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Kings College
University of Cambridge
UK

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Pharmaceutical Nanotechnology

Aims & Scope

Pharmaceutical Nanotechnology publishes original manuscripts, i.e. primary technical papers, rapid technical notes, reviews and commentaries that provide insights into the synthesis, characterisation and pharmaceutical (or diagnostic) application of materials at the nanoscale. The nanoscale is defined as a size range of below $1\ \mu\text{m}$. Scientific findings related to micro and macro systems with functionality residing within features defined at the nanoscale are also within the scope of the journal. Manuscripts detailing the synthesis, exhaustive characterisation, biological evaluation, clinical testing and/ or toxicological assessment of nanomaterials are of particular interest to the journal's readership. Articles should be self contained, centred around a well founded hypothesis and should aim to showcase the pharmaceutical/ diagnostic implications of the nanotechnology approach. Manuscripts should aim, wherever possible, to demonstrate the *in vivo* impact of any nanotechnological intervention. As reducing a material to the nanoscale is capable of fundamentally altering the material's properties, the journal's readership is particularly interested in new characterisation techniques and the advanced properties that originate from this size reduction. Both bottom up and top down approaches to the realisation of nanomaterials lie within the scope of the journal.

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Editor-in-Chief



Zongjin Li

Department of Pathophysiology
Nankai University School of Medicine
Tianjin
(China)

[Biography](#)



Biography of Zongjin Li



Dr. Zongjin Li is a Professor at the Department of Pathophysiology and a Director of the Laboratory of Molecular Imaging and Stem Cell Therapy at Nankai University School of Medicine, Tianjin, China. He received his PhD degree from Peking Union Medical College and completed his postdoctoral training in the Molecular Imaging Program (MIPS) at Stanford University, USA. He has published more than 120 peer-reviewed papers on molecular imaging and stem cell therapy.

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Co-Editors

Jay B. Ramapuram

Department of Drug Discovery and Development



Harrison School of Pharmacy
Auburn, AL
(USA)

[Biography](#)



Biography of Jay B. Ramapuram



Dr. Ramapuram Jayachandra Babu is currently a Professor and Graduate Program Officer at the Department of Drug Discovery and Development, Harrison School of Pharmacy, Auburn University. He received his Bachelor's degree in Pharmacy from the University of Madras and Masters and PhD degrees in Pharmaceutics from Indian Institute of Technology, Varanasi, India. His research interests include formulation development of nanoparticle based formulations for topical and oral delivery, solubility improvement of insoluble drugs, percutaneous penetration enhancement techniques, and transdermal drug delivery systems. He has authored and co-authored over 90 peer reviewed papers and 100 conference abstracts in several national and international conferences. He has served as a chair and co-chair of scientific sessions at the Annual National Meetings of American Association of Pharmaceutical Scientists and Society of Toxicology. He serves as an editorial board member for five journals and as a peer reviewer for more than forty journals. His field of expertise are Transdermal Drug Delivery; Nanoparticles, Solubility improvement; Ocular Drug Delivery.

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Associate Editors



Maria J. Blanco-Prieto

Department of Pharmacy and Pharmaceutical Technology
University of Navarra

Pamplona
(Spain)

[Biography](#)



Biography of Maria J. Blanco-Prieto



Maria J. Blanco-Prieto received her degree of Pharmacy Degree from the University of Santiago de Compostela (Spain), followed by a PhD in Pharmaceutical Sciences from the University of Paris-Sud (France). She completed post-doctoral training at the Swiss Federal Institute of Technology (ETH), Zürich, (Switzerland) and then joined the University of Navarra where presently she is a Full Professor of Pharmacy and Pharmaceutical Technology. Her research interest is in the field of biomaterials and advanced drug carrier systems including the design and the development of

polymer and lipid based micro- and nanoscale carriers, their biological evaluation in in vitro cell cultures and also their pharmacokinetic and dynamic impact in vivo (using relevant animal models of the diseases).

Close



Darryl T. Martin

Department of Urology
Yale University School of Medicine
New Haven, CT
(USA)

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Biography of Darryl T. Martin



Dr. Darryl T. Martin is a Research Scientist at the Yale School of Medicine. He obtained his PhD from the Division of Biomedical Sciences, the Memorial University of Newfoundland in 2010. His research interests include drug delivery systems that target prostate and bladder cancers using nanoparticle-based platforms for diagnostic and therapeutic purposes.

Close



Yu Nie

Department of Biomedical Engineering
Sichuan University (SCU)
Chengdu
(China)

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Biography of Yu Nie



Dr. Yu Nie obtained PhD in Pharmaceutical Sciences from West China School of Pharmacy, Sichuan University, China. She is presently serving as a Professor at NERCB, Sichuan University, China and before that she was an Assistant Professor at the same institution. She also has an experience as a postdoc fellow at Ludwig-Maximilian-University of Munich, Germany. Her research interests include Regenerated bio-materials, medicinal excipients in ophthalmology and Orthopedics. She has contributed more than 50 publications, having citations around 1050.

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Regional Editors

Asia

**Farid Dorkoosh**

Department of Pharmaceutics
Tehran University of Medical Sciences
Tehran
(Iran)

[Biography](#)

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Biography of Farid Dorkoosh

Dr. Dorkoosh received his PhD in pharmaceutics and biopharmaceutics from Leiden University, the Netherlands in 2002. He followed an international training on intellectual property and management of innovation at World Intellectual Property Organization (WIPO) in Geneva, Switzerland in 2005. He got his Diploma in management from Chartered Management Institute of London, UK in 2009. He is currently an associate professor at Tehran University of Medical Sciences. He is also the head of Patent office of Tehran University of Medical Sciences. Dr. Dorkoosh has published more than 80 research articles and held 10 patents and patent applications.

Close

**Murugan Ramalingam**

Centre for Stem Cell Research
Christian Medical College Campus
Vellore
(India)

[Biography](#)

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Biography of Murugan Ramalingam

Dr. Murugan Ramalingam is a Professor at the Centre for Stem Cell Research (India). Concurrently, he is an Adjunct Professor at the Tohoku University (Japan). He worked as Associate Professor at the Université de Strasbourg (France) and Assistant Professor at the WPI-Advanced Institute for Materials Research (Japan). He has also worked at the U.S. National Institute of Standards and Technology (NIST) and the National Institutes of Health (NIH). He received his Ph.D. in Biomaterials from the University of Madras. He is the author of over 260 scientific publications.

Close

Europe



Clare Hoskins

Director of Postgraduate Research Medical Sciences (Laboratory)
Keele University
Newcastle, England
(United Kingdom)

[Biography](#)

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Biography of Clare Hoskins



Dr. Clare Hoskins obtained PhD in Pharmaceutics from Robert Gordon University, Aberdeen. She is presently serving as a Senior Lecturer in Pharmaceutics at Keele University. She is a member of different professional bodies such as Royal Society of Chemistry, Controlled Released Society, British Nano-medicine Society and Higher Education Academy. She has contributed numerous publications in different national and international journals. She also possesses different editorial responsibilities in different journals as a guest editor and editorial board member.

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North America



Glen S. Kwon

School of Pharmacy-Wisconsin Center for NanoBioSystems
University of Wisconsin
Madison, WI
(USA)

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Biography of Glen S. Kwon



Dr. Kwon is the Jens T. Carstensen Distinguished Chair Professor in the School of Pharmacy at University of Wisconsin. He received the Jorge Heller Journal of Controlled Release/Controlled Release Society (CRS) Outstanding Paper Award (1994) and CRS Young Investigator Research Achievement Award (2003). He is a Fellow

of the American Association of Pharmaceutical Scientists (2012) and a highly-cited researcher by Thomson Reuters in the category of Pharmacology & Toxicology (2014). He is co-founder of Co-D Therapeutics Inc., a start-up company dedicated to multi-drug anticancer nanotherapeutics.

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Section Editors



Section: Biodegradable polymers for nanomedicine

Rohidas Arote

Department of Molecular Genetics
Seoul National University

Seoul
(South Korea)

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Biography of Rohidas Arote



Prof. Arote Rohidas is an Associate Professor and the director of Nanomedicine Laboratory in the Dept. of Molecular Genetics, School of Dentistry, Seoul National University. His research includes nanotechnology, drug delivery, molecular targeting, nucleic acid delivery, bioimaging and modulation of cell death mechanism has been published in over 50 international journals and also produced various patents.

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Editorial Board Members



Hua Ai

Department of Radiology
Sichuan University

Chengdu
(China)



Alaa A. Aljabali
Faculty of Pharmacy
Yarmouk University
Irbid
(Jordan)

[Biography](#)

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Biography of Alaa A. Aljabali



Alaa A. Aljabali completed MRes in cancer biomarkers from Essex University and a Ph.D. in Bionanotechnology from John Innes Centre (UK). He worked as a postdoctoral research fellow at the University of Oxford on the development of nanoparticles as clinical imaging agents. Recently, he completed Fellowship in Responsible Conduct of Research at the University of California San Diego. His research interest are Biomaterials, Drug delivery and targeting, Material science, and Nanomedicine.

Close



Christine Allen
Leslie Dan Faculty of Pharmacy
University of Toronto
Toronto, ON
(Canada)

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Biography of Christine Allen



Christine Allen is the GlaxoSmithKline Chair in Pharmaceutics and Drug Delivery and a Professor in the Leslie Dan Faculty of Pharmacy and the Departments of Chemical Engineering and Applied Chemistry and IBBME at the University of Toronto. Allen's research is focused on the design and development of new materials and technologies for the delivery of drugs and contrast agents. Her research has resulted in well over 100 peer-reviewed publications, numerous patent applications and book chapters on both lipid and polymer-based drug delivery systems. She is also the co-founder and President of Nanovista Inc., a start-up housed in Johnson & Johnson Innovations J Labs @Toronto, which is focused on the development of multimodal contrast agents to improve the performance of image-guided high precision cancer therapy.

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Stephanie Allen
School of Pharmacy
University of Nottingham

Nottingham
(UK)

**Giulio Caracciolo**

Department of Molecular Medicine
University of Rome
Rome
(Italy)

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Biography of Giulio Caracciolo

Giulio Caracciolo is Professor at the Molecular Medicine Department of the Sapienza University of Rome. He is mainly interested in understanding the bio–nano interactions between nanodelivery systems and physiological environments. The relationships between synthetic identity, biological identity and physiological response of drug delivery systems will enable researchers to predict their outcome after administration *in vivo*. This would represent a truly new paradigm in the field of pharmaceuticals and nanomedicine.

Close

**Bin Chen**

State Key Laboratory of Multiphase Flow in Power Engineering
Xi'an Jiaotong University
Xi'an Shi
(China)

[Biography](#)

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Biography of Bin Chen

Dr. Bin Chen is now a Full Professor and Vice Director at the State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University. He received his Ph.D in 2002 from Xi'an Jiaotong University, China. Afterwards, he worked as Postdoctoral Research Fellow of Japan Society for the Promotion of Science from 2002 to 2004. For more than a decade, Dr. Chen has devoted his efforts to the research on laser dermatology, in particular with the laser treatment of Port Wine Stain. He is currently working on photothermal-activatable liposomal drug delivery, blood absorption enhancement by nano-particle, as well as animal experiment on thermal damage of blood capillary by 595nm and 1064nm laser. He has published over 50 peer-reviewed journal papers and was invited for more than 20 keynote speeches.

Close

**Pieter Cullis**

Biochemistry and Molecular Biology

University of British Columbia

Vancouver, BC

(Canada)

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Biography of Pieter Cullis

Pieter R. Cullis, Ph.D. FRSC is the Director of Life Sciences Institute at the University of British Columbia (UBC) He is a Professor in the Department of Biochemistry and Molecular Biology and Director of the, NanoMedicines Research Group, UBC. Dr. Cullis and co-workers made fundamental advances in the generation, loading and targeting of lipid nanoparticle (LNP) systems for intravenous delivery of small molecule drugs and macromolecular drugs such as small interfering RNA (siRNA). This work has contributed to three drugs that have been approved by regulatory agencies in the U.S. and Europe for the treatment of cancer and its complications. Dr. Cullis has co-founded ten biotechnology companies, has published over 300 scientific articles and is an inventor of over 60 patents. He also co-founded the BC Personalized Medicine Initiative in 2012. Dr. Cullis received many awards and was elected as the Fellow of the Royal Society of Canada in 2004 and was awarded the Prix Galien, Canada's premier prize for achievements in pharmaceutical R&D, in 2011.

