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sequence 5'TCGGAGTCAACGGATTTG3' and reverse primer 5'CAACAATATCCACTTTACCAGAG3') as reference by using Taq polymerase (TAKARA R001A) with 35 repetitive cycles of denaturation at 95 ℃ for 25 sec, annealing at 59 ℃ for 30 sec and extension 72 ℃ for 35 sec followed by final extension at 72 ℃ for 7 min. PCR products were run on 2% agarose gel and dosimetry calculation were performed.

2.9 STATISTICAL ANALYSIS

Using the Origin 2021 software (OriginLab Corporations, USA), the independent Student's t-test and one-way ANOVA with the Tukey test were used to statistically analyse the *in vitro* and *in vivo* data. Statistical significance was defined at a *P*-value < 0.05. The data are shown as mean ±SD.

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of a certain degree of anti-inflammatory potential. Notably, the findings underscored that PNAG NPs contribute to an accelerated healing rate in a full-thickness *in vivo* skin wound model. This study elucidates the ability of PNAG NPs to induce angiogenesis and mitigate inflammation within the microenvironment of skin cells and tissues. The prominent attributes of PNAG NPs, including angiogenesis promotion, facilitation of cell migration and proliferation, and anti-inflammatory activity, collectively advocate their efficacy in promoting WH and overall tissue well-being. These observations suggest the promising potential of PNAG NPs for topical applications in WH and regenerative nanomedicine, obviating the need for external synergistic factors such as drugs, genes, cytokines, growth factors, or cells.

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and 6.8) for more than 24 h when tested *in vitro*. The cytotoxicity analysis indicated that SP NPs exhibited good biocompatibility in mouse fibroblast (L929) cell lines and displayed negligible hemolytic behaviour on rat RBCs. To evaluate the effect of SP NPs on promoting WH, we prepared SP NPs impregnated nanoformulation using an oleaginous ointment base for enhancing residence time and smooth application during application. The nanoformulation is non-irritant for rat's skin. Both NO and PNAG NPs show synergistic effects on cutaneous WH by enhancing granulation tissue formation, collagen depositions, angiogenesis and regulating cytokines and chemokines and may prove superior compared to the traditional treatment methods. Therefore, SP NPs and SP nanoformulation is a versatile NO-releasing formulation with a promising future in regenerative medicine and is paramount for therapeutic technology.

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observed differential responses emphasize the need for a nuanced understanding of the interactions of MONPs with biological systems. Further investigation of the underlying mechanisms may provide insight into safe biomedical applications of these materials.

3.3.7 REFERENCES

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MALDI-TOF Experiment of PNAG NPs and SP NPs

To measure the molecular weight MALDI-TOF experiments were performed for PNAG NPs and SP NPs using CDCl3 and DMSO-d6 solvent (1:1) and using dithranol matrix. The molecular weight and PDI wer calculated suing the following equations 1-3.

$$\mathrm{Mn} = \frac{\sum MiNi}{\sum Ni} \text{ ---------- (1)}$$

$$M\mathrm{w} = \frac{\sum \mathrm{Mi}^2\,\mathrm{Ni}}{\sum \mathrm{Mi}\,\mathrm{Ni}} \text{ ---------- (2)}$$

$$\mathrm{PDI} = \frac{\mathrm{Mw}}{\mathrm{Mn}} \text{ ---------- (3)}$$

Where, Mn is number average molecular weight, Mw is weight average molecular weight, PDI is polydispersity Index, Mi is the mass of the 'I' oligomer and Ni is number of the i^{th} oligomer.

Results

To determine the average molecular weight, the MALDI-TOF spectrum was obtained (Figure 1A: PNAG NPs) and (Figure 2A: SP NPs) and results showed that the Mn, Mw and PDI for PNAG NPs are 1614.42, 1661.49 and 1.02 and for SP NPs 1709.17, 1801.05 and 1.05, respectively.

