimer's disease, *Chem. Sci.* 2023, 14, 9427-9438.
6. B. Maity, H. Moorthy, T. Govindaraju, Glucose responsive self-regulated injectable silk fibroin hydrogel for controlled insulin delivery, *ACS Appl. Mater. Interfaces* 2023, 15, 49953-49963.
7. S. Pratihar, M. N. Mattath, T. Govindaraju, Coronavirus genomic cDNA derived G-quadruplex as a selective target for fluorometric detection, *Chem. Commun.* 2023, 59, 5717-5720.
8. M. Ramesh and T. Govindaraju, Multipronged diagnostic and therapeutic strategies for Alzheimer's disease, *Chem. Sci.* 2022, 13, 13657-13689.
9. M. N. Mattath, H. Zhang, D. Ghosh, and T. Govindaraju, S. Shi, Nanoclusters with specific DNA overhangs: modifying configurability, engineering contrary logic pairs and the parity generator/checker for error detection, *Nanoscale* 2023, 15, 17386-17397
10. M. Ramesh, C. Balachandra, P. Andhare and T. Govindaraju, Rationally designed molecules Synergistically modulate multifaceted A β toxicity, microglial activation, and neuroinflammation, *ACS Chem. Neurosci.* 2022, 13, 2209-2221.