Activities

"Centre of Excellence in Nanoscience & Technology" was inaugurated by our beloved principal Dr. SP Dhanabal and under JSS Academy of Higher Education & Research, Mysuru to enhance advanced research in the areas of Nanoscience and Nanotechnology, to promote, develop, and binding interdisciplinary research activities, to conduct training and awareness programs on various themes of national interests. Also, the center was involved in research and development projects from consultancy services to industries and research organizations in India.

Centre Inauguration by Dr. S P Dhanabal, Principal, JSS College of Pharmacy, Ooty

From the date of initiation, the centre was involved in series of activities to promote the aim and scope of enhancing advanced research in the stream of Nanoscience and Technology. In the first stage, Academic to academic collaborative research was initiated with the student Mr. Ankit Awasthi, Research Scholar, Lovely Professional University, Punjab, India. He was appointed under MOU and undergone the training for synthesis and characterization NLCs: under the guidance of Dr. K Gowthamarajan and Dr. Karri V V S Narayana Reddy for 03 months (01st Oct-31st Dec 2019), and the same work collaborative publications are under progress. In the second stage, two scientific presentations were done in an international seminar. A poster entitled "Affibody decorated Solid Lipid Nanoparticles for Colorectal Cancer" was presented in KMSO 2019-12th Annual Meeting of Korean Society of Medical oncology held in Seoul, South Korea by Dr. K Gowthamarajan who also received the travel grant of USD 1000. The KSMO has established itself as a leading cancer society and largest nation-wide organization of physicians and health-care professionals in medical oncology, radiation oncology and surgical oncology dedicated to the best cancer care in Korea. As the first

international conference in the field of Korean oncology, KSMO 2019 organised to gather around 1,000 oncologists, scientists and industry representatives from more than 30 countries. The 12th Annual Meeting of the Korean Society of Medical Oncology & 1st International Conference (KSMO 2019) in Seoul, Korea from November 7th to 8th.

Dr K Gowthamarajan with Prof. William G. Kaelin, Jr.'s Nobel Prize in Medicine 2019

Poster entitled "Curcumin Nanogel for the Treatment of Diabetic Retinopathy" was presented at CRS Conference 2020, associated with Roseman University, the USA by Mr. Arun Radhakrishnan.

Further, the centre bound with the University of Newcastle, Australia for the research proposal "Plastics and People: Human health implications of Microplastics in the environment" which was submitted for SPARC-2019 in association with Dr. Thava Palanisami, Prof. Richard Bush from the University of Newcastle, Australia by Dr. Gowthamarajan Kuppusamy, Dr. Praveen T K, Dr. Jawahar Natarajan. This project mainly emphasizes the potential environmental risks associated with the increased detection of microplastic based emerging contaminants in the ecosystem. This highlights the necessity of monitoring and ecological risk assessment of the effluent quality discharged from treated wastewater management system. Bilateral collaboration will leads to exchange of technical knowledge and making publications in high profile journals. This

will strengthen the target beneficiaries directly ie., Central Pollution Control Board , State and Central government which will facilitate them in making policy decisions, frame works and control measures and the indirect beneficiaries were the farmers, municipalities, local people. Follow to that, the product with strong commercialization potential's project proposal was submitted, "Design and development of prototype topical nano-based Terbinafine HCl gel: revalidation, risk assessment, and bioefficacy" BIRAC PACE- AIR-2020 by Dr. Gowthamarajan Kuppuswamy and Dr. V V S Narayana Reddy Karri. Objective of this study is to design a novel dosage form for allylamine antifungal to increase its penetrability and reduce the treatment time there by increasing the patient compliance and reducing the cost of therapy. This is expected since the penetrability would be increased because of nano size of formulation and good spreadability of the formulation there by it leads to good efficacy rates.

Collaborative research was done in association with Pharma solution India, Hosur for the project "Nano Formulation development palbociclib & Ixazomib" and now the centre always invites industries collaboration for binding research activities and also to translate the research activities to potential product development based on the commercial needs.

Moreover, to aid COVID 19 research activities, under the centre affiliation, a review article was written and published "Bite-sized review on an advance delivery system, support in the management of covid-19" by the authors Kothandan S, Venkatesan A, Radhakrishnan A, Reddy KV, Kuppusamy G, Dhanabal SP, Balasubramanian S, Bhojraj S in the journal International Journal of Research in Pharmaceutical Sciences. Furthermore, the collaborative publication was done under the center in association with Lovely Professional University, Punjab; International Medical University, Malaysia; University of a free state, South Africa; University of Technology Sydney, Australia; Fortis Hospital, Punjab; NIPER, Hyderabad, India; Macquarie University, Australia in the impact factor range of 2.734- 5.88 for the advancing the research in the stream of the disease like rheumatoid arthritis, ulcerative colitis, diabetic neuropathy by developing colon targeted minitablets, sliver nanoparticle, nano-formulation of a prodrug of sulfapyridine and publication details were enclosed in Annexure I.

