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CSIR

Central Drug Research Institute

ANNUAL REPORT 2019-20

CSIR-Central Drug Research Institute

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Fundamental
Science Driven Innovation

Captions for the picture included in the cover page

The President of India, Shri Ram Nath Kovind presenting CSIR Technology Award for Innovation for the year 2019 to CSIR-CDRI for development of novel osteo-inductive agent CDRI S0008-399 as medicated bone implant material for fracture healing, on the occasion of CSIR Foundation Day at a function at Vigyan Bhavan, New Delhi on 26 September 2019.

Editorial Board

Acknowledgement

Editorial board sincerely thanks to all who have extended their generous support, advice and help, in the preparation of the Annual Report 2019-20. The effort of each and every person who has contributed in the making of this report is hereby acknowledged. We are grateful to all the Area Coordinators and Chairpersons, In Charge of Divisions, Units, Administration for timely submission of data and for the support.

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ANNUAL REPORT
2019-20

CSIR-Central Drug Research Institute

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Organizational Structure

Shri Narendra Modi
Hon'ble Prime Minister &
President, CSIR

Dr. Harsh Vardhan
Hon'ble Union Minister for Health & Family Welfare, Science & Technology and Earth Sciences and Vice-President, CSIR

Dr. Shekhar C. Mande
Secretary DSIR, & Director General, CSIR

Research Council → **Prof. Tapas K. Kundu**
Director, CSIR-CDRI ← **Management Council**

State of the Art Facilities

- GLP Test Facilities
  - Acute Toxicity
  - Safety Pharmacology
- Knowledge resource Centre
- National Laboratory Animal Facility
- Sophisticated Analytical Instrument facility
- Tissue & Cell Culture Laboratory

Technical Infrastructure Divisions/Units

- Academic Affairs Unit
- Business Development and Intellectual Property Unit
- Computer Centre
- HRD Unit
- Institute Core Facilities
- Laboratory Engineering Services
- Scientific Directorate

R&D Divisions

1. Biochemistry
2. Botany
3. Cancer Biology
4. Endocrinology
5. Medicinal and Process Chemistry
6. Microbiology
7. Molecular & Structural Biology
8. Molecular Parasitology and Immunology
9. Neuroscience and Ageing Biology
10. Pharmaceutics & Pharmacokinetics
11. Pharmacology
12. Toxicology & Experimental Medicine

General Administration and Facilities

- Administration
- Accounts
- Stores & Purchase
- CSIR Dispensary
- Canteen

Field Station

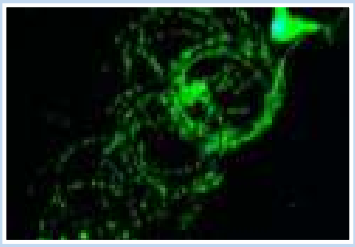
- CDRI Clinical Pharmacology Unit, Seth G.S. Medical College, Mumbai
- KGMU, Lucknow
- PGIMER, Chandigarh

Contents

Thrust Areas of Research

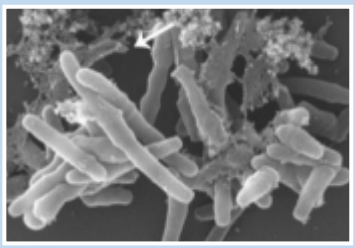
1. Malaria & Other Parasitic Diseases

- Development of new drugs/drug combinations as therapeutic interventions for malaria, leishmaniasis and filariasis;
- Identification of unique targets and pathways for future interventions;
- Investigations on parasite biology and host-parasite interactions.



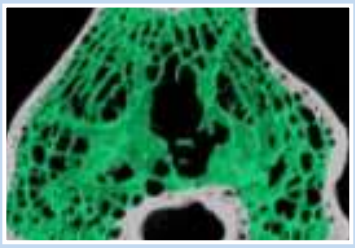
2. AMR: Drug-Resistant Mycobacterial Infections & ESKAPE pathogens

- Drug discovery studies against drug-resistant mycobacterial infections and ESKAPE pathogens;
- Discovery of new therapeutic strategies/interventions/diagnostic approaches by Advancing Knowledge Frontiers.



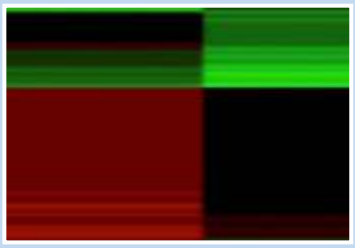
3. Bone Health and Metabolic Bone Diseases

- Development of novel agents for fracture healing and management of osteoporosis through modern drug design, scientific validation of traditional remedies and generation of new knowledge.



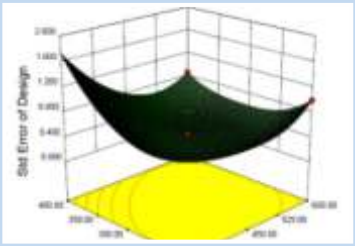
4. Cardiovascular, Neuroscience, Cancer Biology & Reproductive Health

- Development of novel therapeutic agents for CVS, CNS and related disorders, Cancer and Reproductive health;
- Carry out excellent basic research to delineate the molecular mechanisms of these pathologies / abnormalities so as to identify suitable targets for drug discovery, as well as to analyze the possible mechanism(s) of action of the candidate drugs;



5. Translational Research and Drug Development

- Pre-clinical and clinical development of drug substances and drug products for diseases of national importance, international relevance and public health needs;
- Provision of services to the pharmaceutical industry, especially micro, small and medium enterprises and public sector manufacturers;
- Continued engagement with drug regulation and pharmaceutical policy making in India as well as internationally.



From the Director's Desk

The CSIR-Central Drug Research Institute is possessing end-to-end expertise and infrastructure for fundamental chemical and biomedical research driven new drug discovery and development. Apart from the new drug development, the Institute is richly contributing to the advancement of our understanding of disease biology in the areas of national priorities, and set off revolution of Indian pharma sector over the past 70 years. I feel delighted to present the Annual Report of this premier Institute for the year 2019-20 highlighting its significant accomplishments and progress in the service of the nation and humanity as well.

Built on the glorious legacy, the ambitious new CSIR-CDRI for new India is aspiring to be the flag bearer in fundamental research to advance the understandings in the disease biology, innovations for unmet medical needs including traditional knowledge driven phytopharmaceuticals, development of highest-level human resource, and carryout the social outreach programs for social cause at the grass-root level. It is delightful to witness the enthusiasm among the research teams to clasp the newer opportunities and avenues to contribute for New India.

With an aim to bolster the academic and fundamental science driven innovative drug research programs, during the year, R&D divisions of the Institute were reorganized. Two new R&D divisions were created viz. (i) Neuroscience & Ageing Biology and (ii) Cancer Biology. To further strengthen the scientific capabilities, recruitment drive was initiated. We are eagerly looking forward for joining of new faculties in the different divisions in the coming few months' time.

I feel very humble to report that the year bygone is one of the most productive years. Institute successfully filed IND application for S007-867 (antithrombotic) and DCGI permission has been received to conduct Phase I Clinical Trial at KEM, Hospital, Mumbai. IND dossiers are being prepared for S007-1500 (fracture healing) and CDRI219C002 (glucocorticoid induced osteoporosis). We are aiming to initiate clinical trials for all these three

candidate drugs in the year 2020 with due approval of the regulatory authorities. It is remarkable to report that Eight molecules of CSIR-CDRI are taken up in the CSIR IND Mission, a timely ambitious initiative of Dr. Shekhar C. Mande, DG, CSIR. Institute is aiming to file at least 5 new INDs, for diseases of national importance, within next five years of time, and taken through final steps of drug development.

During the year, technology for novel osteo-inductive agent CDRI S008-0399, as medicated bone implant material for fracture healing, was demonstrated to our licensee M/s. OrthoRegenics Pvt. Ltd., Hyderabad and Technology Transfer Document was handed over. I am delighted to inform that this technology received prestigious CSIR Technology Award for Innovation 2019. Shri Ram Nath Kovind, Hon'ble President of India, conferred the award during CSIR Foundation Day celebrations on 26 September 2019 at Delhi. It was a proud and enduring moment for the entire CSIR-CDRI family.

Recently, Institute demonstrated the herbal technology N-012-0001 for the early management of Benign Prostatic Hyperplasia (BPH) to our licensee Lumen Marketing Company, Chennai. The Company is enthusiastic to bring the product to market at the earliest. CSIR-CDRI has also successfully demonstrated the technology for standardized fraction 219C002 for the treatment of Glucocorticoid–induced osteoporosis to our licensee M/s. Pharmanza Herbals Pvt. Ltd., Gujarat and handed over the Technology transfer document. Our licensees are gearing up for commercial launch of CSIR-CDRI technologies licensed to them in the coming year.

The conspicuous progress in INDs, transfer of technologies, product launch and technology awards have reinvigorated the enthusiasm and confidence in the faculty of CSIR-CDRI towards fundamental science driven innovation. In the coming years, Institute is poised to transfer few more technologies for unmet medical needs.

Linkages and partnerships always play catalytic role in augmenting the discovery in research activities. During the year, Institute established collaboration with many of the prestigious research institutes including IIT-Guwahati, IIT-Bombay, IIT-Indore and IIT-Kanpur. These collaborations have given a new dimension to the applications of fundamental research of CSIR-CDRI.

This year, a collaborative research agreement has been signed between CSIR-CDRI and CIPLA, a leading global pharma industry. I am confident that it will be a turning point for both the organizations in the service of humanity. The outcome of this collaboration will have larger societal impact than ever before. I am thankful to Dr. YK Hamied, FRS, Chairman, CIPLA for his willingness to establish a research center at CSIR-CDRI under the Corporate Social Responsibility scheme of Government of India. Institute is determined to initiate much needed research activities in the area of rare genetic disorders to alleviate the sufferings of thousands of affected populace. I take this opportunity to invite all the major Indian pharma companies to join their hands with CSIR-CDRI in its endeavor.

Institute has also initiated nationally relevant and service oriented programs like creation of Department of Scientific & Industrial Research sponsored Common Research and Technology Hub (CRTDH) for clinical trial batch production, drug testing and bioanalysis with an aim to support Pharmaceutical MSME. Institute further wish to establish Pharmacovigilance center at CSIR-CDRI. We are also planning to establish a National Laboratory Animal Centre to cater the needs of industry as well as academia. Our proposal for setting up of Incubation center / innovation center is already under consideration. We may start supporting the start-ups in the areas of health and pharma sector very soon.

In order to contribute in the scientific development of North East region of our Nation, and also to explore the flora and fauna, we are getting closure with our sister Institute CSIR-NEIST, Jorhat. With the enthusiastic support of Dr. Shekhar Mande, Director General, CSIR, we are at present exploring the possibilities of establishing a research Centre of CSIR-CDRI in Manipur.

During past one year, to foster scientific discussions and collaborations between different disciplines of science and medicine, many new initiatives like popular health talks, distinguished scientist lecture series, Nobel symposium, and faculty colloquium have been started. The impact of these programs in amplifying the academic culture in the Institute is remarkable.

While Institute is poised to make strident progress in science & technology arena of the Nation, several of my colleagues are ardently contributing to the scientific social responsibilities program of the Institute, including Skill development, Jigyasa, and Social outreach programs with an aim to promote scientific culture, innovation and instilling the confidence in populace. In the coming years, Institute will expand the scope of these programs for much wider outreach.

During the year, several of my colleagues received prestigious awards and recognitions including CSIR Young Scientist Award, NASI-Reliance Industries Platinum Jubilee Award; Fellow of National Academy Sciences, India; TATA Innovation Fellowship and many more. I congratulate all of them and wish for many more accolades in the coming years. These accomplishments and advancements, detailed in the ensuing pages of this report, validate the strength of the Institute in fundamental research driven innovation.

I am thankful to all my colleagues at all levels, students, advisory committees, chairpersons of the divisions, area coordinators, research and management council members for their constant support in the endeavors of CSIR-CDRI to serve the humanity. I look forward for their continued support in the coming years.