Close

**Sudip Das**

Department of Pharmaceutics & Drug Delivery

Butler University, College of Pharmacy and Health Sciences

Indianapolis, IN

(USA)

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Biography of Sudip Das

Dr. Sudip Das is a professor of pharmaceutical sciences at Butler University, College of Pharmacy & Health Sciences. He is also an Adjunct Professor in the School of Medicine, Indiana University. He was the chair of the department of pharmaceutical sciences and the director of the graduate program in pharmaceutical sciences at Butler University. Dr. Das has over thirty years of teaching and research experience in the professional pharmacy and graduate programs in the USA and Canada. His current research involves targeted delivery of siRNA and anticancer drugs for the treatment of breast cancer and glioblastoma. Dr. Das has over 150 research publications, review articles, patents, proceedings, conference presentations, and book chapters, is a recipient of multiple awards/honors, and has secured

extramural research funding from NIH, PDA, and several pharmaceutical industries.

Close



Nunzio Denora

Department of Pharmacy
University of Bari Aldo Moro
Bari
(Italy)

[Biography](#)

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Biography of Nunzio Denora



Nunzio Denora received the degree in Chemistry and Pharmaceutical Technology from the University of Bari in 2001 and obtained his Ph.D. in Pharmaceutical Technology from the University of Palermo in 2004. After a postdoctoral position in the Department of Pharmaceutical Chemistry at Kansas University (2005-2006), he was appointed as assistant professor and research scientist of Pharmaceutical Technology in the Department of Pharmacy - Drug Sciences of the University of Bari. He has published more than 80 articles, is author of 3 book chapters, more than 100 posters and several oral presentations and is inventor of 3 patents.

Close



Christine Dufès

Strathclyde Institute of Pharmacy and Biomedical Sciences
University of Strathclyde
Glasgow
(UK)

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Biography of Christine Dufès



Dr. Christine Dufès is a Senior Lecturer at the Strathclyde Institute of Pharmacy and Biomedical Sciences (SIPBS), University of Strathclyde, Glasgow, United Kingdom. She obtained a Doctorate in Pharmacy and a PhD from the University of Poitiers (France). Her research interests include the targeted delivery of drugs and therapeutic genes to tumours and cerebral diseases. She has been awarded the Biochemical Journal Young Investigator Award (2009) and the Tom Gibson Memorial Award (2012) for her research, in addition to the Best Overall Strathclyde Teaching Excellence Award 2013 for her teaching. She sits on the editorial boards for 17 journals.

Close

**Martin J. D'Souza**

Vaccine Nanotechnology Laboratory
Mercer University
Atlanta, GA
(USA)

[Biography](#)

**Biography of Martin J. D'Souza**

Dr. Martin J. D'Souza obtained his Ph.D. degree (1987) in Pharmaceutical Sciences from the University of Pittsburgh, Pittsburgh, PA, USA. Dr. D'Souza is currently performing numerous roles at Mercer University, Atlanta, GA, USA, i.e. Professor & Director of Graduate Programs in the College of Pharmacy. He is the Director of Mercer Clinical Laboratory, Co-Director of the Center for Drug Delivery Research, and Chair of the Pharmaceutics. He is the co-founder of Drug Delivery Therapeutics. His main fields of specialization include Vaccines, Pharmacokinetics, Bio-pharmaceutics, Bio-technology, etc.

Close

**Biana Godin**

Department of Nanomedicine
The Methodist Hospital Research Institute
Houston, TX
(USA)

**Khaled F. Greish**

Department of Molecular medicine
Arabian Gulf University
Manama
(Bahrain)

[Biography](#)

**Biography of Khaled F. Greish**

Khaled Greish is Associate Professor of Molecular Medicine, and head of the Nano-research unit, at Princes Al-Jawhara Centre, Arabian Gulf University, Kingdom of Bahrain, and Adjunct Associate Professor of Pharmaceutical Chemistry at University of Utah, USA. He Published > 70 peer reviewed papers, and 10 book chapters in the field of targeted anticancer drug delivery. Controlled Release Society (CRS) awarded him the CRS Postdoctoral Achievement award in 2008 and in 2010; he

was elected as the member of the CRC College of Fellows in 2014 at the University of Otago.

Close



Zhong Gu

National Engineering Research Center for Biomaterials
Sichuan University
Chengdu
(China)

[Biography](#)

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Biography of Zhong Gu



Professor Zhongwei Gu graduated from Peking University in 1981 and served as a senior visiting scholar in the Research Triangle Institute, RTP and the University of Utah, USA, respectively from 1984 to 1986 and 1991 to 1993. He was appointed as a Professor in 1994, and has thrice been the Chief Scientist of the National Basic Research Program of China (the 973 program) since 1999. He is a Fellow of International Union of Societies for Biomaterials Science and Engineering (FBSE). His current research activities focus on the biomedical polymers, nano-biomaterials and drug delivery systems and tissue engineering.

Close



Jianfeng Guo

School of Pharmaceutical Sciences
Jilin University
Changchun
(China)

[Biography](#)

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Biography of Jianfeng Guo



Dr. Jianfeng Guo, Ph.D., is a Professor of Nanomedicine at School of Pharmaceutical Sciences, Jilin University, China. He received his PhD in 2011 from University College Cork (UCC), Ireland. He was a Research Fellow at University of Michigan, Ann Arbor, followed by industrial working experience at the Viva Biotech Ltd., Shanghai, as a Project Manager. He then spent three years at UCC as a Senior Research Fellow, prior to joining in Jilin University in 2016. He was awarded the Embark Initiative Postgraduate Scholarship, Chinese Government Award for Outstanding Self-financed Students Abroad. Dr. Jianfeng Guo has published 24 peer-reviewed scientific articles.

Close

**Umesh Gupta**

Department of Pharmacy
Central University of Rajasthan
Ajmer
(India)

[Biography](#)

**Biography of Umesh Gupta**

Dr. Umesh Gupta, currently working as Assistant Professor in the Department of Pharmacy, Central University of Rajasthan, India. He did Ph.D. in Pharmaceutical Sciences from Dr. H. S. Gour University, Sagar, India under the mentorship of Prof. NK Jain. He has recently been awarded “DAAD Research Stays for Academics and Scientists” at Leibniz-institut fur Polymerforschung Dresden, Germany. He has the past experience of working as Research Scientist at Ranbaxy Research Laboratories, India and Post-Doctoral Research Associate at South Dakota State University, USA. He joined the Central University of Rajasthan in the year 2013.

Close

**Lisbeth Illum**

IDentity - Pharmaceutical Consultancy
Nottingham
(UK)

[Biography](#)

**Biography of Lisbeth Illum**

Professor Lisbeth Illum was the founder and Managing Director of DanBioSyst UK Ltd a drug delivery technology company, sold successfully to West Pharmaceutical Services and now Archimedes Lab Ltd. She was the CEO of Critical Pharmaceuticals Ltd a drug delivery company. She now works as a consultant to the pharmaceutical industry and expert witness in patent litigations. She was awarded M. Pharm, Ph. D and D.Sc. from the Royal Danish School of Pharmacy in 1972, 1978 and 1988, respectively. Her research expertise is in the area of novel drug delivery systems for difficult drugs, such as hydrophilic and insoluble drugs, peptide and proteins. She has published more than 350 scientific papers, co-edited four books and filed more than 45 patent family applications on novel drug delivery systems, of which a large number of patents have been granted. She has lectured extensively throughout the world at conferences and workshops. She is a Fellow of the AAPS and CRS. She has been on the editorial boards of eleven scientific journals.

Close

**Kazunori Kataoka**

Department of Materials Engineering
University of Tokyo
Tokyo
(Japan)

**Xin-Gui Li**

College of Environmental Science & Engineering
Tongji University
Shanghai
(China)

[Biography](#)

**Biography of Xin-Gui Li**

Dr. Xinn- Guii Lii obtained PhD in Polymer Materials from China Textile University, Shanghai. He is presently serving as Professor of Polymer Materials and Director of Inst. of Mater Chem at Tongji University, Shanghai, China. He has been recognized with many awards and honors such as ACS Membership Award in 2015, Natural Science Prize in 2015 and many other awards. He is also a member of different organizations such as ACS, National Engineering Research Center of Electronic Circuits Base Materials of China, Key Laboratory of Advanced Polymer Materials, Shanghai, China, Educational Ministry of China, and Shanghai Key Laboratory for Advanced Polymer Materials.

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**Ulrich Lächelt**

Department of Pharmacy
Ludwig Maximilian University of Munich
Munich
(Germany)

[Biography](#)

**Biography of Ulrich Lächelt**

Ulrich Lächelt studied pharmaceuticals at the University of Heidelberg and received a doctoral degree in Pharmaceutical Biology at the LMU Munich in 2014. He worked on multifunctional sequence-defined nucleic acid carriers together with Prof. Ernst Wagner. Since 2017 he continues the research on drug delivery and nanomedicine as junior research group leader and candidate for habilitation. He is an extraordinary member of the Center for NanoScience (CeNS) at the LMU. His research

focuses on the intracellular delivery of biomacromolecules, such as nucleic acids, peptides and proteins, the development of drug conjugates and inorganic-organic hybrid nanopharmaceuticals.

Close



Achuthamangalam B. Madhankumar

Department of Neurosurgery
Pennsylvania State University
Hershey, PA
(USA)



Tamara Minko

Department of Pharmaceutics
Rutgers University
Piscataway, NJ
(USA)

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Biography of Tamara Minko



Tamara Minko, Ph.D., is a Distinguished Professor and Chair of the Department of Pharmaceutics at Rutgers University. Her current research interests include nanotechnology; drug delivery; personalized nanomedicine; molecular targeting; nucleic acids delivery; mechanisms of multidrug resistance; bioimaging; preclinical evaluation of new therapeutics; and modulation of cell death mechanisms during hypoxia. Professor Minko is author and coauthor of more than 400 publications. Dr. Minko is an elected Fellow of CRS, AAPS, and AIMBE; recipient of numerous awards. She also is an Executive Editor of *Advanced Drug Delivery Reviews*, Editor of *Pharmaceutical Research*, President-Elect of the Controlled Release Society.

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Teresa Musumeci

Department of Drug Science
University of Catania
Catania
(Italy)

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Biography of Teresa Musumeci



Teresa Musumeci is an assistant professor and research scientist in the Department of Drug Sciences at the University of Catania, since 2008. Teresa Musumeci received her Pharmacy degree from the University of Catania (Italy) in 2001. She received her PhD in Pharmaceutical Technology from the University of Palermo (Italy) in 2007. She is the author of 30 per-reviewed papers and 2 book chapters. Her scientific activity is focused on design and characterization of nanocarriers for delivery of drugs.

Close



Caitriona O'Driscoll

School of Pharmacy
University College Cork
Cork
(Ireland)



Kamla Pathak

Department of Pharmaceutics
Uttar Pradesh University of Medical Sciences
Etawah
(India)

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Biography of Kamla Pathak



Professor Kamla Pathak, Professor and Head of the Department of Pharmaceutics, Pharmacy College Saifai, U. P. RIMS&R, Saifai, Etawah, India has a teaching and research experience of more than 26 years. She is actively engaged in research on oral controlled /modulated/targeted and topical drug delivery systems. She has over 200 publications in journals of international and national repute, 3 patents, authored book chapters and more than 180 abstracts of the papers presented in scientific forums to her credit. She has supervised Ph.Ds, more than 120 postgraduate theses and has a h-index of 21.

Close



Qiang Peng

West China Hospital of Stomatology
Sichuan University
Chengdu
(China)

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Biography of Qiang Peng



Dr. Qiang Peng obtained his B.S. degree (2006), M.A. degree (2009), and Ph.D in pharmaceutics (2012) from Sichuan University, China. He joined West China Hospital of Stomatology, Sichuan University as a lecturer in 2012 and promoted as an associate professor in 2014. Dr. Peng once worked in Keele University from 2010 to 2011 and in University of Copenhagen during 2015. His research focuses on nanomaterials-based advanced drug delivery. As a young scientist, he has published more than 20 publications. He won the Sichuan Provincial Award of Outstanding PhD Dissertation in 2014 and the First Prize of Chinese Outstanding Young Investigator Award, IADR-China Division in 2014.