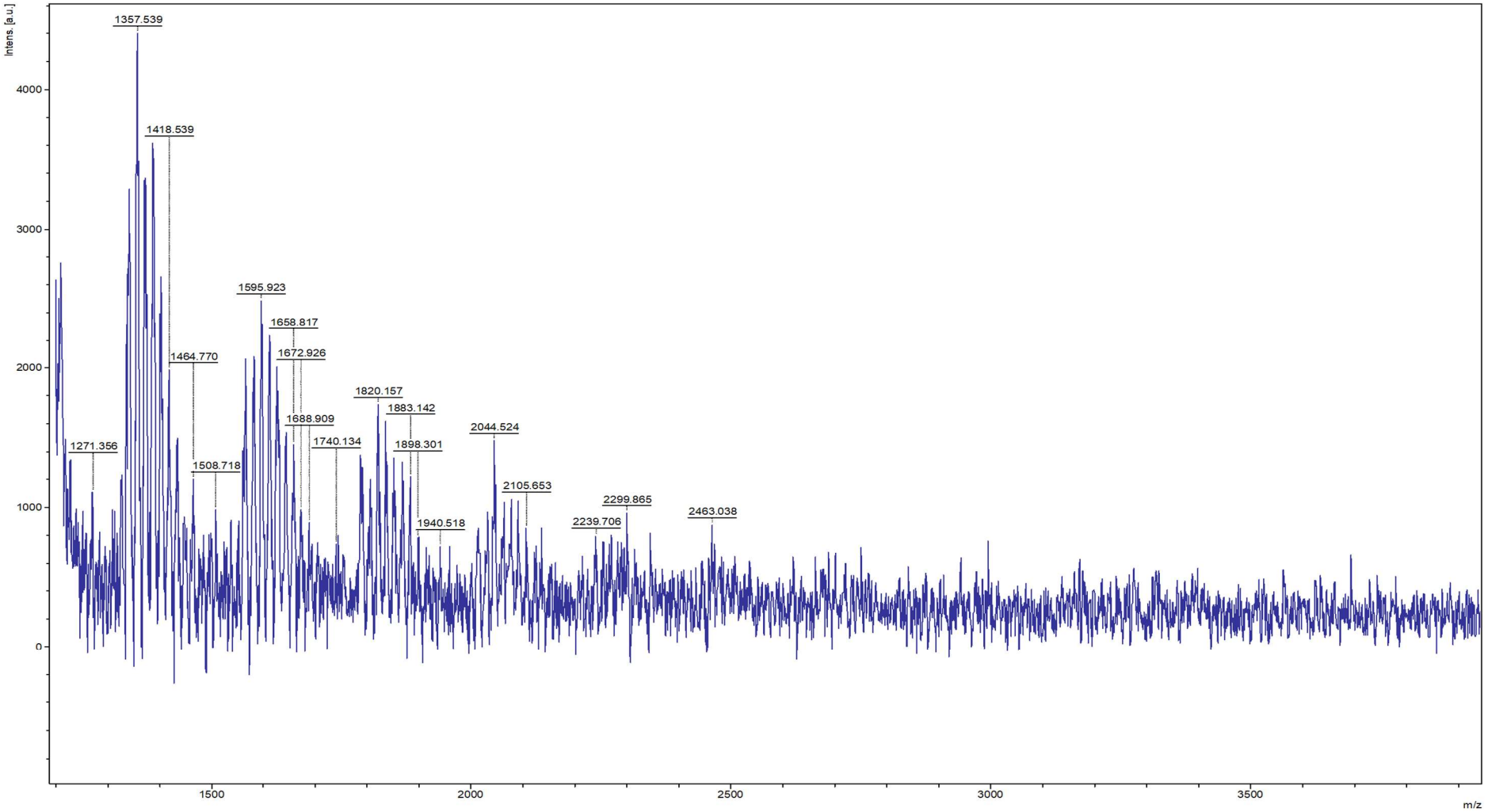

Figure 1A: MALDI-TOF spectra of PNAG NPs, showing Mn, Mw and PDI as 1614.42, 1661.49 and 1.02, respectively.