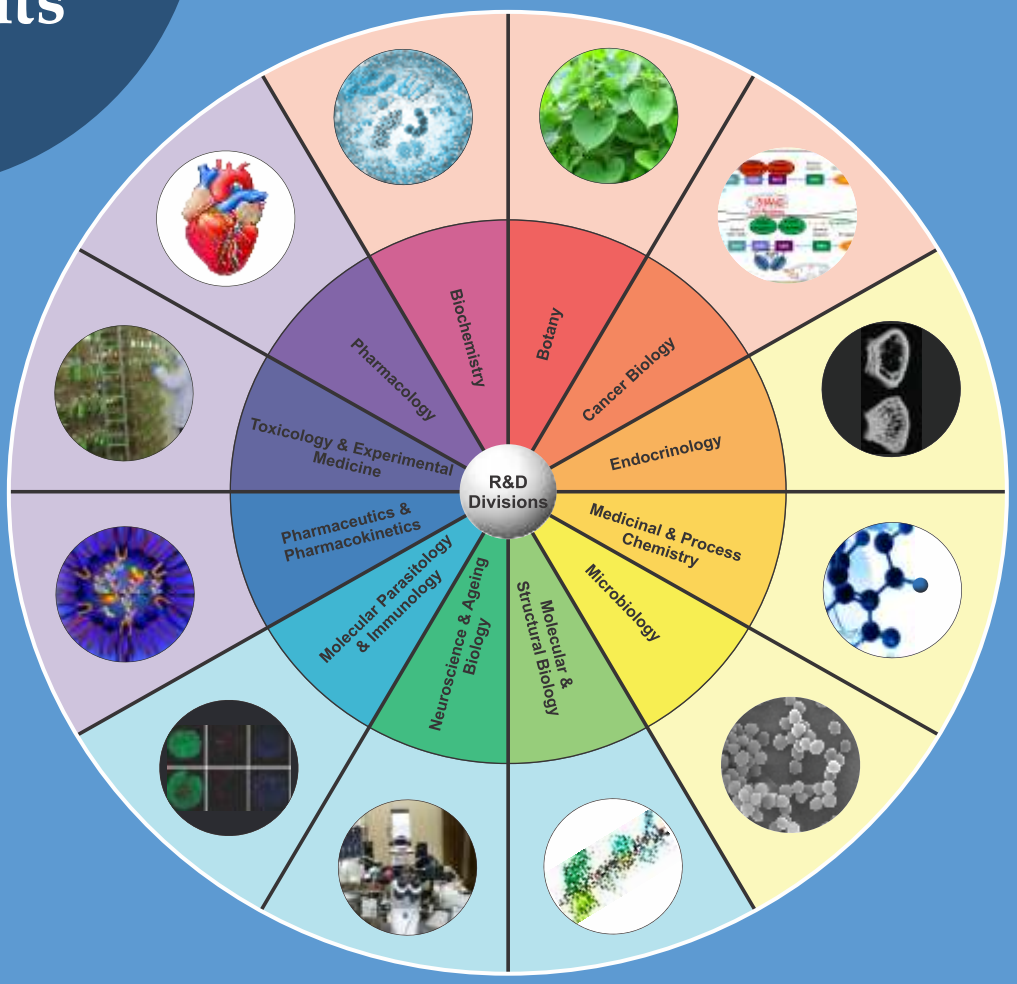
(Tapas K. Kundu)

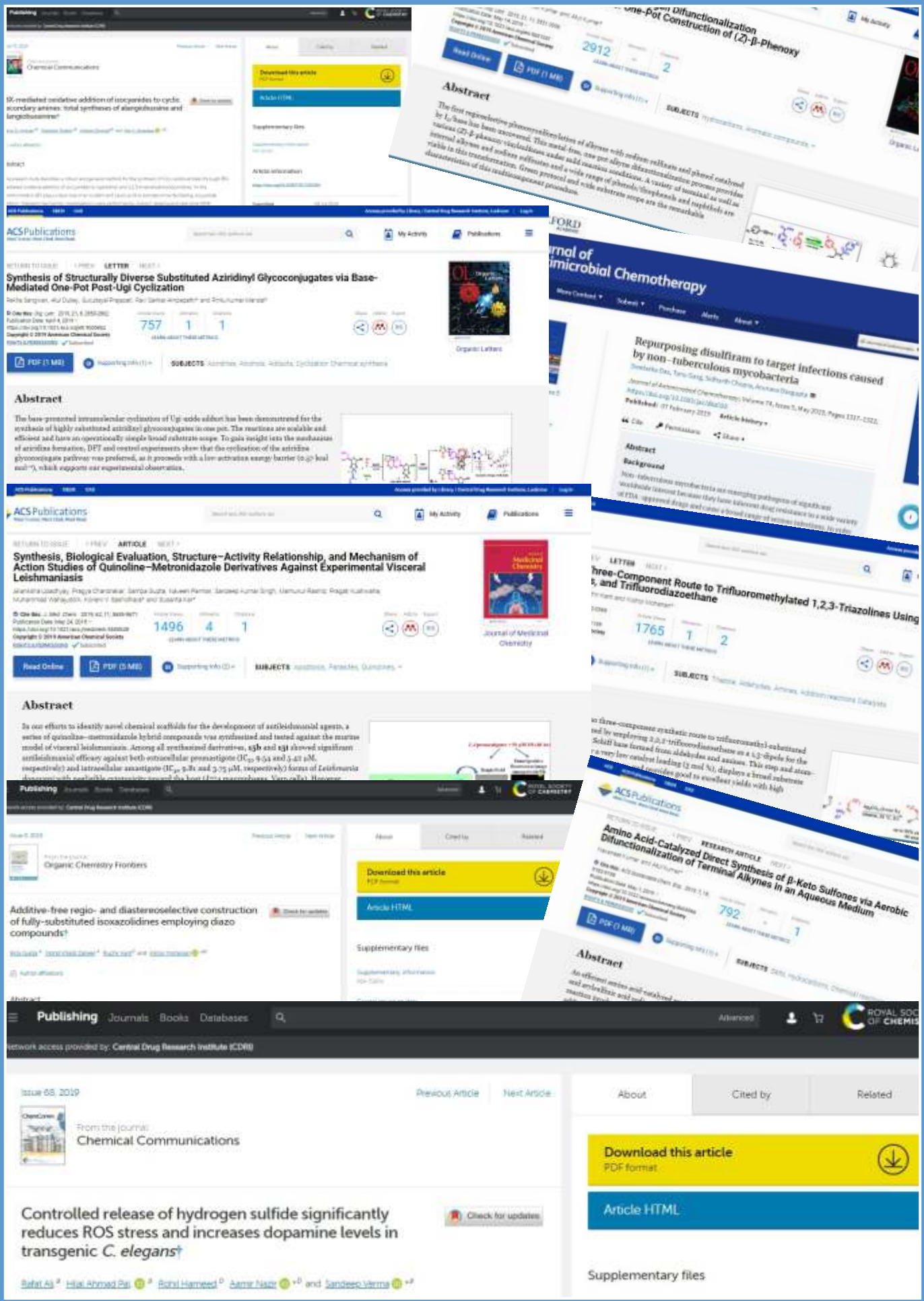
17 February 2020

Highlights of Achievements 2019

Products & Technologies		
IND Permission	:	**1** *(S007-867 for thrombosis)*
Technology Licensing & Demonstration	:	**1** *(N-012-0001 for the early management BPH)*
Technology Demonstration	:	**1** (219C002 for Glucocorticoid-induced Osteoporosis)
Publications in SCI Journals	:	**250**
Average Impact Factor	:	3.628
Publications with >5 Impact Factor	:	34
Patents		
Filed Abroad	:	1
Filed in India	:	1
Granted Abroad	:	7
Granted in India	:	5
Human Resource Development		
Ph.D. Thesis Submitted	:	49
Post graduate / Skill Trainings	:	122
New Projects	:	
Grant-in-Aid Projects Initiated	:	37
Total cost of Approved GAP Projects	:	Rs. 2724.59 Lakh

Executive Summary and R & D Highlights

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Controlled release of hydrogen sulfide significantly reduces ROS stress and increases dopamine levels in transgenic C. elegans†
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and Sandeep Verma
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Repurposing disulfiram to target infections caused by non-tuberculous mycobacteria
Three-Component Route to Trifluoromethylated 1,2,3-Triazolines Using
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Additive-free regio- and diastereoselective construction of fully-substituted isoxazolidines employing diazo compounds†
Organic Chemistry Frontiers

Executive Summary and R & D Highlights

CSIR-CDRI

The CSIR-Central Drug Research Institute (CDRI), Lucknow was seventh in the series of CSIR labs that were established in India right after independence with an aim for technological independence of the Nation. Formally dedicated to the Nation on 17 February 1951, during last 7 decades, Institute has significantly contributed in the domain of its mandate including discovery & development of new drugs to alleviate disease burden of Indian populace and revolutionize the pharmaceutical sector for accessibility and affordability of drugs. Today, CSIR-CDRI is a unique institution possessing end-to-end expertise and capabilities to meet the challenges of new India in the biomedical field. This report highlights some of the outstanding accomplishments of this Institute in the service of humanity during the past year.

Sound academia is the base of every innovation. Modern drug discovery is an integration of multidisciplinary fundamental science to produce innovative solutions for human health problems. In order to give impetus to fundamental research driven innovative drug research activities, during the year, R&D structure of the Institute was reorganized. Two new R&D divisions have been created. Each division has defined mandate, mission and core program aligned with the mandate of the Institute. Creation of two new R&D divisions, viz. Neuroscience & Ageing Biology and Cancer Biology was an outcome of the Institute's vision 2050 owing to incessantly increasing number of aged population in India, alarming trends in ageing associated diseases and incidence of cancer across India. These two divisions are formulating major research programs in collaboration with national and international agencies. To further strengthen and expand the scientific capabilities, recruitment drive has also been initiated and Institute is looking forward for joining of new faculty at the earliest.

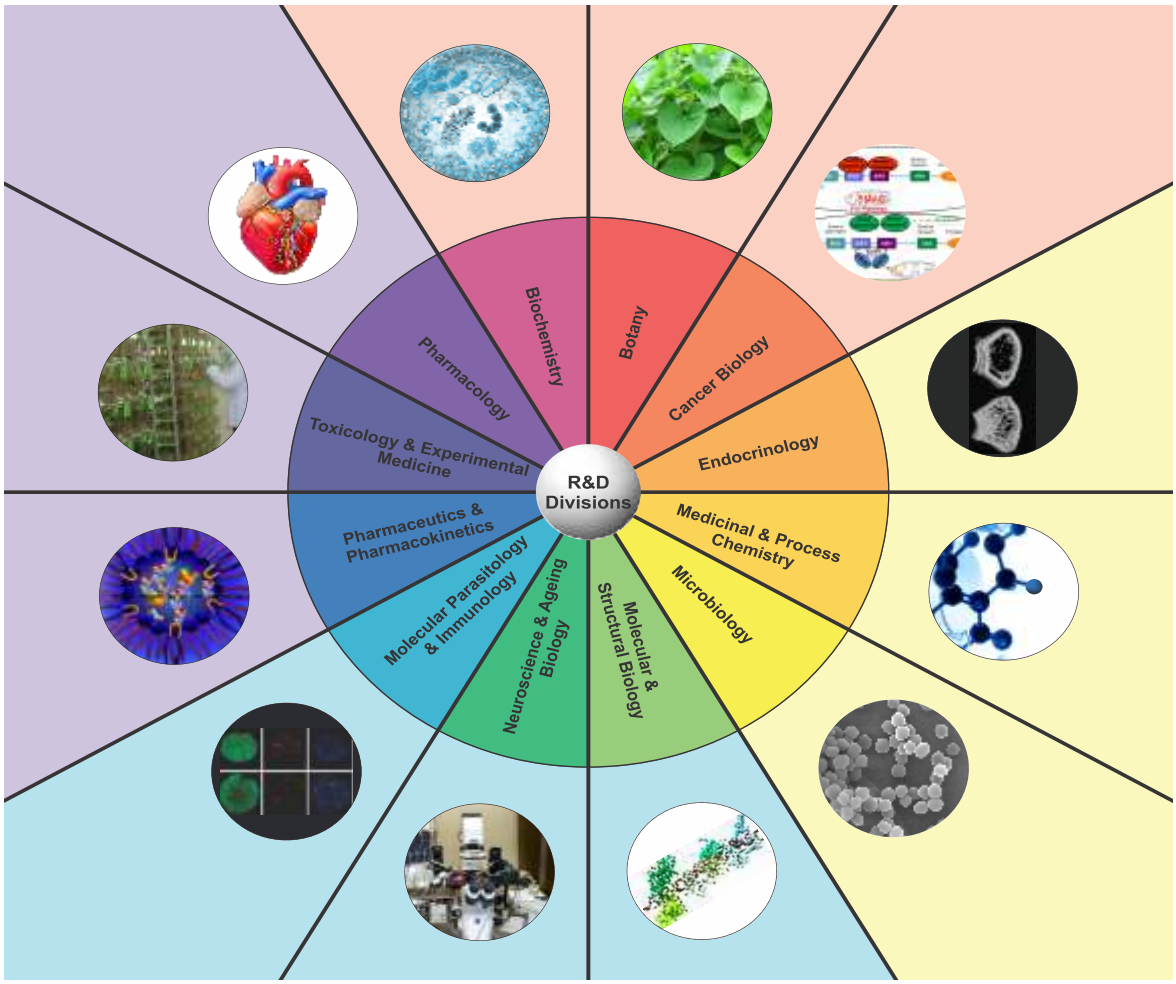
During the year bygone, Institute displayed noteworthy performance in all aspects of its charter, including new drug discovery & development, human resource development, advancing knowledge frontiers and socially relevant activities. Institute received DCGI permission for the Phase I clinical trial for one of the promising lead S007-867 (anti-thrombotic), which was conceptualized, discovered and developed completely at CSIR-CDRI with in-house scientific expertise and capabilities. IND document is being prepared for another promising lead, S007-1500 (fracture healing) discovered by CSIR-CDRI. Another compound of this series, S008-399, which is being developed as medicated bone implant material, has received prestigious CSIR Technology Awards for Innovation 2019. The year bygone has also witnessed demonstration and transfer of technology document for a plant based lead for Benign Prostate Hyperplasia and another phytopharamceutical lead 219C002 for Glucocorticoid Induced Osteoporosis. These milestone accomplishments indicate the unique in-house competency of CSIR-CDRI to discover and develop drugs from concept to commercialization stage.