Close



Stefano Salmaso

Department of Pharmaceutical and Pharmacological Sciences
University of Padova
Padova
(Italy)

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Biography of Stefano Salmaso



Stefano Salmaso is associate professor in the Department of Pharmaceutical and Pharmacological Sciences of the University of Padova (Italy), where he teaches Technology of delivery and controlled release of drugs. He obtained his Ph.D. in Pharmaceutical Sciences in 2004 and the Master degree in Chemistry and Pharmaceutical Technology from the University of Padova. He held positions as assistant professor at the University of Padova and associate scientist at Northeastern University - Boston (USA) in 2005 and 2008. He is author of 58 peer-reviewed publications, 3 book chapters, and inventors of 3 international patents. His scientific activity is focused on the development of responsive “smart” nanocarriers for the delivery of drugs and biopharmaceutics.

Close



Helder Santos

Division of Pharmaceutical Technology, Faculty of Pharmacy
University of Helsinki
Helsinki
(Finland)

[Biography](#)

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Biography of Helder Santos

Dr. Santos obtained a doctorate (D.Sc.) in Chemical Engineering from the Helsinki University of Technology, Helsinki, Finland. Currently Dr. Santos is an



Adjunct Professor in Pharmaceutical Nanotechnology at the University of Helsinki, Finland. He has published more than 150 scientific publications. Dr. Santos serves as Editor and is in the Editorial Board of several international journals.

Close



Sevda Senel

Department of Pharmaceutical Technology
Ankara University
Ankara
(Turkey)

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Biography of Sevda Senel



Sevda Şenel is Professor at the School of Pharmacy at Hacettepe University, Ankara Turkey. Numerous international (NATO-CRG, NATO-CLG, British Council, EU-7-SME) and national (TUBITAK, SAN-TEZ) projects led her group to the development of non-invasive systems for drugs and vaccines via various mucosae (buccal, sublingual and nasal) in human and veterinary field. Dr. Şenel and her research group has been awarded a number of prestigious honors including AAPS-PharmSciTech Best Poster Award (2015), Hacettepe University Science Award (2011), The Distinguished Scientist Award - by the Academy of Science of the Turkish Pharmacists Association (2010), CRSIntervet Best Veterinary Paper Award (2005) and the Novartis Pharmaceutical Technology Research Award (2004). Dr. Şenel is the author of more than 150 research publications, which includes original research and book chapters.

Close



Amanda K.A. Silva

Laboratoire Matière et Systèmes Complexes (UMR 7057)
Paris Diderot University
Paris
(France)

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Biography of Amanda K.A. Silva



Amanda K. A. Silva obtained a degree in Pharmacy in 2005 at UFRN, Brazil, and a PhD in Pharmaceutical Technology in 2008 in the domain of gastro-resistant magnetic microcapsules. She obtained a second PhD in Cellular and Molecular Biology in 2010 from the Université d'Evry, France concerning polysaccharides for thermo-controlled cell culture in 3D. In 2013, Amanda obtained a tenured CNRS

researcher position at Matter and Complex Systems lab in Paris. She works in physical approaches for regenerative medicine, extracellular vesicle engineering, theranosis and photo-activated therapies. Amanda has published 37 papers and is an inventor in 4 patents.

Close



Vladimir P. Torchilin

Center for Pharmaceutical Biotechnology and Nanomedicine
Northeastern University

Boston, MA

(USA)

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Biography of Vladimir P. Torchilin



Vladimir P. Torchilin, Ph.D., D.Sc. is a University Distinguished Professor of Pharmaceutical Sciences and Director, Center for Pharmaceutical Biotechnology and Nanomedicine, Northeastern University, Boston. His interests include drug delivery and targeting, nanomedicine, multifunctional and stimuli-sensitive pharmaceutical nanocarriers, biomedical polymers, experimental cancer therapy. He has published more than 400 original papers, more than 150 reviews and book chapters, wrote and edited 12 books, and holds more than 40 patents. Google Scholar has shown more than 44,000 citations of his papers with an H-index of 96. He is Editor-in-Chief of Current Drug Discovery Technologies, Drug Delivery, and OpenNano, Co-Editor of Current Pharmaceutical Biotechnology and on the Editorial Boards of many other journals. He received more than \$30 M from the governmental and industrial sources in research funding. He has multiple honors and awards and in 2011, Times Higher Education ranked him number 2 among the top world scientists in pharmacology for the period of 2000-2010.

Close



Ernst Wagner

Department of Pharmacy, and Center for Nanoscience (CeNS)

Ludwig-Maximilians-Universität (LMU)

Munich

(Germany)

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Biography of Ernst Wagner

Dr. Wagner is Professor of Pharmaceutical Biotechnology at Ludwig-Maximilians-Universität Munich and a member of the Munich Center for Nanoscience. He coordinates 'Biomedical Nanotechnologies' of the Excellence



Cluster 'Nanosystems Initiative Munich'. After a Ph.D. in Chemistry from the Technical University of Vienna and a postdoctoral stay at the ETH Zurich, he was the group leader at the IMP Vienna and Director for Cancer Vaccines at Boehringer Ingelheim Austria. Dr. Wagner has authored more than 390 publications with an h-index 70. He has been a board member of the German Society for Gene Therapy, Committee member of ASGCT, and BSA member of the CRS.

Close



Roderick Bryan Walker
Division of Pharmaceutics
Rhodes University
Grahamstown
(South Africa)

[Biography](#)

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Biography of Roderick Bryan Walker



Professor Walker completed his Ph.D. degree in Biopharmaceutics and Pharmacokinetics at Rhodes University in Grahamstown, South Africa. He is the former Dean and Head of the Faculty of Pharmacy at Rhodes and is currently the Professor of Pharmaceutics and is the current chair of the Academy of Pharmaceutical Sciences in South Africa. Professor Walker has published and presented over 200 scientific outputs and serves on the editorial boards of a number of journals. Professor Walker undertakes research studies in all aspects of drug delivery and product development.

Close



Zimei Wu
School of Pharmacy
University of Auckland
Auckland
(New Zealand)

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Biography of Zimei Wu



Zimei Wu is an Associate Professor at the School of Pharmacy, University of Auckland, New Zealand (NZ). She holds a PhD from University of Otago (NZ) and a Masters from China Pharmaceutical University. Her 'liposomes' research has attracted wide collaborations. She received an NZ-China Scientist Exchange Award from the Royal Society of NZ. She also researches transdermal delivery with successful stories featured on NZ TV3. Zimei also serves on editorial boards of

Journal of Liposome Research, and Pharmaceutical Development and Technology and a referee for >20 journals. Zimei was the past President of NZ Local Chapter of Controlled Release Society.

Close



Shirley Wu

Department of Pharmaceutical Sciences
University of Toronto
Toronto, ON
(Canada)



Sarita K. Yadav

Department of Pharmacy
MLN Medical College Prayagraj
Uttar Pradesh
(India)

[Biography](#)

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Biography of Sarita K. Yadav



Dr. Sarita K Yadav obtained her B. Pharm from DIPSAR and earned her M. Pharm and Ph.D. from IIT(BHU), India. Currently, she is working as Assistant Professor at MLN Medical College, Prayagraj. She has qualified GATE 2009 with AIR-32. She had worked for two years as drug analyst in testing of drugs and cosmetics products at UPFSDA, Lucknow. She had received “Young Scientist Award-WF” in 2015 by SPER for her research contributions. She holds lifetime membership of APTI, IPGA, SPER, and PRISAL. She is a member of editorial board of Micro and Nano System (MNS) by Bentham Science, IJBST journal group and peer reviewer in Future Journal of Pharmaceutical Sciences, Saudi Pharmaceutical Journal etc. Currently, she has many research/reviews papers to her credit in high impact journals with total impact factor around 60.

Close



Yanjun Zhao

Department of Pharmaceutics
Tianjin University
Tianjin
(China)

[Biography](#)

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Biography of Yanjun Zhao



Prof. Zhao is a Full Professor of Pharmaceutics in the School of Pharmaceutical Science and Technology, Health Science Platform, Tianjin University. He obtained the Bachelor (Polymer), Master (Engineering), and PhD (Pharmacy) degree from Dalian University of Technology, Dalian Institute of Chemical Physics (CAS), and King's College London, respectively. His research interests focus on pharmaceutical micelles, stimuli-responsive drug delivery, and ferroptosis antitumor nanomedicine.

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Associate Editorial Board Members



Goutam Mondal

Postdoctoral Research Associate
National Center for Natural Products Research
University of Mississippi
Oxford, MS
(USA)

[Biography](#)

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Biography of Goutam Mondal



Dr. Goutam Mondal is an emerging pharmaceutics and drug delivery scientist. He is an expert in the design and synthesis of receptor targeted lipids and polymeric systems, the techniques of animal tissue culture, tumor growth inhibition studies, and pharmacokinetics studies of small molecules. Presently, he is associated with Dr. Ikhlas A Khan's research group under supervision of Dr. Ryan Yates at the National Center for Natural Products Research, University of Mississippi, USA where he is actively involved in pre-clinical and clinical pharmacokinetics and pharmacodynamics of natural products. He has published 21 research articles in high impact peer-reviewed journals.

Close



Mariane L. Nogueira

Department of Pharmacy
Federal University of Pernambuco
Recife
(Brazil)

[Biography](#)

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Biography of Mariane L. Nogueira



Dr. Mariane Lira Nogueira is a Pharmacist. She obtained Master's degree in Pharmaceutical Sciences, and Ph.D. in Biological Sciences with an emphasis on Biotechnology. She completed an interuniversity exchange doctorate in Pharmacotechnics (2007-2008) at the Faculté de Pharmacie - Université Paris Sud 11 and an internship at the Universidad de Navarra (2008). She did Post-doc from the Université Paris Saclay (2014-2015). She is currently an Associate Professor at the Federal University of Pernambuco, Brazil, a researcher at the Keizo-Asami Immunopathology Laboratory, and leader of Nanotechnology, Biotechnology, and Cell Culture Research Group. Her research fields are mainly focused on the development and characterization of surface-modified nanocarriers for biomedical applications.

Close



Meysam Omid

Protein Research Centre
Shahid Beheshti University G.C.
Tehran, Velenjak
(Iran)

[Biography](#)

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Biography of Meysam Omid



Dr. Meysam Omid is an Assistant Professor of Protein Research Center, Shahid Beheshti University. Dr. Omid's research is focused on application of nanobiomaterials in soft, hard, and interfacial tissue engineering. He is particularly interested to design and fabricate smart nano drug delivery systems for regenerative medicine application. He has (co)authored over 80 research papers in the field of nanoscience and nanotechnology.

Close



Aniruddha Roy

Department of Pharmacy
Birla Institute of Technology and Science
Pilani
(India)

[Biography](#)

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Biography of Aniruddha Roy

Dr. Aniruddha Roy is currently working as an Assistant Professor in the Department of Pharmacy at Birla Institute of Technology and Science (BITS) -



Pilani, India. He is a Pharmaceutical Technologist by training. He completed PhD in Immunology from National Institute of Immunology (NII), New Delhi, India. His main area of PhD thesis work was immunotherapy of cancer. After PhD, he worked at the Indian Institute of Technology, New Delhi, Ontario Institute for Cancer Research at the University of Toronto, Canada, and University of British Columbia, Canada in various capacities. He has more than ten years of research experience. His research is primarily focused on nanomedicine and targeted drug delivery in different diseases.

Close

Executive Guest Editor(s)



Ismail Ocsoy

Department of Analytical Chemistry
Erciyes University
Kayseri
(Turkey)

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Biography of Ismail Ocsoy



Dr. Ismail Ocsoy is a Professor in the faculty of Pharmacy, Erciyes University, Kayseri, Turkey. He completed his MS and Ph.D. in Chemistry from the Department of Chemistry, University of Florida, USA. His research focuses on Nano biotechnology consisting of DNA Aptamer conjugated nanomaterial, cancer therapy models, anti-cancer, antimicrobial agents and Nano bio-sensor for detection of antibiotic resistant bacteria. He has published more than 70 papers in highly reputable and prestigious journals.