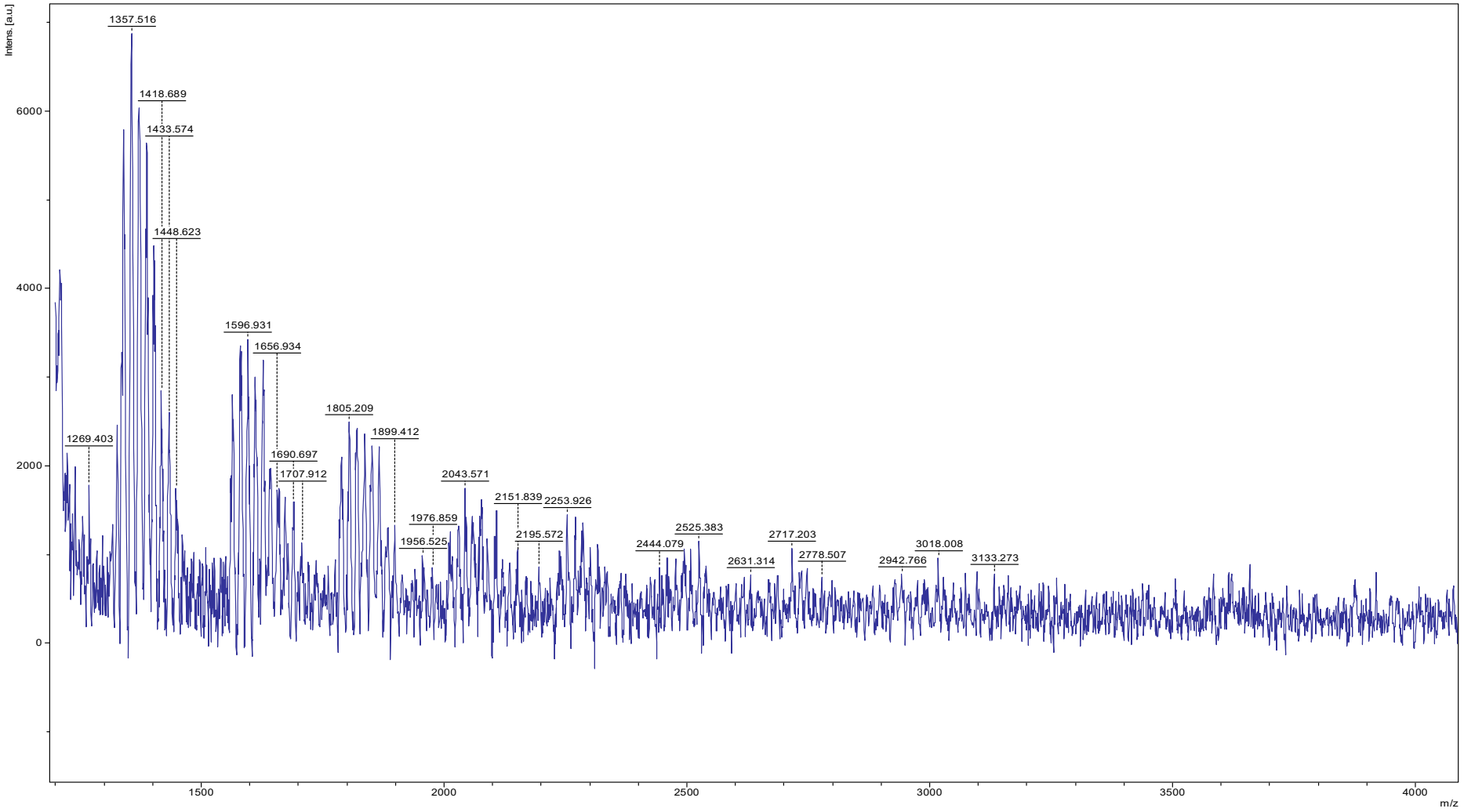

Figure 2A: MALDI-TOF spectra of SP NPs, showing Mn, Mw and PDI as 1709.17, 1801.05 and 1.05, respectively.