Institute has also showed remarkable performance in terms of other measurable performance parameters as well. During the year 2019, Institute scientists published a total of 250 papers with average impact factor of 3.63. Filed One patent each in India and abroad. Further, 5 Indian and 7 foreign patents were granted during the reporting period. Forty-nine research scholars submitted PhD thesis and 122 aspirants received advanced trainings aimed at inculcating advanced scientific & technical skills. During the year, 37 new grant-in-aid

projects were initiated worth Rs. 27.24 Crore. Institute continued to collaborate with national and international research organizations and industries. During the year, 38 National and 17 International agreements were executed, including 18 pharmaceutical industry and 31 universities and research organizations.

Under the aegis of scientific social responsibility, Institute scientists and students participated in the various centrally operated programs as well as in-house conceptualized activities. Under the ambitious Jigyasa program, during the year, 104 faculty and 1121 students from 30 Kendriya Vidyalaya visited CSIR-CDRI. As a part of student motivation programs, 2486 students and 226 faculties from 69 schools and colleges visited CSIR-CDRI. These students interacted with scientists and visited laboratories.

Reorganization of R & D Structure




Sophisticated Analytical Instrument Facility


National Repository of Organic Compound


National Laboratory Animal Facility


Knowledge Resource Centre


GLP Test Facility for Acute Toxicity & Safety Pharmacology


Structural Biology Facility

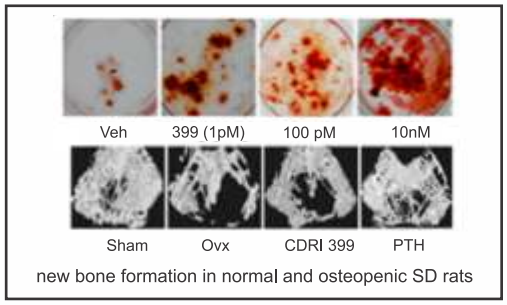

Clinical Trial Facility


Computational Biology and Bioinformatics

Breakthrough Achievement in 2019-20

CSIR Technology Award for Innovation 2019

Technology for Novel Osteo-inductive Agent CDRI S008-0399 as Medicated Bone Implant Material for Fracture Healing



new bone formation in normal and osteopenic SD rats

Osteoporosis leads to weakening of bones and increase susceptibility to bone fractures. There are more than 50 million osteoporotic patients estimated in India with disease being more prevalent in women than men. In addition, bone injuries resulting from road traffic accidents are a major and growing public health problem in India. CSIR-CDRI have designed and developed a novel dual-acting (promotes bone formation and prevents bone resorption) compound CDRI S008-399 that leads to faster bone healing, and enhances bone mineral density. The compound S008-399 promotes osteoblast differentiation and mineralization at dose as low as 1 pM concentration and increases bone mineral density (BMD), mineral apposition rate (MAR) and bone formation rate (BFR) in osteopenic rat model. This bone inducing agent improves bone quality and restores trabecular micro-architecture in ovariectomized osteopenic. CDRI-S008-399 enhances new bone formation and decreased the level of CTX, a collagen breakdown product and bone resorption marker. The compound acts via the stimulation of ER/p38MAPK/p-Smad signaling pathway. The compound is very cost effective and it increases new bone regeneration by enhancing the secretion of bone morphogenetic proteins which are critical for development and regeneration of bone forming cells. This technology has already been transferred to the M/s. Ortho Regenics Pvt. Ltd., Hyderabad. .

Technology Award for Innovation conferred during 76th CSIR Foundation Day 26 September 2019 at Vigyan Bhavan, New Delhi

Breakthrough Achievement in 2019-20

Investigational New Drug S007-867 for Thrombosis

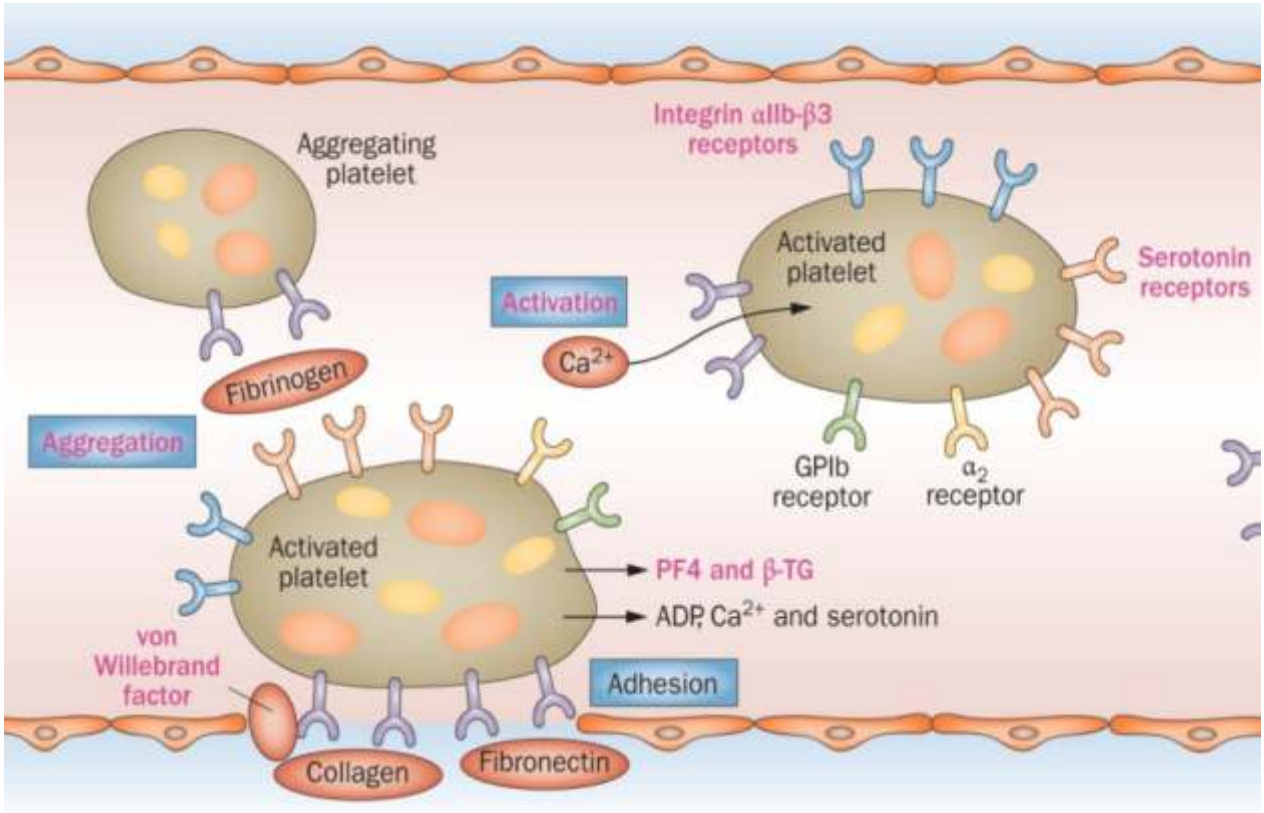
DCGI Approval Received on 30 January 2020 for Phase I Clinical Trial

Antithrombotic drugs are used in the management of clinical conditions like deep vein thrombosis (DVT), pulmonary embolism (PE), peripheral artery disease (PAD), and acute coronary syndromes (ACS). Antithrombotic drugs are one of the most rapidly growing sectors of the cardiovascular market representing >$20 billion USD in sales.

CDRI has a novel small molecule anti-platelet compound which may be useful in treating intravascular arterial thrombosis. This novel compound (chiral) is patented and has unique scaffold. The compound was picked after extensive SAR studies, which are active and selectively inhibit collagen mediated platelet activation. The compound is relatively simple to synthesize (MW < 500) and can easily be chemically modified to obtain the desired ratio of anti-platelet activity.

Unique Features

- ✓ S007-867, orally active, specific inhibitor of collagen induced platelet adhesion and aggregation and offers significant protection in various animal models of thrombosis.
- ✓ It has mild effect on bleeding time at similar efficacy doses as compared to the existing anti-platelet drugs such as Aspirin and Clopidogrel by oral route.
- ✓ No effect on coagulation cascade proteins and no adverse effect on vasoreactivity.
- ✓ Safety pharmacology, mutagenic and toxicity studies in rodents demonstrate no adverse effect.
- ✓ It has been tested in vitro for binding to 451 kinases and important GPCRs.
- ✓ Good pharmacokinetic profile.
- ✓ Toxicity Studies in primate model completed. Compound is safe
- ✓ DCGI Approval Received on 30 January 2020; Phase I Clinical Trial to be initiated shortly at KEM Hospital, Mumbai.

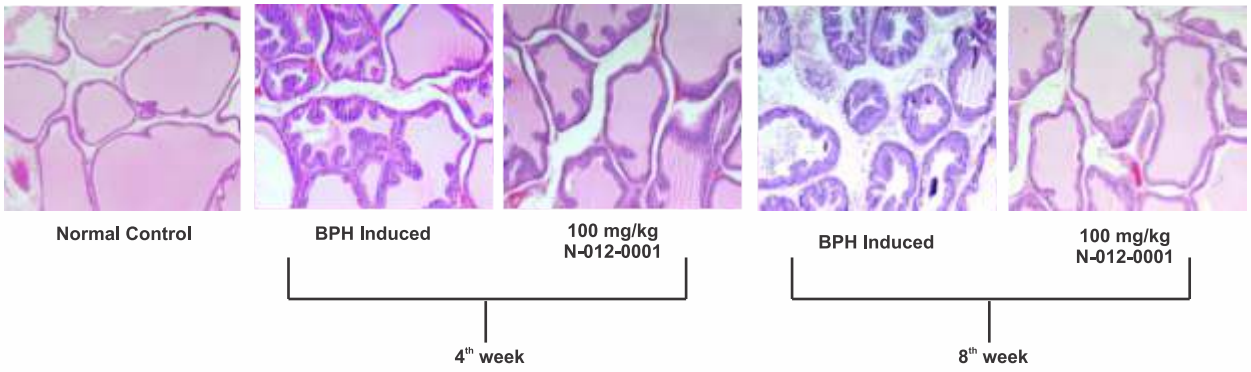


Breakthrough Achievement in 2019-20

Licensing and Demonstration of Technology for Nutraceutical Product for the Prevention and Management of Benign Prostate Hyperplasia

Benign Prostatic Hyperplasia (BPH) is the most common problem of older men as its prevalence increases with age. N-012-0001 is a naturally occurring compound isolated from one of the well-known Indian medicinal plants (CDRI plant code 109) listed by FSSAI to develop as a nutraceutical product. The plant material is renewable and available abundantly in wild and also commercially all over the India. Oral administration of N-012-0001 and its enriched fraction (109-F003) resulted in a significant reduction in prostatic weight, PSA levels and improved histological conditions in rat model of BPH, which was established at CSIR-CDRI. N-012-0001 and its enriched fraction found to be safe in acute toxicity studies on rats, besides overall effect was quite comparable with the commercially existing steroidal drugs in the market. Moreover, it is cost-effective, safer and provides a good alternative natural drug without any side effects. This product could benefit elderly subjects, who are suffering from BPH. The Technology was licensed Lumen Marketing Company, Chennai on 17 February 2019 for further development and commercialization as nutraceutical product.