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Editor-in-Chief



Zongjin Li

Department of Pathophysiology
Nankai University School of Medicine
Tianjin
(China)

[Biography](#)

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Biography of Zongjin Li



Dr. Zongjin Li is a Professor at the Department of Pathophysiology and a Director of the Laboratory of Molecular Imaging and Stem Cell Therapy at Nankai University School of Medicine, Tianjin, China. He received his PhD degree from Peking Union Medical College and completed his postdoctoral training in the Molecular Imaging Program (MIPS) at Stanford University, USA. He has published more than 120 peer-reviewed papers on molecular imaging and stem cell therapy.

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Co-Editors



Jay B. Ramapuram

Department of Drug Discovery and Development
Harrison School of Pharmacy
Auburn, AL
(USA)

[Biography](#)

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Biography of Jay B. Ramapuram



Dr. Ramapuram Jayachandra Babu is currently a Professor and Graduate Program Officer at the Department of Drug Discovery and Development, Harrison School of Pharmacy, Auburn University. He received his Bachelor's degree in Pharmacy from the University of Madras and Masters and PhD degrees in Pharmaceutics from Indian Institute of Technology, Varanasi, India. His research interests include formulation development of nanoparticle based formulations for topical and oral delivery, solubility improvement of insoluble drugs, percutaneous penetration enhancement techniques, and transdermal drug delivery systems. He has authored and co-authored over 90 peer reviewed papers and 100 conference abstracts in several national and international conferences. He has served as a chair and co-

chair of scientific sessions at the Annual National Meetings of American Association of Pharmaceutical Scientists and Society of Toxicology. He serves as an editorial board member for five journals and as a peer reviewer for more than forty journals. His field of expertise are Transdermal Drug Delivery; Nanoparticles, Solubility improvement; Ocular Drug Delivery.

Close

Associate Editors



Maria J. Blanco-Prieto

Department of Pharmacy and Pharmaceutical Technology
University of Navarra
Pamplona
(Spain)

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Biography of Maria J. Blanco-Prieto



Maria J. Blanco-Prieto received her degree of Pharmacy Degree from the University of Santiago de Compostela (Spain), followed by a PhD in Pharmaceutical Sciences from the University of Paris-Sud (France). She completed post-doctoral training at the Swiss Federal Institute of Technology (ETH), Zürich, (Switzerland) and then joined the

University of Navarra where presently she is a Full Professor of Pharmacy and Pharmaceutical Technology. Her research interest is in the field of biomaterials and advanced drug carrier systems including the design and the development of polymer and lipid based micro- and nanoscale carriers, their biological evaluation in in vitro cell cultures and also their pharmacokinetic and dynamic impact in vivo (using relevant animal models of the diseases).

Close



Darryl T. Martin

Department of Urology
Yale University School of Medicine
New Haven, CT
(USA)

[Biography](#)

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Biography of Darryl T. Martin

Dr. Darryl T. Martin is a Research Scientist at the Yale School of Medicine. He obtained his PhD from the Division of Biomedical Sciences, the Memorial University of Newfoundland in 2010. His research interests include drug delivery



systems that target prostate and bladder cancers using nanoparticle-based platforms for diagnostic and therapeutic purposes.

Close



Yu Nie

Department of Biomedical Engineering
Sichuan University (SCU)
Chengdu
(China)

[Biography](#)

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Biography of Yu Nie



Dr. Yu Nie obtained PhD in Pharmaceutical Sciences from West China School of Pharmacy, Sichuan University, China. She is presently serving as a Professor at NERCB, Sichuan University, China and before that she was an Assistant Professor at the same institution. She also has an experience as a postdoc fellow at Ludwig-Maximilian-University of Munich, Germany. Her research interests include Regenerated bio-materials, medicinal excipients in ophthalmology and Orthopedics. She has contributed more than 50 publications, having citations around 1050.

Close

Regional Editors

Asia



Farid Dorkoosh

Department of Pharmaceutics
Tehran University of Medical Sciences
Tehran
(Iran)

[Biography](#)

×

Biography of Farid Dorkoosh

Dr. Dorkoosh received his PhD in pharmaceutics and biopharmaceutics from Leiden University, the Netherlands in 2002. He followed an international training on intellectual property and management of innovation at World Intellectual Property Organization (WIPO) in Geneva, Switzerland in 2005.



He got his Diploma in management from Chartered Management Institute of London, UK in 2009. He is currently an associate professor at Tehran University of Medical Sciences. He is also the head of Patent office of Tehran University of Medical Sciences. Dr. Dorkoosh has published more than 80 research articles and held 10 patents and patent applications.

Close



Murugan Ramalingam
Centre for Stem Cell Research
Christian Medical College Campus
Vellore
(India)

[Biography](#)

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Biography of Murugan Ramalingam



Dr. Murugan Ramalingam is a Professor at the Centre for Stem Cell Research (India). Concurrently, he is an Adjunct Professor at the Tohoku University (Japan). He worked as Associate Professor at the Université de Strasbourg (France) and Assistant Professor at the WPI-Advanced Institute for Materials Research (Japan). He has also worked at the U.S. National Institute of Standards and Technology (NIST) and the National Institutes of Health (NIH). He received his Ph.D. in Biomaterials from the University of Madras. He is the author of over 260 scientific publications.

Close

Europe



Clare Hoskins
Director of Postgraduate Research Medical Sciences (Laboratory)
Keele University
Newcastle, England
(United Kingdom)

[Biography](#)

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Biography of Clare Hoskins

Dr. Clare Hoskins obtained PhD in Pharmaceutics from Robert Gordon University, Aberdeen. She is presently serving as a Senior Lecturer in Pharmaceutics at Keele University. She is a member of different professional bodies such as Royal Society of Chemistry, Controlled Released Society,



British Nano-medicine Society and Higher Education Academy. She has contributed numerous publications in different national and international journals. She also possesses different editorial responsibilities in different journals as a guest editor and editorial board member.

Close

North America



Glen S. Kwon

School of Pharmacy-Wisconsin Center for NanoBioSystems
University of Wisconsin
Madison, WI
(USA)

[Biography](#)

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Biography of Glen S. Kwon



Dr. Kwon is the Jens T. Carstensen Distinguished Chair Professor in the School of Pharmacy at University of Wisconsin. He received the Jorge Heller Journal of Controlled Release/Controlled Release Society (CRS) Outstanding Paper Award (1994) and CRS Young Investigator Research Achievement Award (2003). He is a Fellow of the American Association of Pharmaceutical Scientists (2012) and a highly-cited researcher by Thomson Reuters in the category of Pharmacology & Toxicology (2014). He is co-founder of Co-D Therapeutics Inc., a start-up company dedicated to multi-drug anticancer nanotherapeutics.

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Section Editors



Biodegradable polymers for nanomedicine

Rohidas Arote

Department of Molecular Genetics
Seoul National University
Seoul
(South Korea)

[Biography](#)



Biography of Rohidas Arote



Prof. Arote Rohidas is an Associate Professor and the director of Nanomedicine Laboratory in the Dept. of Molecular Genetics, School of Dentistry, Seoul National University. His research includes nanotechnology, drug delivery, molecular targeting, nucleic acid delivery, bioimaging and modulation of cell death mechanism has been published in over 50 international journals and also produced various patents.

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Editorial Board Members



Hua Ai
Department of Radiology
Sichuan University
Chengdu
(China)



Alaa A. Aljabali
Faculty of Pharmacy
Yarmouk University
Irbid
(Jordan)
[Biography](#)



Biography of Alaa A. Aljabali



Alaa A. Aljabali completed MRes in cancer biomarkers from Essex University and a Ph.D. in Bionanotechnology from John Innes Centre (UK). He worked as a postdoctoral research fellow at the University of Oxford on the development of nanoparticles as clinical imaging agents. Recently, he completed Fellowship in Responsible Conduct of Research at the University of California San Diego. His research interest are Biomaterials, Drug delivery and targeting, Material science, and Nanomedicine.

Close



Christine Allen
Leslie Dan Faculty of Pharmacy
University of Toronto
Toronto, ON

(Canada)

[Biography](#)

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Biography of Christine Allen



Christine Allen is the GlaxoSmithKline Chair in Pharmaceutics and Drug Delivery and a Professor in the Leslie Dan Faculty of Pharmacy and the Departments of Chemical Engineering and Applied Chemistry and IBBME at the University of Toronto. Allen's research is focused on the design and development of new materials and technologies for the delivery of drugs and contrast agents. Her research has resulted in well over 100 peer-reviewed publications, numerous patent applications and book chapters on both lipid and polymer-based drug delivery systems. She is also the co-founder and President of Nanovista Inc., a start-up housed in Johnson & Johnson Innovations J Labs @Toronto, which is focused on the development of multimodal contrast agents to improve the performance of image-guided high precision cancer therapy.

Close



Stephanie Allen

School of Pharmacy
University of Nottingham
Nottingham
(UK)



Giulio Caracciolo

Department of Molecular Medicine
University of Rome
Rome
(Italy)

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Biography of Giulio Caracciolo



Giulio Caracciolo is Professor at the Molecular Medicine Department of the Sapienza University of Rome. He is mainly interested in understanding the bio-nano interactions between nanodelivery systems and physiological environments. The relationships between synthetic identity, biological identity and physiological response of drug delivery systems will enable researchers to predict their outcome after administration in vivo. This would represent a truly new paradigm in the field of pharmaceutics and nanomedicine.

Close

**Bin Chen**

State Key Laboratory of Multiphase Flow in Power Engineering
Xi'an Jiaotong University
Xi'an Shi

(China)

[Biography](#)

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Biography of Bin Chen

Dr. Bin Chen is now a Full Professor and Vice Director at the State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University. He received his Ph.D in 2002 from Xi'an Jiaotong University, China. Afterwards, he worked as Postdoctoral Research Fellow of Japan Society for the Promotion of Science from 2002 to 2004. For more than a decade, Dr. Chen has devoted his efforts to the research on laser dermatology, in particular with the laser treatment of Port Wine Stain. He is currently working on photothermal-activatable liposomal drug delivery, blood absorption enhancement by nano-particle, as well as animal experiment on thermal damage of blood capillary by 595nm and 1064nm laser. He has published over 50 peer-reviewed journal papers and was invited for more than 20 keynote speeches.

Close

**Pieter Cullis**

Biochemistry and Molecular Biology
University of British Columbia
Vancouver, BC

(Canada)

[Biography](#)

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Biography of Pieter Cullis

Pieter R. Cullis, Ph.D. FRSC is the Director of Life Sciences Institute at the University of British Columbia (UBC) He is a Professor in the Department of Biochemistry and Molecular Biology and Director of the, NanoMedicines Research Group, UBC. Dr. Cullis and co-workers made fundamental advances in the generation, loading and targeting of lipid nanoparticle (LNP) systems for intravenous delivery of small molecule drugs and macromolecular drugs such as small interfering RNA (siRNA). This work has contributed to three drugs that have been approved by regulatory agencies in the U.S. and Europe for the treatment of cancer and its complications. Dr. Cullis has co-founded ten biotechnology companies, has published over 300 scientific articles and is an inventor of over 60 patents. He also co-founded the BC Personalized Medicine Initiative in 2012. Dr. Cullis received many awards and was elected as the Fellow of the Royal Society of Canada in 2004 and was awarded the Prix Galien, Canada's premier prize for achievements in pharmaceutical R&D, in 2011.

Close

**Sudip Das**

Department of Pharmaceutics & Drug Delivery
Butler University, College of Pharmacy and Health Sciences
Indianapolis, IN
(USA)

[Biography](#)

**Biography of Sudip Das**

Dr. Sudip Das is a professor of pharmaceutical sciences at Butler University, College of Pharmacy & Health Sciences. He is also an Adjunct Professor in the School of Medicine, Indiana University. He was the chair of the department of pharmaceutical sciences and the director of the graduate program in pharmaceutical sciences at Butler University. Dr. Das has over thirty years of teaching and research experience in the professional pharmacy and graduate programs in the USA and Canada. His current research involves targeted delivery of siRNA and anticancer drugs for the treatment of breast cancer and glioblastoma. Dr. Das has over 150 research publications, review articles, patents, proceedings, conference presentations, and book chapters, is a recipient of multiple awards/honors, and has secured extramural research funding from NIH, PDA, and several pharmaceutical industries.