भारतीय प्रौद्योगिकी संस्थान
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Department of Pharmaceutical Engineering & Technology

Regd. No. 2123/GO/Re/S/21/CPCSEA Date: 03 May, 2022

IAEC Approval Number: **IIT(BHU)/IAEC/2022/078**

CERTIFICATE

This is to certify that the project proposal entitled **"Toxicological, dermal/skin irritation/ Skin hypersensitivity and wound healing study of novel nano biomaterials and bio polymeric nanocarriers and their formulations containing drugs using the proposed rat (male/female) model"** submitted by **Mr.Prem Shankar Gupta** under supervision of **Dr. Pradeep Paik** has been approved/recommended by the IAEC of *Indian Institute of Technology, Banaras Hindu University, Varanasi* in its meeting dated **03/05/2022** and has been sanctioned **56 Male/Female Wistar Rats (200-250 gm)** under this proposal for a duration of **Twelve (12) months.**

Prof. Sushant Kumar Shrivastava	Dr. Vinod Tiwari	Dr. Shesh Narayan Mishra
Name & Signature	**Name & Signature**	**Name & Signature**
Chairman	**Member Secretary**	**Main Nominee of CPCSEA**

Note: The CPCSEA Guideline should be followed strictly while handling the animals

Publications:

1: Agarwal, D. S. K., D. V. E. Salis, D. K. B. Raja, D. C. Karthikeyini, **P. S. Gupta** and D. Saravanan (2021). "Experience of treating COVID-19 with hydroxychloroquine and azithromycin: New Delhi, India." Turkish Journal of Physiotherapy and Rehabilitation 32(3): 795-804.

2: Amgoth, C., G. Dharmapuri, S. Patra, K. Wasnik, **P. S. Gupta**, A. M. Kalle and P. Paik (2021). "'Plate-like-coral' polymer particles with dendritic structure and porous channels: Effective delivery of anti-cancer drugs." Journal of Applied Polymer Science 138(19): 50386.

3: **Gupta, P. S.,** K. Wasnik, S. Patra, D. Pareek, M. Singh, S. Maity, M. Pandey and P. Paik (2022). A Review on Biodegradable Polymeric Materials for Bone Tissue Engineering (BTE) Applications. Encyclopedia of Materials: Plastics and Polymers. M. S. J. Hashmi. Oxford, Elsevier: 498-531.

4: **Gupta, P. S.,** K. Wasnik, G. Singh, S. Patra, D. Pareek, D. D. Yadav, M. S. Tomar, S. Maiti, M. Singh and P. Paik (2023). "In vivo potential of polymeric N-acryloyl-glycine nanoparticles with anti-inflammatory activities for wound healing." Materials Advances 4(20): 4718-4731.

5: Maity, S., M. S. Tomar, K. Wasnik, S. Patra, M. D. Modak, **P. S. Gupta,** D. Pareek, M. Singh and P. Paik (2022). "Azadirachta indica Seed Derived Carbon Nanocapsules: Cell Imaging, Depolarization of Mitochondrial Membrane Potential, and Dose-Dependent Control Death of Breast Cancer." ACS Biomaterials Science & Engineering 8(8): 3608-3622.

6: Pandey, M., M. Singh, K. Wasnik, S. Gupta, S. Patra, **P. S. Gupta**, D. Pareek, N. S. N. Chaitanya, S. Maity, A. B. M. Reddy, R. Tilak and P. Paik (2021). "Targeted and Enhanced Antimicrobial Inhibition of Mesoporous ZnO–Ag2O/Ag, ZnO–CuO, and ZnO–SnO2 Composite Nanoparticles." ACS Omega 6(47): 31615-31631.

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9: Patra, S., D. Pareek, **P. S. Gupta,** K. Wasnik, G. Singh, D. D. Yadav, Y. Mastai and P. Paik (2024). "Progress in Treatment and Diagnostics of Infectious Disease with Polymers." ACS Infectious Diseases.

10: Patra, S., M. Singh, D. Pareek, K. Wasnik, **P. S. Gupta** and P. Paik (2022). "Advances in the Development of Biodegradable Polymeric Materials for Biomedical Applications."

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12: Wasnik, K., **P. S. Gupta,** S. Mukherjee, A. Oviya, R. Prakash, D. Pareek, S. Patra, S. Maity, V. Rai, M. Singh, G. Singh, D. D. Yadav, S. Das, P. Maiti and P. Paik (2023). "Poly(N-acryloylglycine-acrylamide) Hydrogel Mimics the Cellular Microenvironment and Promotes Neurite Growth with Protection from Oxidative Stress." ACS Applied Bio Materials 6(12): 5644-5661.