Benign Prostate Hyperplasia (BPH) induction and treatment by N-012-0001



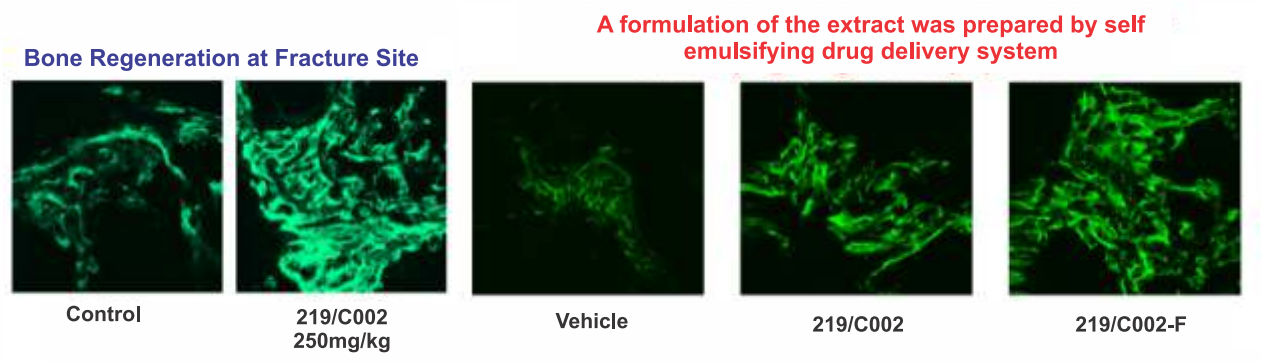
Technology Transfer Document handed over to licensee Lumen Marketing Company, Chennai on 27 September 2019

Breakthrough Achievement in 2019-20

Demonstration and Transfer of Technology Document for Standardized Fraction 219C002 for Treatment of Glucocorticoid–induced Osteoporosis

Glucocorticoid-induced osteoporosis (GIO) is the leading cause of medication-induced osteoporosis. In terms of skeletal safety, there is no "safe dose" of glucocorticoid. Approximately 0.5% of the Indian population receives prolonged glucocorticoid therapy for various diseases and incidence of osteoporosis is 50% in these patients. The global prevalence of fractures in patients receiving long-term glucocorticoid (GC) stands at 30–50%. In addition, GC therapy causes muscle wasting (sarcopenia) leading to further reduction in bone biomechanical strength. The present therapy, bisphosphonates merely inhibit bone loss but does not increase bone formation. Rather, this drug class inhibit bone formation! In addition, high doses glucocorticoids cause osteonecrosis (inadequate blood supply to bone causing death of bone forming cells) and bisphosphonates have also been associated with osteonecrosis.

Phytopreparation prepared by CSIR-CDRI stimulated bone regeneration at the fracture site of rats indicating osteogenic effect. Further studies suggest that standardized fraction of 219/C002 significantly mitigate Methyl Prednisolone-induced bone loss and reverse serum decreased serum osteogenic marker, P1NP, it is the butanolic fraction, and particularly the formulated butanolic fraction completely restored MP-induced loss of BMD and serum osteogenic marker.



Technology demonstration to the team from licensee M/s. Pharmanza Herbals Pvt. Ltd., Gujarat during 10-15 February 2020

Breakthrough Achievement in 2019-20

CSIR-CDRI and CIPLA Collaboration

Joint Venture of a Premier Drug Research Institute and a Leading Multinational Pharmaceutical Company

CSIR-CDRI and Cipla Limited, an Indian multinational pharmaceutical company, signed an agreement on November 15, 2019 for collaboration to jointly develop new drugs for treating various medical conditions and repurposing of drugs for India and global markets.

CSIR - CDRI and Cipla Ltd., Mumbai, also entered into Collaborative Research Agreement for the Development of *Levo Ormeloxifene* for Contraceptive, Osteoporosis, Morning after, Endometriosis in antineoplastic and anti-cancer treatment for further development and commercialization

"Cipla's association with CSIR and CDRI has been ongoing since 1942 and Cipla has benefited over the years from the expertise developed at the labs of CDRI and IICT. Two stalwarts of the CSIR with whom Cipla has been closely associated in the past have been Dr Nitya Anand and Dr AV Rama Rao. Now Cipla and CDRI, under the auspices of CSIR are embarking on a futuristic programme for the development of newer drugs not only for India but globally. Hopefully the results of this collaboration will be forthcoming soon.

- Dr. YK Hamied, Chairman, CIPLA

"This is a great moment for CSIR-CDRI, the premiere drug development and research institute of the country to establish a collaboration for the affordable healthcare programme and repurposing of drugs not only for India but also for the global markets in collaboration and active participation from Cipla. In my view, this is one of the unique efforts of a government institution and of a pharmaceutical industry which de novo generated from this soil and spread all over the world for the affordable healthcare for human beings."

- Prof. Tapas K Kundu, Director, CSIR-CDRI

Advances in Drug Discovery & Developmental Studies

Nature & Name	Indication	Current Developmental Stage
Synthetic Compound		
S007-0867	Antithrombotic	DCGI Permission Received for Phase I Clinical Trial
S007-1500	Fracture healing	IND being filed
S011-1793	Antimalarial	Pre-clinical regulatory toxicity studies ongoing
96-261	Antileishmanial	Pre-clinical regulatory toxicity studies ongoing
GS/IICT5-6	Antiangiogenic	Pre-clinical studies ongoing
S015-2448	Anti depressant KOR Antagonist	*In vivo* efficacy in rodent model
S017-594	Dyslipidaemia (PCSK-9 inhibitor)	Efficacy studies ongoing
S017-0327	Anti-Obesity (5-HT2C PAM)	Efficacy studies ongoing
Phytopharmaceutical		
CDR219C002	Glucocorticoid induced osteoporosis	IND to be filed
CDR267 F018	Anti dyslipidemic / Cardioprotective	IND enabling studies ongoing
NMITLI-118R(T+)	Anti-stroke	Toxicity studies in primates is being planned.
CDRI1703F003	Anti-PCOS	*In vivo* efficacy in rodent model
Mucuna pruriens extract	Male pro-fertility	Efficacy established in rodent model. Open for licensing
Picroliv	NAFLD	*In vivo* efficacy in rodent model
Peptide		
S 016-1348	Anti cancer Smac mimetic	*In vivo* efficacy in rodent model
LP4	Systemic bone growth enhancer	*In vivo* efficacy in rodent model
S 016-1271	Antimicrobial and anti-endotoxin peptide	*In vivo* efficacy in rodent model
AYUSH		
CDRI4655	Dyslipidemia	Nano emulsion formulation approach is being evaluated. In vivo testing in animal models are being done.
CDRI 0135C002	Cognitive impairments	*In vivo* efficacy in rodent model
Formulations		
SMEDD formulation of Arteether and Fansidar	Antimalarial	Efficacy studies in Monkey model is to be done
Dry powder inhalation for pulmonary TB	Antituberculosis	Clinical Testing Plan for Phase-1 trial submitted to Institutional Ethics Committees at KGMU and CSIR-CDRI for approval.
Repurposing of Known drugs		
Anti-leprosy drug	Leukemia	Efficacy established in leukemia stem cells from drug resistant patients.
Pentoxifylline	Bone health	Efficacy established in rodent models
Centchroman	Breast cancer	*In vivo* efficacy studies in rodent models

Industry / Academia Partnership

Number of Agreements executed

National	38
International	17

University/Institution	31
Pharmaceutical Industry	18
Funding Agency	4
Ministry	2

Nature of Agreements Executed

Agreement	Nos
Memorandum of Understanding	13
Sponsored Agreement	1
License Agreement	1
Secrecy Agreement	10
Material Transfer Agreement	14
Memorandum of Agreement	4
Collaborative Agreement	4
Testing Services	8
Total	**55**

Our Collaborators and Industry Partners

Some Important Publications - 2019

Biological Sciences

Author	Title	Journal Vol.(Iss), PP	IF
Jaiswal A, Reddy SS, Maurya M, Maurya P, Barthwal MK.	MicroRNA-99a mimics inhibit M1 macrophage phenotype and adipose tissue inflammation by targeting TNF∝.	**Cellular & Molecular Immunology** 16 (5), 495-507	8.213
Kumar H, Chattopadhyay S, Das N, ……. …….. ……, Trivedi AK, Chattopadhyay N, Ramachandran R and Sanyal S	Leprosy drug clofazimine activates peroxisome proliferator-activated receptor-T and synergizes with imatinib to inhibit chronic myeloid leukemia cells	**Haematologica** haematol.2018.194910	7.570
Tripathi D, Biswas B, Manhas A, Singh A, Goyal D, Gaestel M, Jagavelu K.	Proinflammatory effect of endothelial microparticles Is mitochondria mediated and modulated through MAPKAPK2 (MAPK-Activated Protein Kinase 2) leading to attenuation of cardiac hypertrophy.	**Arteriosclerosis Thrombosis and Vascular Biology** 39(6), 1100-1112	6.618
Ahmad N, Kushwaha P, Karvande A, Tripathi AK, Kothari P, Adhikary S, Khedgikar V, Mishra VK and Trivedi R.	MicroRNA-672-5p identified during weaning reverses osteopenia and sarcopenia in ovariectomized mice.	**Molecular Therapy - Nucleic Acids** 14, 536-549	5.660
Banala VT, Urandur S, Sharma S, Sharma M, Shukla RP, Marwaha D, Gautam S, Dwivedi M and Mishra PR	Targeted co-delivery of the aldose reductase inhibitor epalrestat and chemotherapeutic doxorubicin via a redox-sensitive prodrug approach promotes synergistic tumor suppression.	**Biomaterials Science** 7(7), 2889-2906	5.251
Das S, Garg T, Chopra S and Dasgupta A.	Repurposing disulfiram to target infections caused by non-tuberculous mycobacteria.	**Journal of Antimicrobial Chemotherapy** 74(5), 1317-1322	5.217
Dewangan J, Srivastava S, Mishra S, Divakar A, Kumar S, Rath SK.	Salinomycin inhibits breast cancer progression via targeting HIF-1∝/VEGF mediated tumor angiogenesis *in vitro* and *in vivo*.	**Biochemical Pharmacology** 164, 326-335	4.83
Pawar VK, Singh Y, Sharma K, …. ….. ……. …., Kumar A, Bora HK, Datta D, Lal J, and Chourasia MK	Improved chemotherapy against breast cancer through immunotherapeutic activity of fucoidan decorated electrostatically assembled nanoparticles bearing doxorubicin	**International Journal of Biological Macromolecules** 122, 1100-1114	4.78
Singh K, Hussain I, Mishra V and Akhtar MS	New insight on 8-anilino-1-naphthalene sulfonic acid interaction with TgFNR for hydrophobic exposure analysis	**International Journal of Biological Macromolecules** 122, 636-643	4.78
Sirohi VK, Gupta K, Kapoor R, Dwivedi A.	MicroRNA-145 targets Smad1 in endometrial stromal cells and regulates decidualization in rat.	**Journal of Molecular Medicine** 97(4), 509-522	4.75