Close

**Nunzio Denora**

Department of Pharmacy
University of Bari Aldo Moro
Bari
(Italy)

[Biography](#)

**Biography of Nunzio Denora**

Nunzio Denora received the degree in Chemistry and Pharmaceutical Technology from the University of Bari in 2001 and obtained his Ph.D. in Pharmaceutical Technology from the University of Palermo in 2004. After a postdoctoral position in the Department of Pharmaceutical Chemistry at Kansas University (2005-2006), he was appointed as assistant professor and research scientist of Pharmaceutical Technology in the Department of Pharmacy - Drug Sciences of the University of Bari. He has published more than 80 articles, is author of 3 book chapters, more than 100 posters and several oral presentations and is inventor of 3 patents.

Close

**Christine Dufès**

Strathclyde Institute of Pharmacy and Biomedical Sciences
University of Strathclyde
Glasgow
(UK)

[Biography](#)

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Biography of Christine Dufès

Dr. Christine Dufès is a Senior Lecturer at the Strathclyde Institute of Pharmacy and Biomedical Sciences (SIPBS), University of Strathclyde, Glasgow, United Kingdom. She obtained a Doctorate in Pharmacy and a PhD from the University of Poitiers (France). Her research interests include the targeted delivery of drugs and therapeutic genes to tumours and cerebral diseases. She has been awarded the Biochemical Journal Young Investigator Award (2009) and the Tom Gibson Memorial Award (2012) for her research, in addition to the Best Overall Strathclyde Teaching Excellence Award 2013 for her teaching. She sits on the editorial boards for 17 journals.

Close

**Martin J. D'Souza**

Vaccine Nanotechnology Laboratory
Mercer University
Atlanta, GA
(USA)

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Biography of Martin J. D'Souza

Dr. Martin J. D'Souza obtained his Ph.D. degree (1987) in Pharmaceutical Sciences from the University of Pittsburgh, Pittsburgh, PA, USA. Dr. D'Souza is currently performing numerous roles at Mercer University, Atlanta, GA, USA, i.e. Professor & Director of Graduate Programs in the College of Pharmacy. He is the Director of Mercer Clinical Laboratory, Co-Director of the Center for Drug Delivery Research, and Chair of the Pharmaceutics. He is the co-founder of Drug Delivery Therapeutics. His main fields of specialization include Vaccines, Pharmacokinetics, Bio-pharmaceutics, Bio-technology, etc.

Close

**Biana Godin**

Department of Nanomedicine
The Methodist Hospital Research Institute
Houston, TX
(USA)

**Khaled F. Greish**

Department of Molecular medicine
Arabian Gulf University
Manama
(Bahrain)

[Biography](#)

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Biography of Khaled F. Greish

Khaled Greish is Associate Professor of Molecular Medicine, and head of the Nano-research unit, at Princes Al-Jawhara Centre, Arabian Gulf University, Kingdom of Bahrain, and Adjunct Associate Professor of Pharmaceutical Chemistry at University of Utah, USA. He Published > 70 peer reviewed papers, and 10 book chapters in the field of targeted anticancer drug delivery. Controlled Release Society (CRS) awarded him the CRS Postdoctoral Achievement award in 2008 and in 2010; he was elected as the member of the CRC College of Fellows in 2014 at the University of Otago.

Close

**Zhong Gu**

National Engineering Research Center for Biomaterials
Sichuan University
Chengdu
(China)

[Biography](#)

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Biography of Zhong Gu

Professor Zhongwei Gu graduated from Peking University in 1981 and served as a senior visiting scholar in the Research Triangle Institute, RTP and the University of Utah, USA, respectively from 1984 to 1986 and 1991 to 1993. He was appointed as a Professor in 1994, and has thrice been the Chief Scientist of the National Basic Research Program of China (the 973 program) since 1999. He is a Fellow of International Union of Societies for Biomaterials Science and Engineering (FBSE). His current research activities focus on the biomedical polymers, nano-biomaterials and drug delivery systems and tissue engineering.

Close

**Jianfeng Guo**

School of Pharmaceutical Sciences
Jilin University
Changchun

(China)

[Biography](#)



Biography of Jianfeng Guo



Dr. Jianfeng Guo, Ph.D., is a Professor of Nanomedicine at School of Pharmaceutical Sciences, Jilin University, China. He received his PhD in 2011 from University College Cork (UCC), Ireland. He was a Research Fellow at University of Michigan, Ann Arbor, followed by industrial working experience at the Viva Biotech Ltd., Shanghai, as a Project Manager. He then spent three years at UCC as a Senior Research Fellow, prior to joining in Jilin University in 2016. He was awarded the Embark Initiative Postgraduate Scholarship, Chinese Government Award for Outstanding Self-financed Students Abroad. Dr. Jianfeng Guo has published 24 peer-reviewed scientific articles.

Close



Umesh Gupta

Department of Pharmacy
Central University of Rajasthan
Ajmer
(India)

[Biography](#)



Biography of Umesh Gupta



Dr. Umesh Gupta, currently working as Assistant Professor in the Department of Pharmacy, Central University of Rajasthan, India. He did Ph.D. in Pharmaceutical Sciences from Dr. H. S. Gour University, Sagar, India under the mentorship of Prof. NK Jain. He has recently been awarded “DAAD Research Stays for Academics and Scientists” at Leibniz-institut fur Polymerforschung Dresden, Germany. He has the past experience of working as Research Scientist at Ranbaxy Research Laboratories, India and Post-Doctoral Research Associate at South Dakota State University, USA. He joined the Central University of Rajasthan in the year 2013.

Close



Lisbeth Illum

Identity - Pharmaceutical Consultancy
Nottingham
(UK)

[Biography](#)



Biography of Lisbeth Illum



Professor Lisbeth Illum was the founder and Managing Director of DanBioSyst UK Ltd a drug delivery technology company, sold successfully to West Pharmaceutical Services and now Archimedes Lab Ltd. She was the CEO of Critical Pharmaceuticals Ltd a drug delivery company. She now works as a consultant to the pharmaceutical industry and exert witness in patent litigations. She was awarded M. Pharm, Ph. D and D.Sc. from the Royal Danish School of Pharmacy in 1972, 1978 and 1988, respectively. Her research expertise is in the area of novel drug delivery systems for difficult drugs, such as hydrophilic and insoluble drugs, peptide and proteins. She has published more than 350 scientific papers, co-edited four books and filed more than 45 patent family applications on novel drug delivery systems, of which a large number of patents have been granted. She has lectured extensively throughout the world at conferences and workshops. She is a Fellow of the AAPS and CRS. She has been on the editorial boards of eleven scientific journals.

Close



Kazunori Kataoka

Department of Materials Engineering
University of Tokyo
Tokyo
(Japan)



Xin-Gui Li

College of Environmental Science & Engineering
Tongji University
Shanghai
(China)

[Biography](#)

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Biography of Xin-Gui Li



Dr. Xinn- Guii Lii obtained PhD in Polymer Materials from China Textile University, Shanghai. He is presently serving as Professor of Polymer Materials and Director of Inst. of Mater Chem at Tongji University, Shanghai, China. He has been recognized with many awards and honors such as ACS Membership Award in 2015, Natural Science Prize in 2015 and many other awards. He is also a member of different organizations such as ACS, National Engineering Research Center of Electronic Circuits Base Materials of China, Key Laboratory of Advanced Polymer Materials, Shanghai, China, Educational Ministry of China, and Shanghai Key Laboratory for Advanced Polymer Materials.

Close

Ulrich Lächelt

Department of Pharmacy
Ludwig Maximilian University of Munich



Munich
(Germany)
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Biography of Ulrich Lächelt



Ulrich Lächelt studied pharmaceuticals at the University of Heidelberg and received a doctoral degree in Pharmaceutical Biology at the LMU Munich in 2014. He worked on multifunctional sequence-defined nucleic acid carriers together with Prof. Ernst Wagner. Since 2017 he continues the research on drug delivery and nanomedicine as junior research group leader and candidate for habilitation. He is an extraordinary member of the Center for NanoScience (CeNS) at the LMU. His research focuses on the intracellular delivery of biomacromolecules, such as nucleic acids, peptides and proteins, the development of drug conjugates and inorganic-organic hybrid nanopharmaceuticals.

Close



Achuthamangalam B. Madhankumar

Department of Neurosurgery
Pennsylvania State University
Hershey, PA
(USA)



Tamara Minko

Department of Pharmaceutics
Rutgers University
Piscataway, NJ
(USA)

[Biography](#)



Biography of Tamara Minko



Tamara Minko, Ph.D., is a Distinguished Professor and Chair of the Department of Pharmaceutics at Rutgers University. Her current research interests include nanotechnology; drug delivery; personalized nanomedicine; molecular targeting; nucleic acids delivery; mechanisms of multidrug resistance; bioimaging; preclinical evaluation of new therapeutics; and modulation of cell death mechanisms during hypoxia. Professor Minko is author and coauthor of more than 400 publications. Dr. Minko is an elected Fellow of CRS, AAPS, and AIMBE; recipient of numerous awards. She also is an Executive Editor of *Advanced Drug Delivery Reviews*, Editor of *Pharmaceutical Research*, President-Elect of the Controlled Release Society.

Close



Teresa Musumeci
Department of Drug Science
University of Catania
Catania
(Italy)

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Biography of Teresa Musumeci



Teresa Musumeci is an assistant professor and research scientist in the Department of Drug Sciences at the University of Catania, since 2008. Teresa Musumeci received her Pharmacy degree from the University of Catania (Italy) in 2001. She received her PhD in Pharmaceutical Technology from the University of Palermo (Italy) in 2007. She is the author of 30 peer-reviewed papers and 2 book chapters. Her scientific activity is focused on design and characterization of nanocarriers for delivery of drugs.

Close



Caitriona O'Driscoll
School of Pharmacy
University College Cork
Cork
(Ireland)



Kamla Pathak
Department of Pharmaceutics
Uttar Pradesh University of Medical Sciences
Etawah
(India)

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Biography of Kamla Pathak



Professor Kamla Pathak, Professor and Head of the Department of Pharmaceutics, Pharmacy College Saifai, U. P. RIMS&R, Saifai, Etawah, India has a teaching and research experience of more than 26 years. She is actively engaged in research on oral controlled /modulated/targeted and topical drug delivery systems. She has over 200 publications in journals of international and national repute, 3 patents, authored book chapters and more than 180 abstracts of the papers presented in scientific forums to her credit. She has supervised Ph.Ds, more than 120 postgraduate theses and has a h-index of 21.

Close

**Qiang Peng**

West China Hospital of Stomatology
Sichuan University
Chengdu
(China)
[Biography](#)

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Biography of Qiang Peng

Dr. Qiang Peng obtained his B.S. degree (2006), M.A. degree (2009), and Ph.D in pharmaceutics (2012) from Sichuan University, China. He joined West China Hospital of Stomatology, Sichuan University as a lecturer in 2012 and promoted as an associate professor in 2014. Dr. Peng once worked in Keele University from 2010 to 2011 and in University of Copenhagen during 2015. His research focuses on nanomaterials-based advanced drug delivery. As a young scientist, he has published more than 20 publications. He won the Sichuan Provincial Award of Outstanding PhD Dissertation in 2014 and the First Prize of Chinese Outstanding Young Investigator Award, IADR-China Division in 2014.

Close

**Stefano Salmaso**

Department of Pharmaceutical and Pharmacological Sciences
University of Padova
Padova
(Italy)
[Biography](#)

x

Biography of Stefano Salmaso

Stefano Salmaso is associate professor in the Department of Pharmaceutical and Pharmacological Sciences of the University of Padova (Italy), where he teaches Technology of delivery and controlled release of drugs. He obtained his Ph.D. in Pharmaceutical Sciences in 2004 and the Master degree in Chemistry and Pharmaceutical Technology from the University of Padova. He held positions as assistant professor at the University of Padova and associate scientist at Northeastern University - Boston (USA) in 2005 and 2008. He is author of 58 peer-reviewed publications, 3 book chapters, and inventors of 3 international patents. His scientific activity is focused on the development of responsive “smart” nanocarriers for the delivery of drugs and biopharmaceutics.