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(Citations=113, h-index=6, i10-index=5)

SUMMARY

As a research scholar at the esteemed Indian Institute of Technology (BHU) in Varanasi, Uttar Pradesh, India, my focus revolves around pioneering advancements in the realm of drug nanocarriers and nanomedicine made up of polymers. I am renowned for my adeptness in crafting and characterizing drug nanocarriers tailored for precise drug delivery, coupled with an in-depth understanding and application of pharmaceutical technology. My comprehensive skill set extends to rigorous *in vitro* and *in vivo* assessments of novel drug delivery systems, positioning me at the forefront of cutting-edge nanomedicine research. As a dedicated academician, I contribute significantly to the enrichment of future pharmacy professionals, imparting knowledge at both graduate and undergraduate levels. My prolific publication record in prestigious journals and dynamic presentations at renowned conferences underscore my commitment to advancing pharmaceutics. With a diverse research portfolio, including pharmacokinetics, biodistribution studies, and innovative drug delivery strategies, my work remains pivotal in shaping the landscape of contemporary healthcare. Engaging in impactful projects further substantiates my dedication to pushing the boundaries of knowledge and innovation in pharmaceutics.

EXPERIENCE

7. Associate Professor (Pharmaceutics)
Maharishi Markandeshwar College of Pharmacy, Maharishi Markandeshwar (Deemed to be University), Ambala, Haryana
April 2024-Currently working here

6. Associate Professor (Pharmacy: Pharmaceutics)
KJ College of Pharmacy, Varanasi, Uttar Pradesh
December 2023- March 2024

5. Senior Research Fellow cum Teaching assistant (During PhD)
School of Biomedical Engineering, Indian Institute of Technology (BHU), Varanasi, Uttar Pradesh, India *December 2020 – December 2024*

4. Junior Research Fellow cum Teaching assistant (During PhD)
School of Biomedical Engineering, Indian Institute of Technology (BHU), Varanasi, Uttar Pradesh, India *December 2017 - December 2020*

3. Senior Research Fellow
Department of Pharmaceutical Engineering and Technology, Indian Institute of Technology (BHU), Varanasi, Uttar Pradesh, India *August 2016 - December 2017*

2. Assistant Professor
Varanasi College of Pharmacy, Varanasi, Uttar Pradesh; July *2014 - July 2016.*

1. Assistant Professor
Devsthali Vidyapeeth, College of Pharmacy, Rudrapur, Uttarakhand; May *2011 - May 2014.*

EDUCATION

6. **PhD (Thesis Submitted on 31-01-2024)**
Indian Institute of Technology (BHU), Varanasi, Uttar Pradesh, India *Dec 2017 – Jan 2024*
Thesis Title: Development of Polymeric Nanomedicine for Accelerating Tissue

Regeneration and Biological Activity Assessment of Antimicrobial Components

5. **Master of Pharmacy (Pharmaceutics)**
   Rajiv Academy for Pharmacy, Mathura, Uttar Pradesh, India ***Jul 2009 – June 2011***
   Thesis Title: Effect of Melt Sonocrystallization on Physicochemical, Pharmacotechnical and Pharmacokinetic Properties of Piroxicam
4. **Bachelor of Pharmacy**
   Ram-Eesh Institute of Vocational and Technical Education, Greater Noida, Uttar Pradesh, India *July 2006 - June 2009*
3. **Diploma in Pharmacy**
   Government Polytechnic, Kashipur, Uttarakhand, India *Jul 2004 - Jun 2006*
2. **Intermediate**
   Government Inter College, Lalkuan, Nainital, Uttarakhand, India *Jul 2001 - Jul 2003*
1. **Highschool**
   Government Inter College, Lalkuan, Nainital, Uttarakhand, India *Jul 1999 - Jun 2001*