Centre also involved in the development of various products in association with Dr. Shrinivasan, Former Principal, JSS College of Pharmacy, Ooty. Development of Nano ocular delivery of herbal based product for the treatment of glaucoma was initiated under the centre, and their development was under progress. Copper oxide Nanoparticle disinfectant spray for the management of viral infection also initiated and their product was developed, and their inhibitory studies on the various viruses including COVID 19 is under progress.

Centre paved a ways for M Pharm Students and Research Scholar to develop knowledge on Nano Particle and their related preparation technologies via an internal workshop for the instrument, nano spray dryer, ultra centrifugator, LiteSizer. Centre is now primarily focused for the Nano lab 3 in association with Bharathiyar university, Coimbatore, secondarily to the guest lectures from the Nanoscience and Nanotechnology expertise in National and International level.

Annexure I
Publication Details

Title	Authors Name	Journal	Year	Collaborator	IF	Weblink
Development of modified apple polysaccharide capped silver nanoparticles loaded with mesalamine for effective treatment of ulcerative colitis.	Kaur G, Singh SK, Kumar R, Kumar B, Kumari Y, Gulati M, Pandey NK, Gowthamarajan K, Ghosh D, Clarisse A, Wadhwa S.	Journal of Drug Delivery Science and Technology	2020	• Lovely Professional University, Punjab. • University of Technology Sydney, Australia • NIPER, Hyderabad, India • Macquarie University, Australia	2.734	https://www.sciencedirect.com/science/article/abs/pii/S1773224720312697
Effect of co-administration of probiotics with guar gum, pectin and eudragit S100 based colon targeted mini tablets containing 5-Fluorouracil for site specific release	Kumar A, Gulati M, Singh SK, Gowthamarajan K, Prashar R, Mankotia D, Gupta JP, Banerjee M, Sinha S, Awasthi A, Corrie L.	Journal of Drug Delivery Science and Technology	2020	• Lovely Professional University, Punjab.	2.734	https://www.sciencedirect.com/science/article/abs/pii/S1773224720312934
Fail-safe nano-formulation of prodrug of sulfapyridine: Preparation and evaluation for treatment of rheumatoid arthritis.	Kapoor B, Gulati M, Singh SK, Khatik GL, Gupta R, Kumar R, Kumar R, Gowthamarajan K, Mahajan S, Gupta S.	Materials Science and Engineering: C	2021	• Fortis Hospital, Punjab • Lovely Professional University, Punjab.	5.88	https://www.sciencedirect.com/science/article/abs/pii/S0928493120332501
Opening eyes to therapeutic perspectives of bioactive polyphenols and their nanoformulations against diabetic neuropathy and related complications	Rubiya Khursheed, Sachin Kumar Singh, Sheetu Wadhwa, Monica Gulati, Bhupinder Kapoor, Ankit Awasthi, Arya Kr, Rajan Kumar, Faheem Hyder Pottoo, Vijay Kumar, Harish Dureja, Krishnan Anand, Dinesh Kumar Chellappan, Kamal Dua & K. Gowthamarajan	Expert Opinion on Drug Delivery	2020	• Lovely Professional University, Punjab. • International Medical University, Malaysia • University of free state, South Africa • University of Technology Sydney, Australia	4.838	https://www.tandfonline.com/doi/abs/10.1080/17425247.2021.1846517
Bite-sized review on advance delivery system, support in the management of covid-19.	Kothandan S, Venkatesan A, Radhakrishnan A, Reddy KV, Kuppusamy G, Dhanabal SP, Balasubramanian S, Bhojraj S.	International Journal of Research in Pharmaceutical Sciences.	2020	-	-	https://pharmascope.org/ijrps/article/view/2342

1. **Development of modified apple polysaccharide capped silver nanoparticles loaded with mesalamine for effective treatment of ulcerative colitis.**

The objective of study was to develop modified apple polysaccharide (MAP) based silver nanoparticles (AgNPs) loaded with mesalamine (MES) for effective treatment of ulcerative colitis in acetic acid induced rat model. AgNPs were prepared by reducing silver nitrate using MAP solution. The size and zeta potential of AgNPs was 89 ± 3 nm and −16.3 ± 1.54 mV and AgNPs loaded with MES (AgNPs-MES) was 101 ± 9 nm and −14.27 ± 2.16 mV. The dissolution study revealed about 54% drug release after 5 h indicating release of drug at the colonic site. The in vivo study was carried out on acetic acid induced ulcerative colitis rats and efficacy of treatment was assessed through evaluation of disease activity index and level of antioxidants as well as tumor necrosis factor-α after 7th and 14th day of induction of colitis. Histopathological evaluation of colonic tissue was also carried out. The results revealed that AgNPs-MES (high dose) provided better therapeutic efficacy for the treatment of UC as compared to its low dose, MES alone, MES-MAP, AgNPs alone and MAP alone. It was concluded that MAP based AgNPs loaded with MES were successfully formulated and found to be effective in treating ulcerative colitis.