Close

Helder Santos

Division of Pharmaceutical Technology, Faculty of Pharmacy
University of Helsinki



Helsinki
(Finland)
[Biography](#)



Biography of Helder Santos



Dr. Santos obtained a doctorate (D.Sc.) in Chemical Engineering from the Helsinki University of Technology, Helsinki, Finland. Currently Dr. Santos is an Adjunct Professor in Pharmaceutical Nanotechnology at the University of Helsinki, Finland. He has published more than 150 scientific publications. Dr. Santos serves as Editor and is in the Editorial Board of several international journals.

Close



Sevda Senel
Department of Pharmaceutical Technology
Ankara University
Ankara
(Turkey)
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Biography of Sevda Senel



Sevda Şenel is Professor at the School of Pharmacy at Hacettepe University, Ankara Turkey. Numerous international (NATO-CRG, NATO-CLG, British Council, EU-7-SME) and national (TUBITAK, SAN-TEZ) projects led her group to the development of non-invasive systems for drugs and vaccines via various mucosae (buccal, sublingual and nasal) in human and veterinary field. Dr. Şenel and her research group has been awarded a number of prestigious honors including AAPS-PharmSciTech Best Poster Award (2015), Hacettepe University Science Award (2011), The Distinguished Scientist Award - by the Academy of Science of the Turkish Pharmacists Association (2010), CRSIntervet Best Veterinary Paper Award (2005) and the Novartis Pharmaceutical Technology Research Award (2004). Dr. Şenel is the author of more than 150 research publications, which includes original research and book chapters.

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Amanda K.A. Silva
Laboratoire Matière et Systèmes Complexes (UMR 7057)
Paris Diderot University
Paris
(France)
[Biography](#)



Biography of Amanda K.A. Silva



Amanda K. A. Silva obtained a degree in Pharmacy in 2005 at UFRN, Brazil, and a PhD in Pharmaceutical Technology in 2008 in the domain of gastro-resistant magnetic microcapsules. She obtained a second PhD in Cellular and Molecular Biology in 2010 from the Université d'Evry, France concerning polysaccharides for thermo-controlled cell culture in 3D. In 2013, Amanda obtained a tenured CNRS researcher position at Matter and Complex Systems lab in Paris. She works in physical approaches for regenerative medicine, extracellular vesicle engineering, theranosis and photo-activated therapies. Amanda has published 37 papers and is an inventor in 4 patents.

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Vladimir P. Torchilin

Center for Pharmaceutical Biotechnology and Nanomedicine
Northeastern University
Boston, MA
(USA)

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Biography of Vladimir P. Torchilin



Vladimir P. Torchilin, Ph.D., D.Sc. is a University Distinguished Professor of Pharmaceutical Sciences and Director, Center for Pharmaceutical Biotechnology and Nanomedicine, Northeastern University, Boston. His interests include drug delivery and targeting, nanomedicine, multifunctional and stimuli-sensitive pharmaceutical nanocarriers, biomedical polymers, experimental cancer therapy. He has published more than 400 original papers, more than 150 reviews and book chapters, wrote and edited 12 books, and holds more than 40 patents. Google Scholar has shown more than 44,000 citations of his papers with an H-index of 96. He is Editor-in-Chief of Current Drug Discovery Technologies, Drug Delivery, and OpenNano, Co-Editor of Current Pharmaceutical Biotechnology and on the Editorial Boards of many other journals. He received more than \$30 M from the governmental and industrial sources in research funding. He has multiple honors and awards and in 2011, Times Higher Education ranked him number 2 among the top world scientists in pharmacology for the period of 2000-2010.

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Ernst Wagner

Department of Pharmacy, and Center for Nanoscience (CeNS)
Ludwig-Maximilians-Universität (LMU)
Munich
(Germany)

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Biography of Ernst Wagner



Dr. Wagner is Professor of Pharmaceutical Biotechnology at Ludwig-Maximilians-Universität Munich and a member of the Munich Center for Nanoscience. He coordinates 'Biomedical Nanotechnologies' of the Excellence Cluster 'Nanosystems Initiative Munich'. After a Ph.D. in Chemistry from the Technical University of Vienna and a postdoctoral stay at the ETH Zurich, he was the group leader at the IMP Vienna and Director for Cancer Vaccines at Boehringer Ingelheim Austria. Dr. Wagner has authored more than 390 publications with an h-index 70. He has been a board member of the German Society for Gene Therapy, Committee member of ASGCT, and BSA member of the CRS.

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Roderick Bryan Walker

Division of Pharmaceutics
Rhodes University
Grahamstown
(South Africa)

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Biography of Roderick Bryan Walker



Professor Walker completed his Ph.D. degree in Biopharmaceutics and Pharmacokinetics at Rhodes University in Grahamstown, South Africa. He is the former Dean and Head of the Faculty of Pharmacy at Rhodes and is currently the Professor of Pharmaceutics and is the current chair of the Academy of Pharmaceutical Sciences in South Africa. Professor Walker has published and presented over 200 scientific outputs and serves on the editorial boards of a number of journals. Professor Walker undertakes research studies in all aspects of drug delivery and product development.

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Zimei Wu

School of Pharmacy
University of Auckland
Auckland
(New Zealand)

[Biography](#)

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Biography of Zimei Wu

Zimei Wu is an Associate Professor at the School of Pharmacy, University of Auckland, New Zealand (NZ). She holds a PhD from University of Otago (NZ) and a Masters from China Pharmaceutical University. Her 'liposomes' research has attracted wide collaborations. She received an NZ-China Scientist Exchange



Award from the Royal Society of NZ. She also researches transdermal delivery with successful stories featured on NZ TV3. Zimei also serves on editorial boards of Journal of Liposome Research, and Pharmaceutical Development and Technology and a referee for >20 journals. Zimei was the past President of NZ Local Chapter of Controlled Release Society.

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Shirley Wu

Department of Pharmaceutical Sciences
University of Toronto
Toronto, ON
(Canada)



Sarita K. Yadav

Department of Pharmacy
MLN Medical College Prayagraj
Uttar Pradesh
(India)

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Biography of Sarita K. Yadav



Dr. Sarita K Yadav obtained her B. Pharm from DIPSAR and earned her M. Pharm and Ph.D. from IIT(BHU), India. Currently, she is working as Assistant Professor at MLN Medical College, Prayagraj. She has qualified GATE 2009 with AIR-32. She had worked for two years as drug analyst in testing of drugs and cosmetics products at UPFSDA, Lucknow. She had received “Young Scientist Award-WF” in 2015 by SPER for her research contributions. She holds lifetime membership of APTI, IPGA, SPER, and PRISAL. She is a member of editorial board of Micro and Nano System (MNS) by Bentham Science, IJBST journal group and peer reviewer in Future Journal of Pharmaceutical Sciences, Saudi Pharmaceutical Journal etc. Currently, she has many research/reviews papers to her credit in high impact journals with total impact factor around 60.

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Yanjun Zhao

Department of Pharmaceutics
Tianjin University
Tianjin
(China)

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Biography of Yanjun Zhao



Prof. Zhao is a Full Professor of Pharmaceutics in the School of Pharmaceutical Science and Technology, Health Science Platform, Tianjin University. He obtained the Bachelor (Polymer), Master (Engineering), and PhD (Pharmacy) degree from Dalian University of Technology, Dalian Institute of Chemical Physics (CAS), and King's College London, respectively. His research interests focus on pharmaceutical micelles, stimuli-responsive drug delivery, and ferroptosis antitumor nanomedicine.

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Associate Editorial Board Members



Goutam Mondal

Postdoctoral Research Associate
National Center for Natural Products Research
University of Mississippi
Oxford, MS
(USA)

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Biography of Goutam Mondal



Dr. Goutam Mondal is an emerging pharmaceutics and drug delivery scientist. He is an expert in the design and synthesis of receptor targeted lipids and polymeric systems, the techniques of animal tissue culture, tumor growth inhibition studies, and pharmacokinetics studies of small molecules. Presently, he is associated with Dr. Ikhlas A Khan's research group under supervision of Dr. Ryan Yates at the National Center for Natural Products Research, University of Mississippi, USA where he is actively involved in pre-clinical and clinical pharmacokinetics and pharmacodynamics of natural products. He has published 21 research articles in high impact peer-reviewed journals.

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Mariane L. Nogueira

Department of Pharmacy
Federal University of Pernambuco
Recife
(Brazil)

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Biography of Mariane L. Nogueira



Dr. Mariane Lira Nogueira is a Pharmacist. She obtained Master's degree in Pharmaceutical Sciences, and Ph.D. in Biological Sciences with an emphasis on Biotechnology. She completed an interuniversity exchange doctorate in Pharmacotechnics (2007-2008) at the Faculté de Pharmacie - Université Paris Sud 11 and an internship at the Universidad de Navarra (2008). She did Post-doc from the Université Paris Saclay (2014-2015). She is currently an Associate Professor at the Federal University of Pernambuco, Brazil, a researcher at the Keizo-Asami Immunopathology Laboratory, and leader of Nanotechnology, Biotechnology, and Cell Culture Research Group. Her research fields are mainly focused on the development and characterization of surface-modified nanocarriers for biomedical applications.

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Meysam Omid

Protein Research Centre
Shahid Beheshti University G.C.
Tehran, Velenjak
(Iran)

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Biography of Meysam Omid



Dr. Meysam Omid is an Assistant Professor of Protein Research Center, Shahid Beheshti University. Dr. Omid's research is focused on application of nanobiomaterials in soft, hard, and interfacial tissue engineering. He is particularly interested to design and fabricate smart nano drug delivery systems for regenerative medicine application. He has (co)authored over 80 research papers in the field of nanoscience and nanotechnology.

Close



Aniruddha Roy

Department of Pharmacy
Birla Institute of Technology and Science
Pilani
(India)

[Biography](#)

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Biography of Aniruddha Roy



Dr. Aniruddha Roy is currently working as an Assistant Professor in the Department of Pharmacy at Birla Institute of Technology and Science (BITS) - Pilani, India. He is a Pharmaceutical Technologist by training. He completed PhD in Immunology from National Institute of Immunology (NII), New Delhi, India. His main area of PhD thesis work

was immunotherapy of cancer. After PhD, he worked at the Indian Institute of Technology, New Delhi, Ontario Institute for Cancer Research at the University of Toronto, Canada, and University of British Columbia, Canada in various capacities. He has more than ten years of research experience. His research is primarily focused on nanomedicine and targeted drug delivery in different diseases.

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Executive Guest Editor(s)



Ismail Ocsoy
Department of Analytical Chemistry
Erciyes University
Kayseri
(Turkey)

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Biography of Ismail Ocsoy



Dr. Ismail Ocsoy is a Professor in the faculty of Pharmacy, Erciyes University, Kayseri, Turkey. He completed his MS and Ph.D. in Chemistry from the Department of Chemistry, University of Florida, USA. His research focuses on Nano biotechnology consisting of DNA Aptamer conjugated nanomaterial, cancer therapy models, anti-cancer, antimicrobial agents and Nano bio-sensor for detection of antibiotic resistant bacteria. He has published more than 70 papers in highly reputable and prestigious journals.

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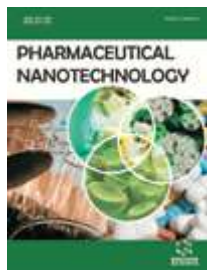
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Pharmaceutical Nanotechnology

ISSN 2211-7385 (Print)



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The Influence of Surface Charge on The Antiviral Effect of Curcumin Loaded in Nanocarrier System

Najwa Nabila^a, Siti Riqqah Hasan^a, Gladys Pinkan Larasati^a, Benediktus Yohan^c, R. Tedjo Sasmono^c, Annis Catur Adi^d, Ferry Iskandar^{b,e}, Heni Rachmawati^{a,b}

^aSchool of Pharmacy, Bandung Institute of Technology, Ganesa 10, Bandung, 40132, Indonesia.