TRAINING COURSES

5. Flow Cytometry for a Comprehensive Understanding of its Usefulness in Basic, Applied & Clinical Research
   Department of Biochemistry, Institute of life sciences, Banaras Hindu University, Varanasi, *Nov 2022 - Nov 2022*
4. Spectroscopic, Chromatographic, Bioanalytical & Imaging Techniques, Central University of Punjab, Bhatinda, Punjab *Nov 2022 - Nov 2022*
3. LaTeX for Beginners, IEEE IAS student chapter and IEEE student Chapter *Jul 2018 - Jul 2018*
2. Course on Computer Concepts, National Institute of Electronics and Information Technology *Aug 2016 - Aug 2016*
1. Recent Prospective and Alternatives to Animals on Experimental Pharmacology, Devsthali Vidyapeeth, College of Pharmacy *Oct 2013 - Oct 2013*

AWARDS

8. Best Poster Award: Gas Therapy for Chronic Wound Healing (Advanced Functional Materials: Future Perspectives)
7. Awarded to participate in DST-Sponsored the 7-day Residential STUTI Workshop at Central University of Punjab.
6. Institute Teaching Assistantship: Indian Institute of Technology (BHU), Varanasi; Awarded for doing PhD at IIT (BHU), MHRD, India
5. Received Scholarship from MHRD, Govt. of India for M. Pharm (Pharmaceutics)
4. GATE Qualified 2009: Indian Institute of Technology, Roorkee, Uttarakhand
3. Registered Pharmacist, Uttarakhand Pharmacy Council, Dehradun.
2. Qualified, National Level Pharmacy Talent Search Examination, Organized by Pharma Helpline Society, Jaipur, Rajasthan, India
1. Qualified, Pharmacy Talent Search Examination, Organized by Pharma Publications, Delhi, India

PROJECTS

2. **Development of Polymeric Nanomedicine for Accelerating Tissue Regeneration and Biological Activity Assessment of Antimicrobial Components**
   Active Researcher *Dec 2017 – Present*
   Preparation and characterization of biocompatible PNAG NPs (35 nm), and loaded with nitric oxide, enhance proliferation & migration of L929 cells, demonstrates 31% higher efficiency *in vivo* (rat model). Reduces TNF-α & IL6 and IL1β, results in reduced inflammation. Increases IGF-1 promote angiogenesis. Thus, offers promising solution with regenerative & skin restoration potential in wound healing.
1. **Effect of Melt Sonocrystallization on Physicochemical, Pharmacotechnical and Pharmacokinetic Properties of Piroxicam**
   Active Researcher July 2009- June 2011
   Solubility enhancement of poorly soluble API without the use of any excipient.

PUBLICATIONS

(A) Guest Editor (Topic: Nano- Preparations in the Design of Drug Delivery Systems)

Frontiers in Nanotechnology
https://www.frontiersin.org/research-topics/63849/nano-preparations-in-the-design-of-drug-delivery-systems

(B) JOURNAL ARTICLES

15. Paik P., Wasnik, K., **Gupta, P. S.,** Singh G., Maity S., Patra S., Pareek D., Kumar S., Rai V., Prakash R., Acharya A., Maiti P., Mukherjee, S., and Mastai Y (2023). Neurogenic and Angiogenic poly(N-acryloylglycine)-co-(acrylamide)-co-(N-acryloyl-glutamate) Hydrogel: Preconditioning Effect Under Oxidative Stress and use in neuroregeneration. Journal of Materials
14. Chemistry B, DOI https://doi.org/10.1039/D4TB00243A (IF: 7)

Patra, S., Pareek, D., **Gupta, P. S.,** Wasnik, K., Singh, G., Yadav, D. D., Mastai, Y., & Paik, P. (2024). Progress in Treatment and Diagnostics of Infectious Disease with Polymers. *ACS Infectious Diseases*, *10*(2), 287-316. https://doi.org/https://doi.org/10.1021/acsinfecdis.3c00528 (IF: 5.3)

13. **Gupta, P. S.,** Wasnik, K., Patra, S., Pareek, D., Singh, G., Yadav, D. D., Maity, S., & Paik, P. (2024). Nitric oxide releasing novel amino acid-derived polymeric nanotherapeutic with anti-inflammatory properties for rapid wound tissue regeneration. *Nanoscale*, *16*(4), 1770-1791. https://doi.org/10.1039/D3NR03923D (IF: 8.3)
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(E) Abstracts Submitted in Conferences and Seminars Attended