Some Important Publications - 2019

Chemical Sciences

Author	Title	Journal Vol.(Iss), PP	IF
Kumar N and Kumar A	Amino Acid-Catalyzed Direct Synthesis of beta-Keto Sulfones via Aerobic Difunctionalization of Terminal Alkynes in an Aqueous Medium	**ACS Sustainable Chemistry & Engineering** 7(10), 9182-9188	6.970
Nagode SB, Kant R and Rastogi N	Hantzsch Ester-Mediated Benzannulation of Diazo Compounds under Visible Light Irradiation	**Organic Letters** 21(16), 6249-6254	6.555
Ansari MY, Kumar N, Kumar A.	Regioselective Intermolecular Sulfur-Oxygen Difunctionalization (Phenoxysulfonylation) of Alkynes: One-Pot Construction of (Z)-Î²-Phenoxy Vinylsulfones.	**Organic Letters** 21(11), 3931-3936	6.555
Kumar A, Ahamad S, Kant R and Mohanan K	Silver-Catalyzed Three-Component Route to Trifluoromethylated 1,2,3-Triazolines Using Aldehydes, Amines, and Trifluorodiazoethane	**Organic Letters** 21(8), 2962-2965	6.555
Sangwan R, Dubey A, Prajapati G, Ampapathi RS and Mandal PK	Synthesis of Structurally Diverse Substituted Aziridinyl Glycoconjugates via Base-Mediated One-Pot Post-Ugi Cyclization	**Organic Letters** 21(8), 2859-2862	6.555
Ali R, Pal HA, Hameed R, Nazir A and Verma S.	Controlled release of hydrogen sulfide significantly reduces ROS stress and increases dopamine levels in transgenic C. elegans.	**Chemical Communications** 55(68), 10142-10145	6.164
Ambule MD, Tripathi S, Ghoshal A and Srivastava AK	IBX-mediated oxidative addition of isocyanides to cyclic secondary amines: total syntheses of alangiobussine and alangiobussinine	**Chemical Communications** 55(73), 10872-10875	6.164
Kumar A, Pasam VR, Thakur RK, Singh M, …. ….. …. …. , Dwivedi AK, Siddiqi MI, Lal J, Tripathi RP and Yadav PN	Novel Tetrahydroquinazolinamines as Selective Histamine 3 Receptor Antagonists for the Treatment of Obesity	**Journal of Medicinal Chemistry** 62(9), 4638-4655	6.054
Upadhyay A, Chandrakar P, Gupta S, Parmar N, Singh SK, Rashid M, Kushwaha P, Wahajuddin M, Sashidhara KV and Kar S	Synthesis, Biological Evaluation, Structure-Activity Relationship, and Mechanism of Action Studies of Quinoline-Metronidazole Derivatives Against Experimental Visceral Leishmaniasis	**Journal of Medicinal Chemistry** 62(11), 5655-5671	6.054
Raziullah, Kumar M, Kant R and Koley D	Cu-Catalyzed Directed C7-H Imidation of Indolines via Cross-Dehydrogenative Coupling	**Advanced Synthesis & Catalysis** 361(13), 3108-3113	5.451
Dutta HS, Ahmad A, Khan AA, Kumar M, Raziullah and Koley D	Metal Free Benzylation and Alkylation of Quinoxalin-2(1H)-ones with Alkenes Triggered by Sulfonyl Radical Generated from Sulfinic Acids	**Advanced Synthesis & Catalysis** 361(24), 5534-5539	5.451

Research Highlights

Cellular & Molecular Immunology

Manoj K Barthwal

Sukka S Reddy

MicroRNA-99a mimics inhibit M1 macrophage phenotype and adipose tissue inflammation by targeting TNF ∝

Anant Jaiswal[1], Sukka Santosh Reddy[2], Mohita Maurya[1], Preeti Maurya[2] and Manoj Kumar Barthwal[1]

Cellular & Molecular Immunology 2019 16 (5), 495-507

In human adipose tissue and obesity, miR-99a expression is negatively correlated with inflammation. Therefore, the present study investigated the role of miR-99a in macrophage phenotype activation and adipose tissue inflammation. M2 BMDMs showed a significant increase in miR-99a expression when compared to the M0 and M1 phenotypes. Phenotype-switching experiments established an association between upregulated miR-99a expression and the M2 phenotype. Overexpression of miR-99a prevented M1 phenotype activation and attenuated bactericidal activity. Likewise, knockdown of miR-99a abolished M2 phenotype activation. By means of in silico target prediction tools and a luciferase reporter assay, TNFα was identified as a direct target of miR-99a. Knockdown of TNFα recapitulated the effect of miR-99a overexpression in M1 BMDMs. In a db/db mice model, miR-99a expression was reduced in eWAT and F4/80+ ATMs. Systemic overexpression of miR-99a in db/db mice attenuated adipocyte hypertrophy with increased CD301 and reduced CD86 immunostaining. Flow cytometry analysis also showed an increased M2 and a reduced M1 macrophage population. Mimics of miR-99a also improved the diabetic dyslipidemia and insulin signaling in eWAT and liver, with an attenuated expression of gluconeogenesis and cholesterol metabolism genes in the liver. Furthermore, adoptive transfer of miR-99a-overexpressing macrophages in the db/db mice recapitulated *in vivo* miR-99a mimic effects with increased M2 and reduced M1 macrophage populations and improved systemic glucose, insulin sensitivity, and insulin signaling in the eWAT and liver.

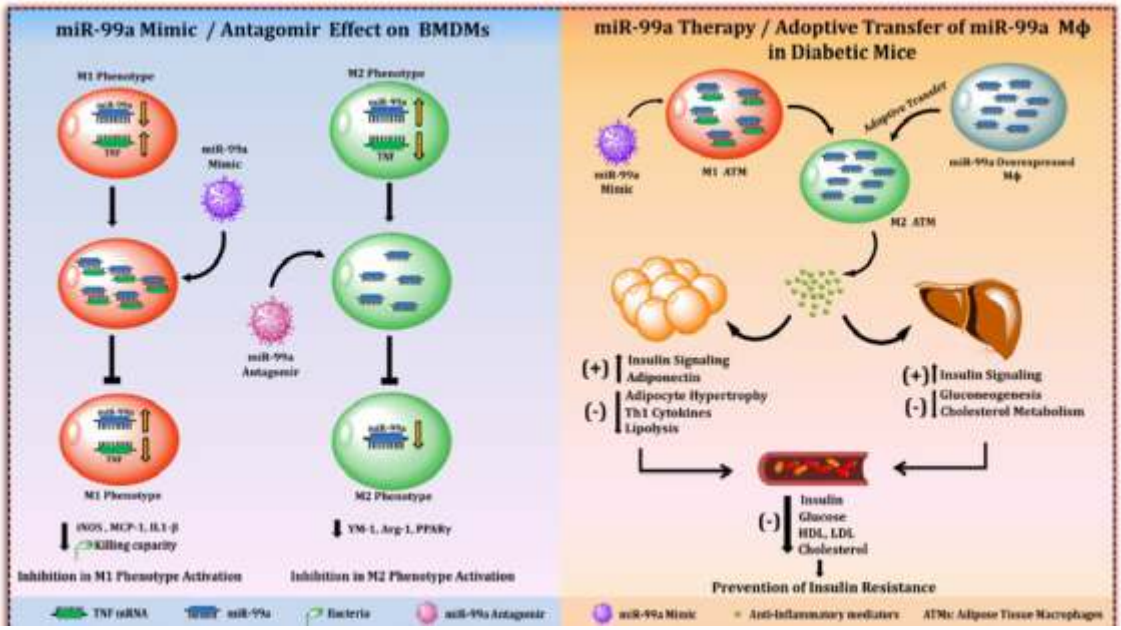


Figure: Graphical illustration demonstrating the effect of miR-99a on macrophage phenotype activation & adipose tissue inflammation

Research Highlights

haematologica
Journal of the European Hematology Association
Published by the Ferrata Storti Foundation

Sabyasachi Sanyal

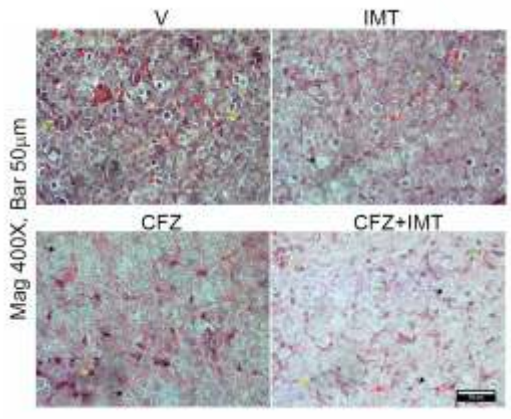
Harish Kumar

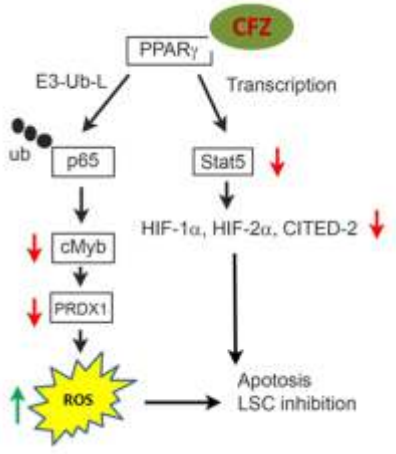
Leprosy drug clofazimine activates peroxisome proliferator-activated receptor-γ and synergizes with imatinib to inhibit chronic myeloid leukemia cells

Kumar H, Chattopadhyay S, Das N, Shree S, Patel D, Mohapatra J, Gurjar A, Kushwaha S, Singh AK, Dubey S, Lata K, Kushwaha R, Mohammed R, Ghosh Dastidar K, Yadav N, Vishwakarma AL, Gayen JR, Bandyopadhyay S, Chatterjee A, Jain MR, Tripathi AK, Trivedi AK, Chattopadhyay N, Ramachandran R, Sanyal S

Haematologica, haematol.2018.194910

Leukemia stem cells contribute to drug-resistance and relapse in chronic myeloid leukemia and BCR-ABL1 inhibitor monotherapy fails to eliminate them, thereby necessitating alternate therapeutic strategies. Peroxisome proliferator-activated receptor- (PPAR) agonist pioglitazone downregulates signal transducer and activator of transcription 5 (STAT5) and in combination with imatinib induces complete molecular response in imatinib-refractory patients by eroding leukemia stem cells. Thiazolidinediones like pioglitazone however, are associated with severe side effects. To identify alternate therapeutic strategies for chronic myeloid leukemia were screened FDA-approved drugs in K562 cells and identified the leprosy drug clofazimine as an inhibitor of viability. Here we show that clofazimine induces apoptosis in chronic myeloid leukemia patient-derived blood mononuclear cells, with particularly robust effect in imatinib-resistant cells. Clofazimine also induced apoptosis in $CD34^{+}38^{-}$progenitors and quiescent $CD34^{+}$ cells from chronic myeloid leukemia patients but not healthy donor-derived hematopoietic progenitors. Mechanistic evaluation revealed that clofazimine via physical interaction with PPAR induced nuclear factor kB-p65 proteasomal degradation, which led to sequential MYB and peroxiredoxin 1 downregulation and concomitant induction of reactive oxygen species-mediated apoptosis. Clofazimine also suppressed STAT5 expression and consequently downregulated stem cell maintenance factors hypoxia-inducible factor -1α and -2α and Cbp/P300 Interacting Transactivator with Glu/Asp rich Carboxy-Terminal Domain 2. Combining imatinib with clofazimine caused a far superior synergy than pioglitazone where clofazimine reduced imatinib's IC_{50} by >4 logs and remarkably eroded quiescent $CD34^{+}$ cells. In a K562 xenograft study clofazimine and imatinib co-treatment showed more robust efficacy than individual treatments. We propose clinical evaluation of clofazimine in imatinib-refractory chronic myeloid leukemia.