^bResearch Center for Nanosciences and Nanotechnology, Bandung Institute of Technology, Ganesa 10, Bandung, 40132, Indonesia.

^cEijkman Institute for Molecular Biology, Ministry of Research, Technology, and Higher Education, Jl. Diponegoro 69 Jakarta 10430, Indonesia.

^dDepartment of Nutrition, Faculty of Public Health, University of Airlangga, Mulyorejo, Surabaya, 60115.

^eStudy Program of Physics, Faculty of Mathematics and Natural Sciences, Bandung Institute of Technology, Ganesa 10, Bandung, 40132, Indonesia.

Abstract: Background : Curcumin is a well-documented bioactive compound present in *Curcuma sp.*, a tropical medicinal plant. This substance exhibits broad spectrum biological activities including antiviral.

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Objective : This study aims to produce curcumin nanoemulsion with different surface charge (curcumin (+) nanoemulsion and curcumin (-) nanoemulsion) and to evaluate its physical characteristics, *in vitro* cell cytotoxicity and antiviral activity against dengue virus (DENV) 1 and 2.

Method : Two forms of nanoemulsion were prepared which were differed from their surface charge through spontaneous procedure resulting similar characteristics except the zeta potential value. Cytotoxicity was determined using RT-PCR method in A549 cell line and anti-DENV properties were determined by calculation of inhibitory concentration 50 (IC₅₀) value.

Results : The positively charge of curcumin-loaded nanoemulsion showed better effect in reducing the viral replication represented by lower IC₅₀ value. In addition, DENV-1 was more sensitive and responsive to curcumin as compared to DENV-2.

Conclusion : Positively surface charge of curcumin-loaded nanoemulsion improves the antiviral effect of the curcumin suggesting a promising approach for alternative treatment for dengue virus infection.

Keywords: curcumin, dengue virus, nanoemulsion, surface charge, antiviral activity

1. INTRODUCTION

Dengue is the most prevalent arthropod-borne viral disease of human, a member of the *Flaviviridae* family which is transmitted between human individuals through *Aedes sp.* mosquitoes's bites. Dengue virus (DENV) can cause an endemic called dengue fever [1]. DENV can be differentiated into four serotypes: DENV-1, DENV-2, DENV-3, and DENV-4 [2]. The transmission of DENV to a susceptible human host can cause infections with broad effects, ranging from dengue fever (DF), dengue

hemorrhagic fever (DHF), and dengue shock syndrome (DSS), with changes in hemostasis and vascular permeability [3,4]. The cases of dengue infection in Indonesia on 2017 was 204,171, mostly found in West Java (10,016 cases), East Java (7,838 cases), and Central Java (7,400 cases) [5].

*Address correspondence to this author at the School of Pharmacy, Bandung Institute of Technology, Ganesha 10, Bandung 40132, Indonesia; Tel: +62-22 250 4852; E-mail: h_rachmawati@fa.itb.ac.id

Although DENV infection causes severe effects, currently there are no recommended antiviral therapies [6,7]. The only available vaccine was developed by Sanofi Pasteur in 2015, however offers limited use for population below nine years old [7].

Curcumin is an isolate from Indonesia's natural ingredients, *Curcuma sp.* This bioactive compound has been reported to show several activities such as antibacterial, antifungal, antiviral, antioxidant, antiameba, anti-inflammatory, antifertility, antidiabetic, and anticancer [8,9]. In particular to dengue virus, curcumin can effectively reduce the replication of DENV-2 [10] particles in cells (BHK-21) and can modify the life cycle of DENV [9,11]. One mechanism that allows curcumin to inhibit DENV-2 replication is related to the changes in cytoskeleton and cell apoptosis. Curcumin inhibits the replication and synthesis complex of DENV-2 RNA by decreasing the regulation of the ubiquitin proteasome system (UPS) [12,13], which is one of the main pathway for protein degradation [11,14]. Despite the potential use of curcumin, it has various weaknesses such as low bioavailability and low therapeutic effect, there are low solubility in water, high metabolism in the body, and high systemic elimination, which all limit its clinical application [15]. Numerous approach have been taken to improve the effectivity of curcumin *in vivo*, including nano-based encapsulation systems, one of them is nanoemulsion [16]. Using nanoemulsion, physicochemical stability and shelf life of curcumin were enhanced [17].

Nanocarriers offer potential promise in targeted drug delivery to a particular sites by manipulating the physicochemical properties, including the surface modification. One of the most important characteristics of nanocarriers is surface charge [18]. Nanocarriers with positive surface charge or cationic nanocarriers interact more with cell membranes which is negatively charged, as compared with the neutral or negatively charged ones, due to favourable electrostatic interaction [19]. Nowadays, cationic polymers nanocarriers showed superior properties including strong interaction with DNA and the ability to provide oriented bonds with proteins [20]. Based on several studies, cationic nanocarriers show better results such as positively charged polymeric nanoparticles with polyethylene glycol, which showed a favourable distribution and higher bioavailability in Caco-2 cells *in vitro* and small intestinal epithelial cells *in vivo* [21]. In the same way, the positively charged magnetic nanoparticles provides better internalization process in human breast cancer cells [22], as well as the positively charged silver nanoparticles which showed highest bactericidal activity against *Staphylococcus aureus*, *Staphylococcus mutans* and *Streptococcus pyogenes* [23].

Previously, we successfully developed curcumin nanoemulsion using Cremophor RH 40 and PEG 400 with the average droplet size of 40.85 ± 0.919 nm. Although, this nano system suppressed the growth of DENV, there was still no significant difference compared to the curcumin solution in DMSO. This might be happened because of the negative value of the droplet surface (-7.039 ± 0.532 mV) [16]. Therefore, in present study we added didodesyldymethylammonium bromide (DDAB) to change the surface charge into positive [24,25], to enhance the

virucidal effect of the curcumin on A549 cell-infected DENV-1 and DENV-2. It has been reported that the cationic surface charge using DDAB demonstrates better penetration across intestinal epithelium due to electrostatic interaction with the negatively charged cell membranes. Thereby, it will be increasing the retention time of the drug on the cell surface and then the oral bioavailability [26,27].

2. MATERIALS AND METHOD (FOR RESEARCH ARTICLES ONLY)

2.1 Materials

The human alveolar epithelial cell line A549 was obtained from the culture collection at Eijkman Institute for Molecular Biology (Indonesia). RPMI-1640 medium, Minimum Essential Medium (MEM) medium, fetal bovine serum (FBS), Antibiotic-Antimycotic, Dulbecco's Phosphate Buffer Saline (DPBS) and Trypsin-EDTA were purchased from Gibco-Thermo Scientific. Two DENV strains were isolated from clinical isolates and propagated in Vero cells. DENV-1 JMB-034-P2 was isolated from dengue patients in Jambi (Indonesia) and DENV-2 SUB-011-P4 was isolated from patients in Surabaya (Indonesia). Curcumin (98.2% purity) was obtained from PT. Combiphar (Indonesia). Castor Oil and polyethylene glycol 400 were obtained from PT Brataco, Bekasi, Indonesia and Cremophor RH 40 was obtained from Clariant Iberica Production, Banten, Indonesia. Didodecyldimethylammonium bromide (DDAB) (98% purity) was purchased from Sigma-aldrich, St. Louis, USA. QIAamp Viral Mini Kits was obtained from Qiagen, Hilden, Germany. Superscript III reverse transcriptase was obtained from Invitrogen-Life Technologies, Carlsbad, CA, and PowerUp™ SYBR™ Green Master Mix was obtained from Applied Biosystems, CA.

2.2 Curcumin-Loaded Emulsion

Curcumin was loaded in the nanoemulsion system containing castor oil, Cremophor RH 40, and PEG 400. Castor oil (oil phase), cremophor RH 40 (surfactant), and PEG 400 (co-surfactant) were mixed with the ratio of 1:8:1 using a magnetic stirrer (Thermo Scientific) at 100 rpm for 2 hours to form the homogenous oil phase. Further, the oil phase was sonicated for 60 minutes in a sonicator bath. Subsequently, aquabidest was added to the oil phase with the ratio of 5:1 and then stirred to make a clear and homogeneous curcumin nanoemulsion. Further, we mention this preparation as curcumin (-) nanoemulsion. As a comparison, curcumin solution was prepared in DMSO with same concentration.

2.3 Curcumin Cationic Nanoemulsion

Curcumin was loaded in the nanoemulsion system containing castor oil, Cremophor RH 40, and PEG 400. Castor oil (oil phase), cremophor RH 40 (surfactant), and PEG 400 (co-surfactant) were mixed with the ratio of 1:8:1 using a magnetic stirrer (Thermo Scientific) at 100 rpm for 2 hours to form the homogenous oil phase. On another vial, DDAB was dissolved in aquabidest and stirred for 3 hours. Further, the oil phase was sonicated for 60 minutes in a sonicator bath. Subsequently, DDAB solution was added to

the oil phase with the ratio of 5:1 and then stirred to make a clear and homogeneous curcumin nanoemulsion. Further, we mention this preparation as curcumin (+) nanoemulsion.

2.4 Evaluation and Characterization of Curcumin Nanoemulsion

The particle size and polydispersity index of both curcumin nanoemulsion were determined using Delsa™ Nano C Particle Analyzer, Beckman Coulter. Zeta potential value of both curcumin nanoemulsion was measured by NanoPartica SZ-100, Horiba, Japan. The morphology of curcumin nanoemulsion was observed using negative staining transmission electron microscope JEM-1010, JEOL, Japan. Briefly, 10 µL of sample was dropped on a 400 mesh cryo-TEM grid and allowed to dry for 30 seconds before being stained with 10 µL of uranyl acetate (2%). Grid was allowed to dry for 5 minutes and place into the transmission electron microscope at Eijkman Institute for Molecular Biology, to inspect the morphology of curcumin nanoemulsion.

The calculation of curcumin content in nanoemulsions was performed by a direct method. Both curcumin nanoemulsion were centrifuged at 14,000 rpm for 20 min and 5 mL of DMSO was added to 10 µL of supernatant, to extract the curcumin. Curcumin concentration in DMSO was measured using a UV-Visible spectrophotometer (Beckman DU 7000). A calibration curve was generated with concentrations in the range of 1.5 - 5 ppm ($R^2 = 0.995$).

The curcumin content in the nanoemulsion was calculated using the following equation:

$$\%LC = \text{Measured amount of curcumin entrapped in nanoemulsion} \times (\text{Total amount of curcumin applied in preparing nanoemulsion})^{-1} \times 100\%$$

2.5 Cell Viability Assay

MTT assay was done using Vybrant® MTT Cell Proliferation Assay Kit (V-13154) according to manufacturer's instructions. Twelve mM MTT stock solution was prepared by dissolving MTT powder in Dulbecco's Phosphate Buffered Saline (DPBS). Then, 10 mL of 0.01 M HCl was added to one tube containing 1 g of SDS. A549 cells (1×10^5 cells/well) was prepared in 96-well plate. Plates were incubated at 37°C with 5% CO₂ for 16-24 hours. Samples were diluted with various concentrations in the range of 6.25-200 µg/mL for (-) nanoemulsion, 0.25-4 µg/mL for (+) nanoemulsion, and 0.1% v/v blank nanoemulsion and (+) nanoemulsion. Medium from the wells were removed and replace with 100 µL sample/well. Plates were incubated at 37°C with 5% CO₂ for 48 hours. Following the incubation period, the supernatant was removed from each well and replenished with 100 µL of fresh medium followed by the addition of 10 µL of 12 mM MTT solution and the plates were incubated at 37°C with 5% CO₂ for 2 hours. Then, 100 µL of the SDS-HCl solution was added to each well and plates were incubated for 4-18 hours. Absorbance was recorded at 570 nm using Multiskan™ FC Microplate Photometer (Thermo Fisher Scientific, CA, USA).