11. *D Pareek1**, *K Wasnik1,* ***PS Gupta1****, S Patra1, G Singh1, DD Yadav1, Y Mastai2, P Paik1*,* Amino acid-based polymer nanocapsules stimulate naïve macrophages and protect them from oxidative damage during controlled drug release, Michael Sela Symposium, to be held during 7th June, 2023 to 8th June, 2023 at Weizmann Institute of Science , Israel.
10 *Sukanya Patra1*, Chander Amgoth2, **Prem Shankar Gupta1** , Kirti Wasnik1, Divya Pareek1, Pradip Paik1* , Thermosensitive Porous Polymeric Film of (pNIPAM)-b-(PCL) for Control Drug Delivery, Mahatma Gandhi University Kerala (12-05-2023)
9. International Conference on Nanotechnology: Opportunities and Challenges ICONC 2022. Oral presentation: Kirti Wasnik1, **Prem Sankar Gupta1**, Sukanya Patra1 , Divya Pareek1, Pradip Paik1, Novel Nanopolymer: Synthesis Characterization And Application For Cancer Treatment Without Conventional Drugs Jamia Millia Islamia, Date: 28-30th Nov, 2022
8. International Conference on Nanotechnology: Opportunities and Challenges ICONC 2022. Poster: Delivery of nitric oxide through polymer nanoparticles for chronic wound healing, Jamia Millia Islamia, Date: 28-30th Nov, 2022
7. International Conference on Drug Discovery 2022 ICDD 2022. Kirti Wasnik1, **Prem Sankar Gupta1**, Alagu Oviya1, , Sukanya Patra1, Divya Pareek1,Pradip Paik1*, Novel Nanopolymer for poor prognosis cancer treatment without Conventional Drugs in heparanase driven malignancies, BITS Pilani, K. K. Birla Goa Campus and Schrodinger, 10-11th November, 2022
6. International Conference on Science and Technology of Polymers and Advanced Materials through Innovation, Entrepreneurship and Industry MACRO-SPSI 2022. Poster: Kirti Wasnik1, **Prem Sankar Gupta1**, Divya Pareek1, Sukanya Patra1, Pradip Paik1, Anti-tumorigenic characteristics of poly (N-Acryloyl-glycine- acrylamide) co-polymeric hydrogel NCL-Pune, 2-4th November, 2022
5. International Conference on Science and Technology of Polymers and Advanced Materials through Innovation, Entrepreneurship and Industry MACRO-SPSI 2022: Poster: **Prem Sankar Gupta1** Kirti Wasnik1, Divya Pareek1, Sukanya Patra1, Pradip Paik1 Nitric oxide realising polymer for wound healing, NCL-Pune, 2- 4th November, 2022.
4. Advanced functional materials; future perspectives 2022. **Prem Sankar Gupta1** Kirti Wasnik1, Divya Pareek1, Sukanya Patra1, Pradip Paik1 , Gas therapy for chronic wound healing, Dr. B. R. Ambedkar, National Institute of Technology Jalandher. 6-8th August, 2022 (Awarded Best poster).
3. International Conference on Nanotechnology: Opportunities and Challenges, November 28-30, 2022; ICNOC 2022, Jamia- MiliyaIshlamia, New Delhi
2. International Conference on Science and Technology of Polymers and Advanced Materials through Innovation, Entrepreneurship and Industry, 2 to 4th November, 2022; SPSI-MACRO-2022, CSIR-NCL, Pune, Indian Institute for Science Education and Research, Pune.
1. International Conference on “Advanced Functional Materials: Future Perspectives” 6th to 8th August, 2022; AMFP-2022, Dr.B. R. Ambedkar NIT, Jalandhar, Sant Longowal Institute of Engineering and Technology, Longowal, Université de Bejaia, Defence Institute of Advanced Technology, Pune- Best Poster Award Winner

DECLARATION

I Prem Shankar Gupta, hereby declare that the information given is correct and best to my knowledge. If any discrepancy is found in the information, then I will be solely responsible.

Date:
Place: Prem Shankar Gupta