Research Highlights

Kumaravelu J

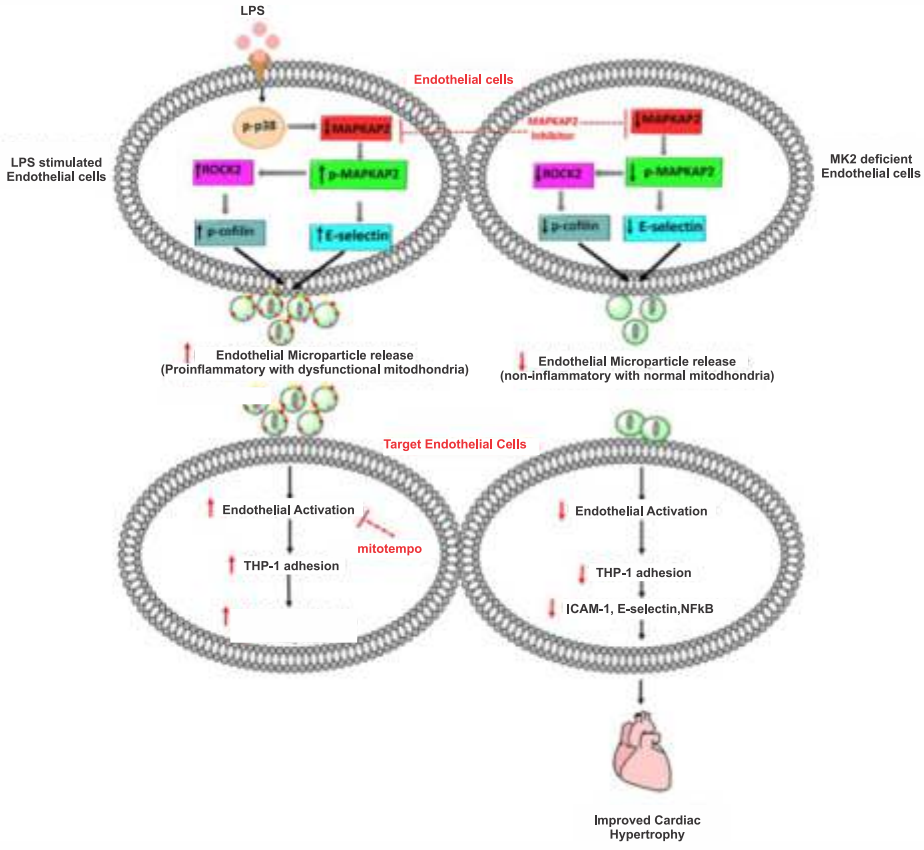
Dipti Tripathi

Pro-inflammatory effect of EMP is dysfunctional mitochondria mediated and modulated through MAPKAPK2 leading to attenuation of cardiac hypertrophy

Tripathi D, Biswas B, Manhas A, Singh A, Goyal D, Gaestel M, Jagavelu K.

Arteriosclerosis, Thrombosis, and Vascular Biology, 2019, 39(6), 1100-1112

This Study showed the functional significance of mitochondria present in EMP and how MK2 (MAPKAPK2) governs EMP production and its physiological effect on cardiac hypertrophy. Flow cytometric analysis, confocal imaging, OCR measurement through Seahorse were used to confirm the presence of functionally active mitochondria in non-treated EMP (c-EMP), LPS and oligomycin treatment increased mitochondrial ROS activity in EMP (l- and o-EMP, respectively). The dysfunctional mitochondria contained in l- and o-EMP induced the expression of pro-inflammatory mediators in the target endothelial cells leading to the augmented adhesion of THP-1 monocyte cells on EA.hy926 cells. Multiphoton real-time imaging detected the increased adherence of o-EMP at the site of carotid artery injury as compared to c-EMP. MK2-deficient EMP reduced the E-selection and ICAM-1 expression on target endothelial cells leading to reduced monocyte attachment and reduced cardiac hypertrophy in mice. In conclusion MK2 promotes the pro-inflammatory effect of EMP mediated through dysfunctional mitochondria. MK2 modulates the inflammatory effect induced during cardiac hypertrophy through EMP.



Cartoon depicting how dysfunctional mitochondria loaded EMP regulates pro-inflammatory mediators via MAPKAPK2

Research Highlights

ACS Sustainable Chemistry & Engineering

Atul Kumar

Navaneet Kumar

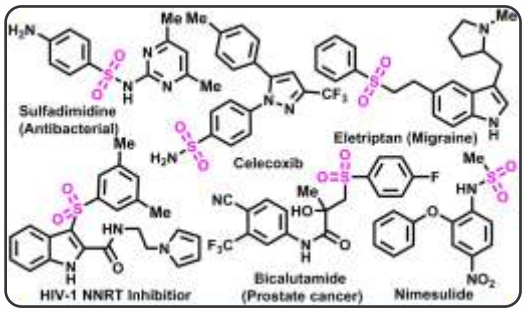
Amino acid-Catalyzed Direct Synthesis of β-Keto Sulfones via Aerobic Difunctionalization of Terminal Alkynes in an aqueous medium

Navaneet Kumar, and Atul Kumar*

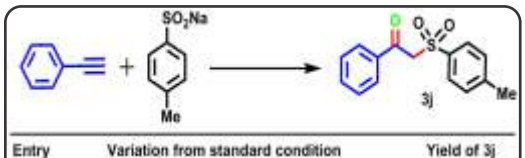
ACS Sustainable Chemistry & Engineering 2019, 7, 9182-9188

An efficient amino acid-catalyzed protocol for the synthesis of β-keto sulfones using terminal alkynes and arylsulfinic acid sodium salts under aerobic conditions in water/AcOH has been developed. This reaction involves an in situ generated vinyl radical intermediate and an atom transfer radical addition (ATRA) process via oxygen capture to form the desired products in good to excellent yields. We have developed a novel and operationally simple organo-catalyzed protocol for the synthesis of β-keto sulfones using alkynes via a dioxygen-triggered radical process.

FDA Approved Sulfonyl scaffolds containing drugs.

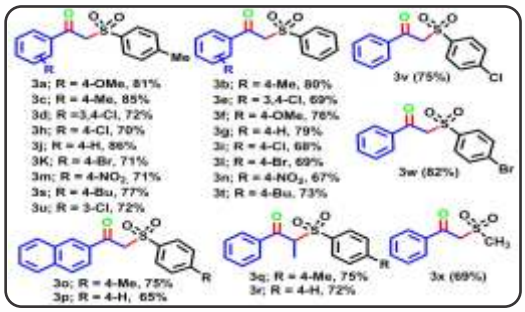


Control Experiments

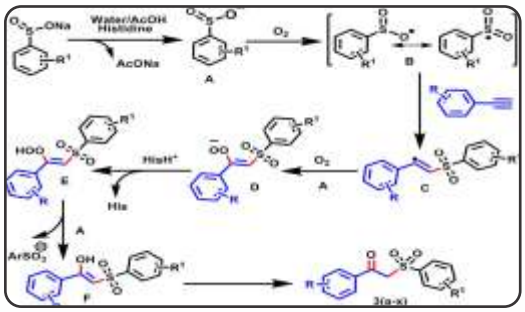


Entry	Variation from standard condition	Yield of 3j
1	Without amino acid-catalysis	15%
2	Role of air as the oxygen source	86%
3	Under N_2 atmophere	trace
4	Under radical pathway	0%
5	^{18}O-Labeling experiment	86%

Substrate Scope and versatility of the reaction



Plausible Reaction Mechanism



Research Highlights

Atul Kumar

Regioselective Intermolecular Sulfur-Oxygen Difunctionalization (Phenoxysulfonylation) of Alkynes : One-Pot Construction of (Z)-β Plenoxy Vinylsulfones

Mohd Yeshab Ansari, Navaneet Kumar and Atul Kumar

Org. Lett. 2019, 21, 3931-3936

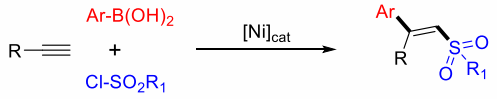
Mohd Yeshab Ansari

The first regioselective phenoxysulfonylation of alkynes with sodium sulfinate and phenol catalyzed by I_2/base has been uncovered. This metal-free, one pot alkyne difunctionalization process provides various (*Z*)-*β*-phenoxy vinylsulfones under mild reaction conditions. A variety of terminal as well as internal alkynes, sodium sulfinates and wide range of phenols/ thiophenols and naphthols are viable in this transformation. Green protocol and wide substrate scope are the remarkable characteristics of this multicomponent procedure.

Previous Work

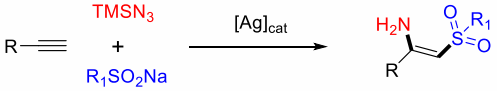
(a) Intermolecular Carbosulfonylation of Alkynes

Nevado *et.al*, Angew. Chem. 2017 [12a]

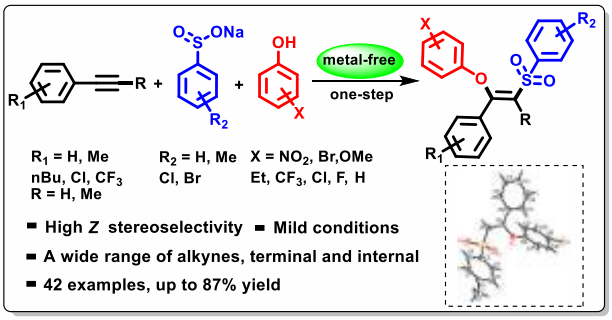


(b) Stereoselective Aminosulfonylation of Alkynes

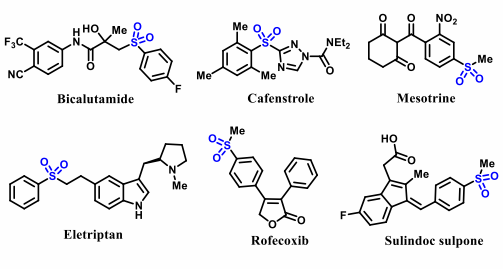
Bi *et.at*, Angew. Chem. 2017 [13a]



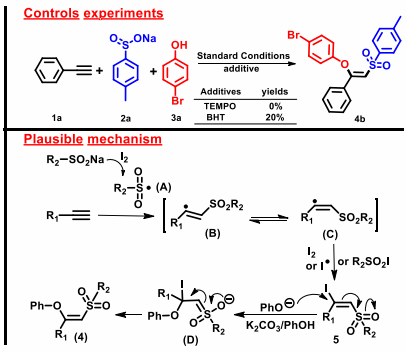
This Work: Phenoxysulfonylation via sulfonyl radical addition



As an extremely important functionality, the sulfone functional group is widely found in natural products and biologically active compounds. Additionally, sulfone serves as a valuable synthetic intermediate in a range of useful chemical transformation. Thus, the fabrication of sulfone groups into organic frame-works strongly fosters the synthetic quest of chemist. Difunctionalizations of alkynes represent much more convenient strategies that involve the incorporation of an SO_2-containing group. Thus, efficient protocols for sulfonylations of alkynes with simultaneous formation of C-H, C-O, C-Se, C-halide, C-C, and C-N, bonds have been reported. We herein disclose the hitherto unexplored metal-free intermolecular difunctionalization of alkynes through an unprecedented sulfonylation/ phenoxide ion addition cascade. This approach represents an attractive means to achieve alkyne phenoxy functionalization under mild reaction conditions; extension to other nucleophilic species and radical is under progress, and will be disclosed in due course



Some bioactive molecules containing sulfone group



Research Highlights

OL | Organic Letters

P. K. Mandal

Synthesis of Structurally Diverse Substituted Aziridinyl Glycoconjugates via Base Mediated One-pot Post Ugi Cyclization

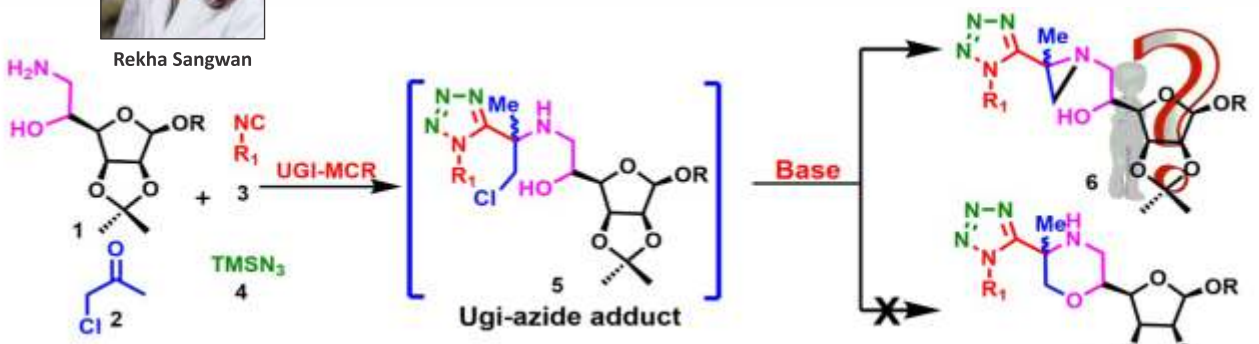
Rekha Sangwan, Atul Dubey, Gurudayal Prajapati, RaviSankar Ampapathi,* and Pintu Kumar Mandal*

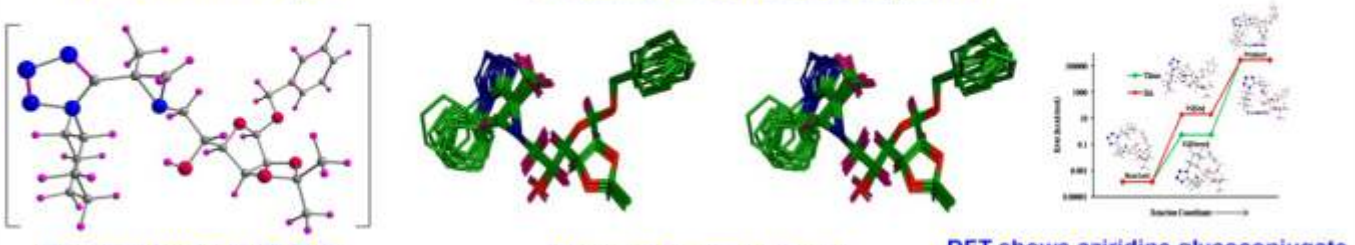
Org. Lett. 2019, 21, 2859-2862.