2.6 Study The Antiviral Effect of Curcumin Nanoemulsion

A549 cells were seeded 2×10^5 cells/well in 96-well plate and incubated overnight. The cells were subjected to infection with DENV-1 and DENV-2 (2×10^5 PFU/well) serotypes with multiplicity of infection (m.o.i) value of 1, and with the presence of both curcumin nanoemulsion at various concentrations. The supernatants were harvested 48 hours post-treatment and transferred to 1.5 mL tube prior to be stored in the -80°C. The total viral RNAs were extracted from 50 samples using QIAamp Viral Mini Kits (Qiagen, Hilden, Germany) according to manufacturer's instructions. Viral RNA binds specifically to the QIAamp silica membrane, and pure viral RNA is eluted in buffer provided with kit.

Dengue viral RNAs were measured using a two-step RT-PCR reaction method. In the reverse transcription (RT) step, the total RNA were reverse-transcribed into cDNAs by reverse transcription-polymerase chain reaction (RT-PCR; SimpliAmp™ Thermal Cycler, Applied Biosystems, CA) using Superscript III reverse transcriptase (RT; Invitrogen-Life Technologies, Carlsbad, CA) and pan-dengue primers (reverse) for all serotypes of DENV. In the PCR step, PCR products are synthesized from cDNA samples using the PowerUp™ SYBR™ Green Master Mix (Applied Biosystems, CA) with generic pan-dengue primers (forward and reverse) for all serotypes of DENV. The PCR reactions were allowed to run on an ABI 7500 fast real-time PCR machine (Applied Biosystems, CA) with thermal cycle settings according to manufacturer's recommendation.

3. RESULTS AND DISCUSSION (FOR RESEARCH ARTICLES ONLY)

We successfully produced curcumin (+) nanoemulsion and curcumin (-) nanoemulsion with transparent visual appearance (Fig. 1), simply indicating the droplet size was smaller than the wavelengths of visible light. As shown in table 1, the droplets size of curcumin (+) nanoemulsion was bigger than that of curcumin (-) nanoemulsion, confirming the influence of the cationic surfactant. Both curcumin nanoemulsions have uniform size with the polydispersity index value was less than 0.5 [28].



Fig.1. Visual appearance of curcumin (-) nanoemulsion (left) and curcumin (+) nanoemulsion (right).

As depicted in Fig.1, there is no different physical appearance between two preparations of the nanoemulsion and both systems show good physical stability. Unlike other colloidal systems, the physical stability of nanoemulsion

does not depend on zeta potential value as presented in table 1. This was due to the high concentration of surfactant located on the surface of oil droplets which will avoid the attractive force among the droplets [17]. Cremophor RH40 is a polyoxyl 40 hydrogenated castor oil and it contains a fatty acid ester that contributed to the negative charge of curcumin nanoemulsion as previously reported [17]. However, the addition of DDAB to the nanoemulsion system changed the surface charge into positive and concentration dependence. When substrate with negative surface charges (droplet of nanoemulsion) was placed in an aqueous solution contains didodecyldimethylammonium bromide (DDAB), the cationic surfactant with two hydrocarbon chains could be assembled into the biomembrane-like tail-to-tail double-layer structure on the solid surface with the positively charged head groups toward outside, making the surface charge reverse from negative to positive [24]. As seen in table 1, curcumin was almost completely encapsulated in both nanoemulsion systems accounted to >90%. Thus, all data listed in table 1 are very promising results for this successful self-emulsification technique, which will contribute to provide good rate and extent of drug release, absorption and then the bioavailability of curcumin [17].

Table 1. The physical parameter of curcumin-loaded nanocarrier system.

Parameter	Curcumin (+) Nanoemulsion	Curcumin (-) Nanoemulsion
Particle size (nm) (average \pm SD; n=3)	28.17 \pm 4.02	24.8 \pm 2.5
Polydispersity index (average \pm SD; n=3)	0.447 \pm 0.027	0.189 \pm 0.385
Zeta Potential (mV) (average \pm SD; n=3)	+2.2 \pm 0.17	-4.3 \pm 0.5
Loading Capacity (%) (average \pm SD; n=3)	99.43 \pm 0.501	93.745 \pm 0.948

The morphology of curcumin (+) nanoemulsion and curcumin (-) nanoemulsion were analyzed using transmission electron microscope (TEM). It confirms the spherical shape of both nanoemulsions with uniform size and nearly monodisperse system (Fig. 2). Visualization techniques of nanoemulsion using TEM imaging is likely the most powerful and accurate technique to determine a specimen's morphology, purity and particle size distribution [17]. As seen in figure 2, curcumin in (+) nanoemulsion demonstrates bigger droplet size, confirming the measurement using PSA technique as before mentioned.

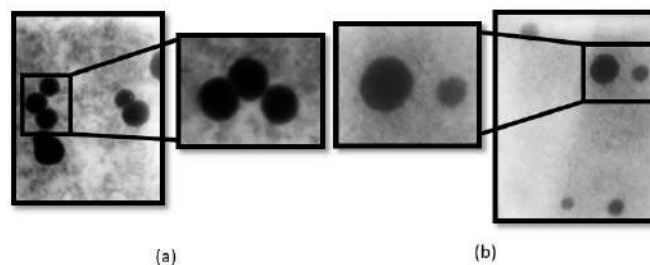


Fig.(2). Cryo-TEM photographic of (a) curcumin (-) nanoemulsion and (b) curcumin (+) nanoemulsion. Magnification 30.000x.

We also did comparison on the cytotoxicity and viral inhibitory characteristics of curcumin (+) nanoemulsion and curcumin (-) nanoemulsion, to understand the effect of surface charge. The CC_{50} value represents the concentration of an active substance that can induce 50% reduction of the cell population. Based on our study, the CC_{50} value of curcumin in the form of (+) nanoemulsion was smaller than in the (-) nanoemulsion (Table 2). It concludes that (+) nanoemulsion has higher toxicity effect to A549 cell lines.

Table 2. The in vitro characteristics of curcumin (+) nanoemulsion and curcumin (-) nanoemulsion in A549 cell lines as determined by CC_{50} and IC_{50} values.

Parameters	Curcumin (+) Nanoemulsion	Curcumin (-) Nanoemulsion
Cell cytotoxicity/ CC_{50} (μ g/mL)	2.1	12.42
IC_{50} of challenge virus (μg/mL)		
DENV-1	0.777	1.688
DENV-2	1.764	4.809

A significant decrease in cell viability was observed after treated with both curcumin (+) nanoemulsion and curcumin (-) nanoemulsion, respectively at the concentration of 4 μ g/mL and 25 μ g/mL. A lower cell viability was observed in curcumin (+) nanoemulsion-treated cells than in curcumin (-) nanoemulsion and there was significant impact observed on cell viability treated with vehicle control of curcumin (+) nanoemulsion. The use of surfactants in the nanoemulsion was known to be toxic to cultured cells at a certain concentration [29], so that the vehicle control of curcumin (+) nanoemulsion was also cytotoxic to a certain concentration limit. Obviously, the DDAB-generated (+) nanoemulsion was more cytotoxic. DDAB is a cationic surfactant that can cause death the cancer cells, including A549 cells, through inducing the caspase pathway or by creating pores in the cancer cell membrane [30]. In other site, DDAB can also increase the cellular uptake of curcumin [25], which was potential to promote cancer cells apoptosis [31]. Figure 3 shows the cell viability as a function of curcumin concentration in the nanoemulsion system. As

seen, more than 80% cells viable was observed when they treated with 2 $\mu\text{g/mL}$ and 10 $\mu\text{g/mL}$ of curcumin respectively loaded in (+).

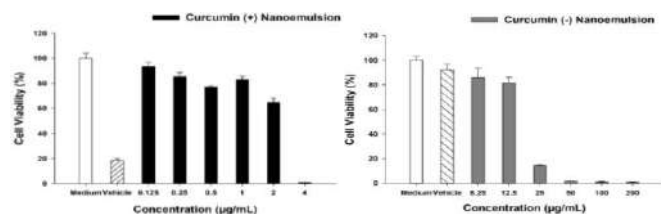


Fig.(3). A549 cell viability treated with different concentration of curcumin (+) nanoemulsion and curcumin (-) nanoemulsion.

The inhibitory effect of nanoemulsion against DENV was measured as a percentage of viable virus titre in the supernatant of treated cells to the viral titre in the control medium. In this study, we used co-treatment method in which cells were exposed to various concentrations of both curcumin nanoemulsions mixed with dengue virus at the same time. This method was used to observe the virucidal of both curcumin nanoemulsions when given along with the entry of the dengue virus. As seen from the data, the decrease in virus titre was directly proportional to the increasing concentration of the curcumin in both nanoemulsions system after 48 hours of incubation, indicating the virucidal properties on the dengue virus.

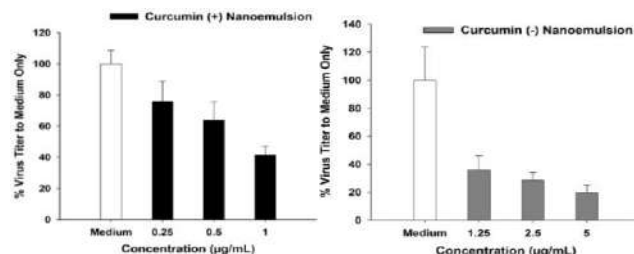


Fig.(4). Inhibitory effect of curcumin (+) nanoemulsion and curcumin (-) nanoemulsion to the replication of DENV-1 using co-treatment approach.

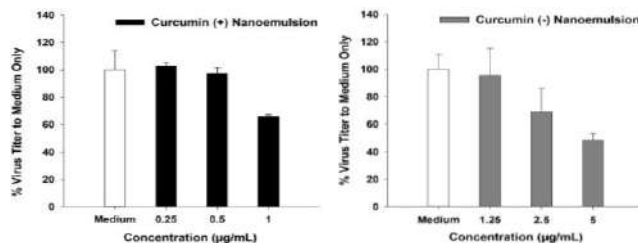


Fig.(5). Inhibitory effect of curcumin (+) nanoemulsion and curcumin (-) nanoemulsion to the replication of DENV-2 using co-treatment approach.

The viral titre values after incubation with curcumin (+) nanoemulsion and curcumin (-) nanoemulsion were calculated from RT-qPCR results. The viral titre of DENV-1

and DENV-2 decreased after treated with either curcumin (+) nanoemulsion and curcumin (-) nanoemulsion (Fig. 4 and Fig. 5). Against DENV-1, curcumin (+) nanoemulsion's virucidal effect was lower than curcumin (-) nanoemulsion (Table 2). This phenomena may happened because the use of cationic surfactant may affect the interaction of nanoparticles with negatively charged biological components and cell membranes, and thus determines the ultimate clinical application of nanoparticle drug delivery system [21, 22, 33]. Thereby, it will be increasing the retention time of the drug on the cell surface [26,27]. In contrast to DENV-2, although the decrease in viral titre was directly proportional to the increasing concentration of the curcumin, the provision of both curcumin (+) nanoemulsion and curcumin (-) nanoemulsion did not provide significant results when compared to the control (Fig. 5). Several possibilities might explain this phenomena, such as the concentration was still too low or the faster replication rate of the DENV-2 than DENV-1. Overall, we address important clue i.e the curcumin (+) nanoemulsion was more powerful to show the antiviral effect on DENV at the *in vitro* model.

CONCLUSION

Curcumin (+) nanoemulsion was successfully developed with the particle size less than 50 nm and the system was nearly monodisperse, confirmed by the value of polydispersity index and morphology analysis using cryo-Transmission Electron Microscope. Addition of cationic surfactant results the nanoemulsion with zeta potential value was $+2.2 \pm 0.17$ mV. This cationic nanoemulsion exhibits higher virucidal effect against DENV-1 and DENV-2 as compared with the (-) corresponding form. This finding emphasizes the important charge on the virucidal effect of the curcumin loaded in the nanoemulsion system, especially against DENV-1 and DENV-2 in the *in vitro* model.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not Applicable.

HUMAN AND ANIMAL RIGHTS

No Animals/Humans were used for studies that are base of this research.

CONSENT FOR PUBLICATION

Not applicable

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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SUPPORTIVE/SUPPLEMENTARY MATERIAL

The data that support the findings of this study are available from the corresponding author, [Prof. Dr. Heni Rachmawati], upon request.

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