2. **Effect of co-administration of probiotics with guar gum, pectin and eudragit S100 based colon targeted mini tablets containing 5-Fluorouracil for site specific release**

Oral colon targeted mini-tablets containing 5-Fluorouracil (5-FU) were developed by using guar gum, pectin and Eudragit S100. Probiotics were co-administered to constantly replenish the gut microflora of colon that gets damaged due to pathophysiology of cancer and side effect of 5-FU. Replacement of microbial count ensures that the polysachharide used for sustaining the drug release gets digested to release the drug, once the formulation reaches the colon. The site-specific release of coated tablets was confirmed by dissolution studies in medium containing rat caecal contents (RCC), wherein, the formulation containing Eudragit S100, pectin and guar gum in the ratio of 04:03:03 w/w, showed less than 10% drug release in initial 5 h and immediate burst release (100%) between 5th to 10th hour. The cell line studies carried for pooled dissolution samples indicated that more than 90% cells were viable in all the cases till 5th hour. Significant ($p < 0.05$) decline in cellular viability was observed in case of coated mini tablets as compared to un-coated one. The pharmacokinetic studies showed a lower as well as delayed plasma concentration in the coated formulations endorsing the original hypothesis of reduction in drug exposure of the non-target sites.

3. **Fail-safe nano-formulation of prodrug of sulfapyridine: Preparation and evaluation for treatment of rheumatoid arthritis.**

Aim of the present study was to give a second life to the long-abandoned drug, sulfapyridine (SP) for its anti-arthritic potential by design of nano-vesicular delivery system. For this, intra-articular delivery of its liposomal formulation was tried. As the prepared formulation exhibited rapid drug leakage, an arthritis responsive prodrug of SP showing lability towards synovial enzymes was synthesized to exploit the over-expression of arthritis specific enzymes. Prodrug

(SP-PD) exhibited better retention in liposomes as compared to the drug, preventing its escape from synovium. Hydrolysis of SP-PD in human plasma and synovial fluid indicated its high susceptibility to enzymes. The liposomes of SP-PD exhibited larger mean size, less PDI and higher zeta potential as compared to those for SP liposomes. In arthritic rats, prodrug liposomes were found to reverse the symptoms of inflammation, including the levels of biochemical markers. Liposomes of bio-responsive prodrug, therefore, offer a revolutionary approach in the treatment of rheumatoid arthritis.

4. **Opening eyes to therapeutic perspectives of bioactive polyphenols and their nanoformulations against diabetic neuropathy and related complications**

In this review various polyphenol based nanoformulations such as nanospheres, self-nanoemulsifying drug delivery systems, niosomes, electrospun nanofibers, metallic nanoparticles explored exclusively to treat DN are discussed. However, the literature available related to polyphenol based nanoformulations to treat DN is limited. Moreover, these experiments are limited to preclinical studies. Hence, more focus is required towards development of nanoformulations using simple and single step process as well as inexpensive and non-toxic excipients so that a stable, scalable, reproducible and non-toxic formulation could be achieved and clinical trials could be initiated.

5. **Bite-sized review on advance delivery system, support in the management of covid-19.**

COVID-19 are an unprecedented challenge for healthcare providers; there are no approved treatments for this disease, nor are there no approved vaccines. The sources of infection of novel coronavirus detected mainly from animals to humans or infected human to healthy human through respiratory droplets and long contact period are the most prominent way of transmission. Coronaviruses are structurally large-sized single-stranded RNA viruses. The capability of regular therapies is constantly fading away exactly in case of coronavirus due to the modification of new strain, which could be certainly due to speedy adaptation in a protein sequence. The scientist should understand the pandemic situation of virus infection, also as they ought to identify the newest pathway research to regulate the virus infection. Developing new and smart strategies for drugs already in the development pipeline or already exiting drug can be treating diseases in patients could be useful to ϑight against COVID-19. In the last few years, several new smart drug delivery approaches made the changeover from the laboratory development to clinical applications. At present technology, researchers provide effective and low toxicity drug delivery when compared with classical delivery. This approach will be a great opportunity for the scientist to work and update preclinical research of advance drug delivery systems to cloneable and convertible production to the human trial success rate. In conclusion, by understanding the new drug delivery research approaches for antiviral therapy are increases to produce safe and high-quality therapies at reasonable costs.