R. S Ampapathi

Rekha Sangwan

The base promoted intramolecular cyclization of Ugi-tetrazol adduct has been demonstrated for synthesis of highly substituted aziridinyl glycoconjugates in one-pot. The reactions are scalable, efficient and operationally simple with range of broader substrate scope. To gain insight into the mechanism of aziridine formation, DFT and control experiments show that the cyclization of aziridine glycoconjugate pathway was preferred, as it proceeds with low activation energy barrier (0.57 kcal mol-1), which supports our experimental observation.





We have shown a general one-pot post Ugi-cyclization reaction as an innovative synthetic method for the synthesis of carbohydrate derived highly strained substituted azaricline.

Research Highlights

OL | Organic Letters

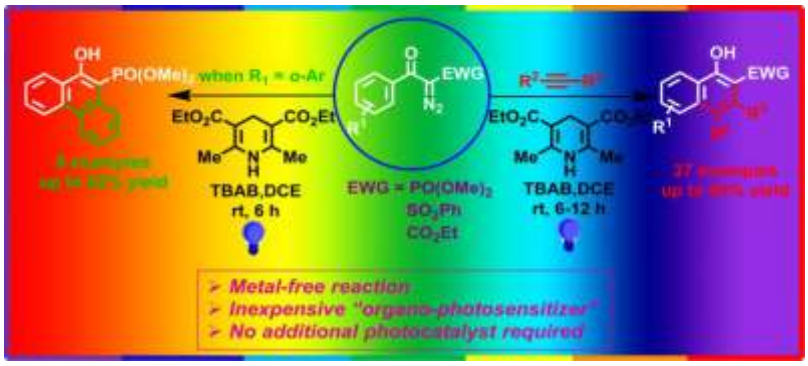
Namrata Rastogi

Savita B. Nagode

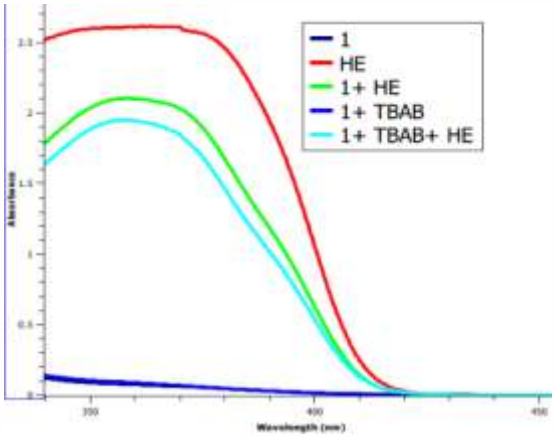
Hantzsch Ester-Mediated Benzannulation of Diazo Compounds under Visible Light Irradiation

*Savita B. Nagode, Ruchir Kant, and Namrata Rastogi**

Org. Lett. 2019, *21*, 6249-6254

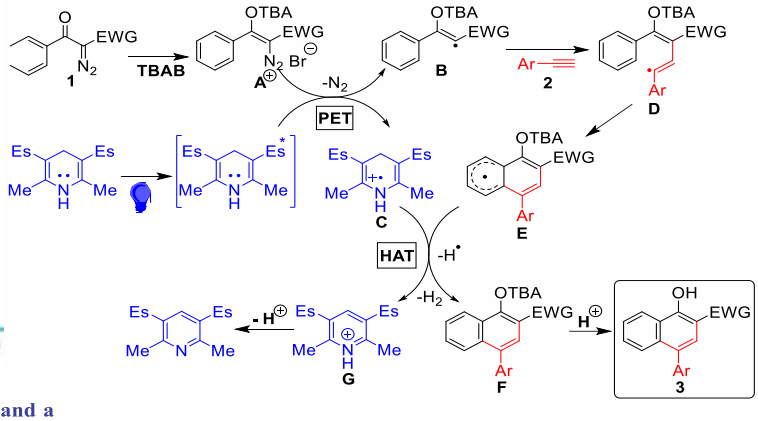


Our group developed metal-free benzannulation of *α*-diazo compounds with alkynes, or intramolecularly enabling direct access to the functionalized naphthalene-1-ols & phenanthren-10-ols, respectively under visible light irradiation. The reaction employs Hantzsch ester (HE) as photoreductant and sequential Photoinduced Electron Transfer (PET) and Hydrogen Atom Transfer (HAT) from excited HE are the key mechanistic steps of the reaction. Detailed control experiments were performed to establish the "electron-transfer" mechanism over "energy-transfer" or "electron donor-acceptor (EDA) complex formation" mechanism.



UV-visible absorption spectra of HE, diazophosphonate 1a and a mixture of 1a with HE & TBAB (0.001 M in DCE)

Plausible mechanism



Research Highlights

Kishor Mohanan

Anuj Kumar

Silver-Catalyzed Three-Component Route to Trifluoromethylated 1,2,3-Triazolines Using Aldehydes, Amines, and Trifluorodiazoethane

Anuj Kumar, Shakir Ahamad, Ruchir Kant and Kishor Mohanan*

Org. Lett. **2019**, 21, 2962–2965

A novel silver-catalyzed domino three-component synthetic route to trifluoromethyl-substituted 1,2,3-triazolines has been realized by employing 2,2,2-trifluorodiazoethane as a 1,3-dipole for the cycloaddition reaction with the Schiff base formed from aldehydes and amines. This step and atom-economic protocol requires only a very low catalyst loading (3 mol %), displays a broad substrate scope with good functional group tolerance, and provides good to excellent yields with high diastereoselectivities.

Research Highlights

ChemComm

Aamir Nazir

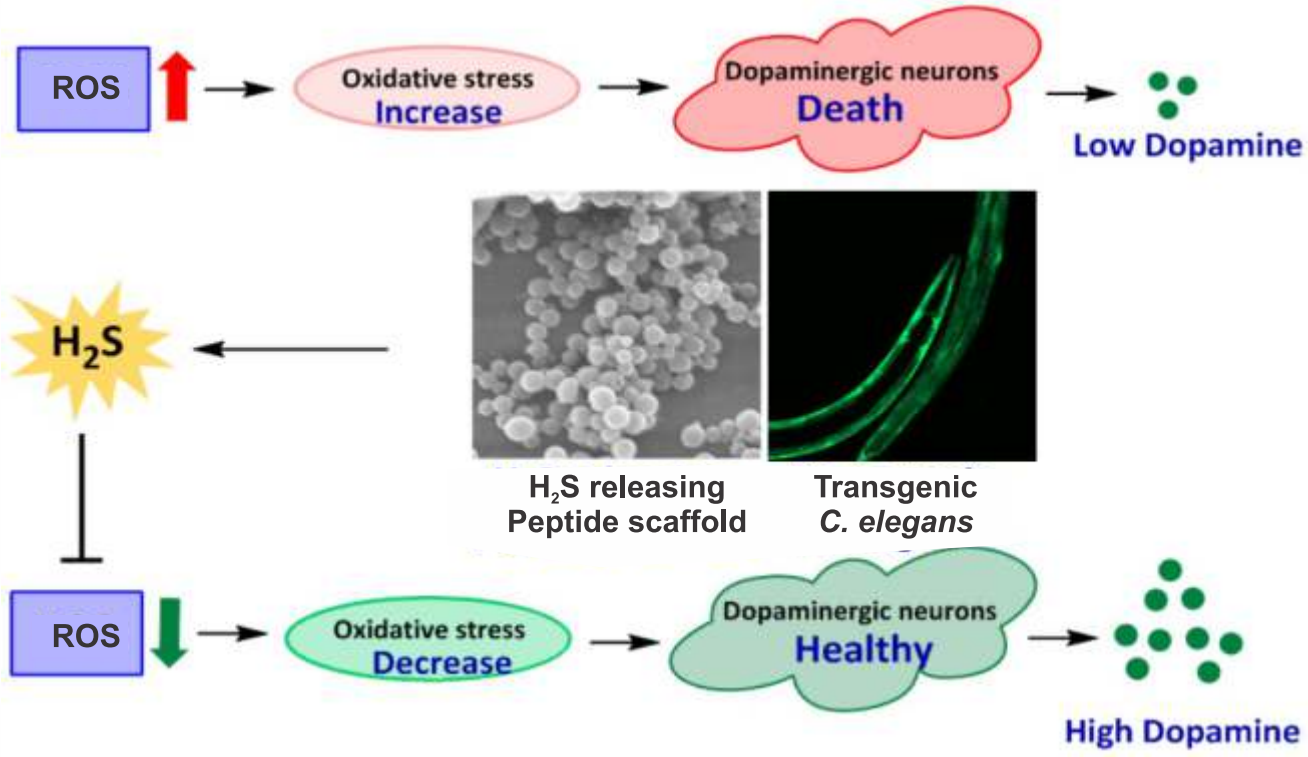
Rohil Hameed

Novel peptide conjugates that lead to 'slow and sustained' release of hydrogen sulfide, designed towards reducing ROS stress and increasing dopamine levels

Ali R, Pal HA, Hameed R, Nazir A and Verma S.

Chemical Communications 2019, 55(68), 10142-10145

- Hydrogen sulfide, an endogenous signalling molecule, is central to several pathophysiological processes.
- The rapid volatilization of H_2S from spontaneously releasing sulfide salts has been a challenge.
- In collaboration with Prof. Sandeep Verma at IIT Kanpur, novel peptide conjugates which exhibit tris(2-carboxyethyl)phosphine mediated "slow and sustained" H_2S release have been designed and tested in *C. elegans*.
- The conjugates reduced hydrogen peroxide-induced oxidative stress and significantly increased dopamine levels.



Research Highlights

ChemComm

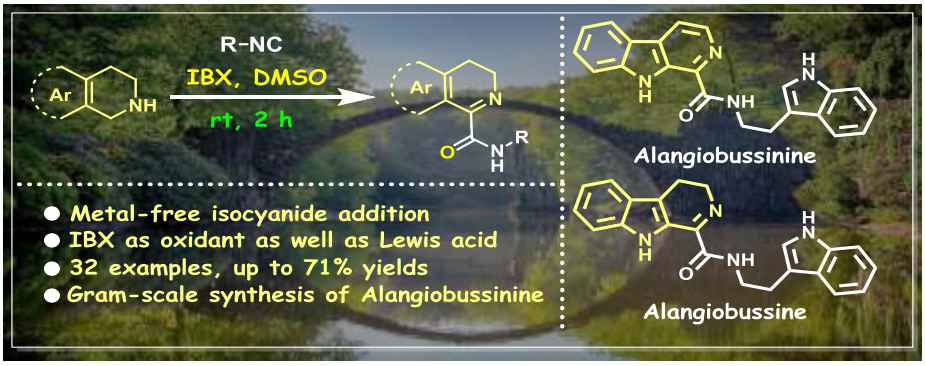
A. K. Srivastava

M. D. Ambule

IBX-mediated oxidative addition of isocyanides to cyclic secondary amines: Total syntheses of alangiobussine and alangiobussinine

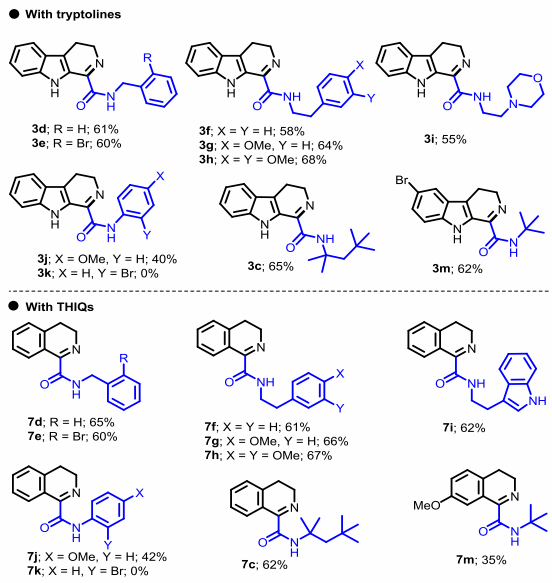
M. D. Ambule, S. Tripathi, A. Ghoshal, and A. K. Srivastava*

Chem. Commun. 2019, 55, 10872-10875

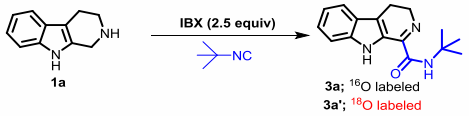


Herein, we have reported a metal-free oxidative isocyanide addition on the C(*1*)- carbon of tryptoline and THIQ to offer 4,9- dihydro-3*H*-pyrido[3,4-*b*]indole-1- carboxamides and 3,4-dihydro-isoquinoline- 1-carboxamides respectively, in the presence of IBX without N(2) functionalization. The method is efficient, robust and IBX plays a dual role of oxidant as well as Lewis acid to activate the imine facilitating the isocyanide addition. Detailed mechanistic investigations were performed by isotopic labeling and real-time NMR experiments. The method was utilized for the gram-scale syntheses of naturally occurring alkaloids alangiobussine and alangiobussinine in 63% and 45% overall yields respectively.

Selected examples

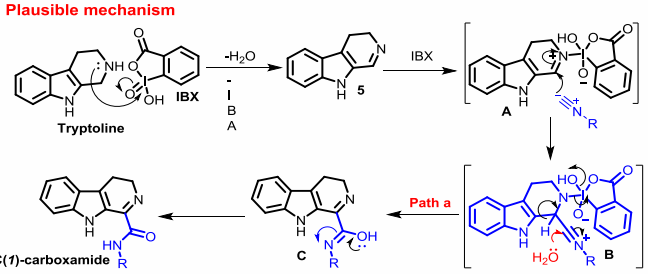


Isotopic labelling experiments



Entry	variation from standard condition	yield of 3a/3a'
1	Anhydrous DMSO, $H_2{}^{18}O$ under Ar	62% [**3a** (20%) + **3a'**(80%)]
2	Anhydrous DMSO, 4 Å MS under Ar	50% (**3a**)
3	AcOH (1.0 equiv.)	60% (**3a**)
4	PhCOOH (1.0 equiv.)	59% (**3a**)

Plausible mechanism



Research Highlights

Journal of Medicinal Chemistry

Susanta Kar

KV Sashidhara

Pragya Chandrakar

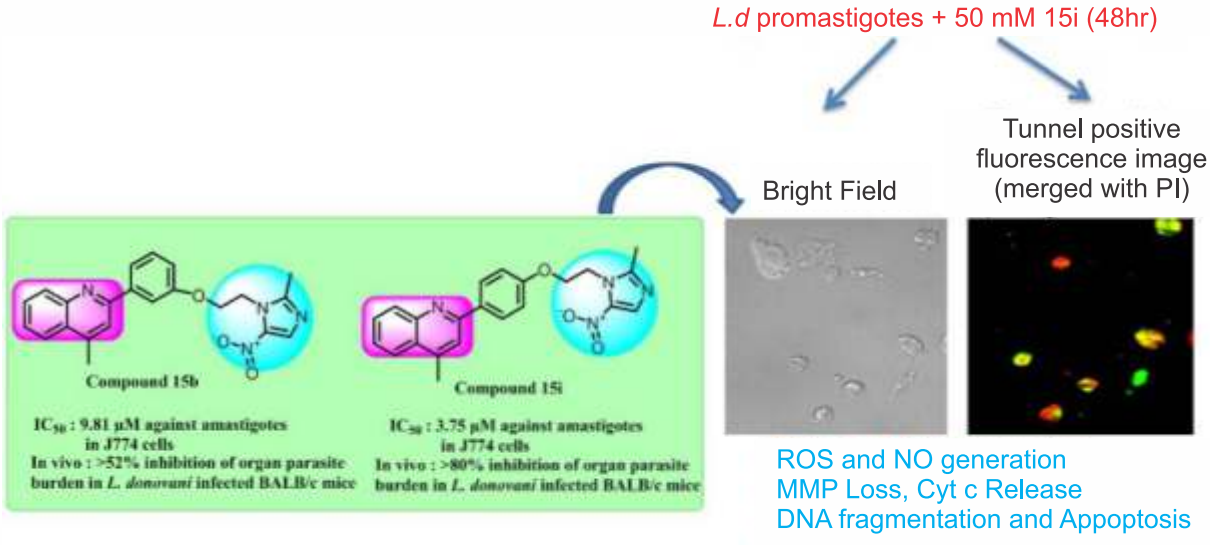
Akanksha Upadhyay

Synthesis, Biological Evaluation, Structure-Activity Relationship and Mechanism of Action Studies of Quinoline-metronidazole Derivatives against Experimental Visceral Leishmaniasis

Akanksha Upadhyay, Pragya Chandrakar, Sampa Gupta, Naveen Parmar, Sandeep Kumar Singh, Mamunur Rashid, Pragati Kushwaha, Muhammad Wahajuddin, Koneni V. Sashidhara, Susanta Kar

J. Med. Chem. 2019, 62, 11, 5655-5671

To identify novel chemical scaffolds for the development of antileishmanial agents, a series of quinoline-metronidazole was synthesized and tested against murine model of visceral leishmaniasis. Among all synthesized derivatives, **15b** and **15i** showed promising antileishmanial efficacy against both extracellular promastigote (IC_{50} 9.54 μM and 5.42 μM respectively) and intracellular amastigote (IC_{50} 9.81 μM and 3.75 μM respectively) form of *L. donovani* with negligible cytotoxicity towards host (J774 macrophages, Vero cells). However compound **15i** showed better *in vivo* efficacy and effectively eliminated spleen and liver parasite burden (>80 %) in BALB/c mice model of VL. Mechanistic studies revealed that **15i** triggers oxidative stress, induces bioenergetic collapse and apoptosis of the parasite by depleting ATP production and loss in mitochondrial membrane potential. Structure−activity analyses and pharmacokinetic studies revealed **15i** as a promising antileishmanial lead and suggests quinoline-metronidazole series as a suitable platform for future development of antileishmanial agents.



Research Highlights

The Journal of Immunology

Susanta Kar

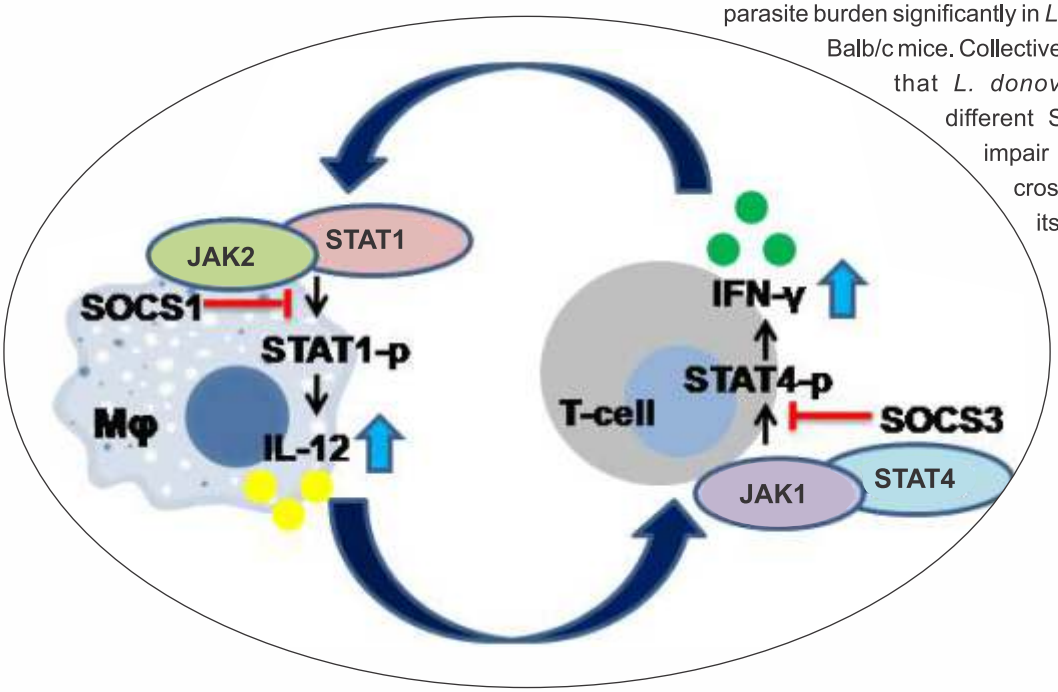
Pragya Chandrakar

Differential induction of SOCS isoforms by *Leishmania donovani* impairs macrophage- T cell crosstalk and host defense

Pragya Chandrakar, Naveen Parmar, Albert Descoteaux, Susanta Kar

J Immunol, 2019, 204 (3), 596-610

Immune evasion strategies adopted by *Leishmania donovani* involve the exploitation of SOCS proteins that are well-known negative regulators of the JAK/STAT pathway. However, the cellular mechanism underpinning the induction of SOCS isoforms and their role in breaching the multilevel regulatory circuit connecting the innate and adaptive arms of immunity are still ambiguous during experimental visceral leishmaniasis. Using bone marrow macrophages (BMMϕs) and CD 4^+ T cells, we observed that *L. donovani* preferentially upregulates SOCS1 and SOCS3 expression in macrophages and T cells respectively, while SOCS1 level remains consistently high in BMMϕs, SOCS3 expression is pronounced and long-lasting in T cells. Consequently, this inhibits STAT1 mediated IL-12 induction in macrophages & STAT4 mediated IFN-γ synthesis in T cells. Mechanistically, PI3K/Akt-mediated SRF activation promotes nuclear translocation and binding of Egr2 to SOCS1 promoter for its early induction in infected BMMϕs. Additionally, *L. donovani* activates IDO/kynurenine/AHR signaling in BMMϕs in order to maintain prolonged SOCS1 expression. Later, prostaglandin E2, secreted from infected BMMϕs induces cAMP-PKA pathway by binding to the EP2/EP4 receptor of CD 4^+ T cells, leading to SP1, CREB and GATA1 activation and SOCS3 expression. SiRNA-mediated silencing of SOCS1 and SOCS3 in macrophage and T cells respectively restored IL-12 and IFN-γ cytokine levels and BMMϕs-T cell interaction. Vivo morpholino-mediated silencing of SOCS1 and SOCS3 resulted in protective cytokine responses, thereby reducing organ parasite burden significantly in *L. donovani*-infected Balb/c mice. Collectively, our results imply that *L. donovani* orchestrates different SOCS isoforms to impair macrophage-T cell crosstalk and preserve its own niche.



STEM IMPACT Award

CSIR-CDRI team received the STEM IMPACT Award for Reunion (*Dalbergia sissoo*) technology transfer from Marc Sedam, ATUM Chair, Elect. at Hyderabad

Technology for Reunion®, a novel oral intervention made from *Dalbergia sissoo* for rapid fracture healing.

This technology was developed by Dr. Rakesh Maurya, Dr. Ritu Trivedi, Dr. Divya Singh, Dr. Preety Dixit, Dr. Vikram Khedgikar, Dr. Jyoti Gautam, Dr. Avinash Kumar, Dr. Sheelendra P. Singh, Dr. Mohd. Wahajuddin, Dr. Girish K. Jain and Dr. Naibedya Chattopadhyay

Announcement

CDRI Awards 2020 for Excellence in Drug Research

The prestigious CDRI Awards 2020 for Excellence in Drug Research in **Chemical Sciences** category has been awarded to **Dr. Surajit Ghosh**, Professor, IIT, Jodhpur.

In **Life Sciences** category, awarded to **Dr. Bushra Ateeq**, Assistant Professor, Department of Biological Sciences & Bioengineering, IIT, Kanpur & **Dr. Ravi Manjithaya**, Faculty Fellow, JNCASR, Bengaluru

Our heartiest congratulations to the awardees!

The felicitation ceremony will be held on 26th September 2020 during CSIR Foundation Day Celebrations

Activities under the aegis of Scientific Social Responsibility (SSR)

JIGYASA – Quest for Curiosity

JIGYASA is a student-scientist connect programme, initiated by Council of Scientific and Industrial Research (CSIR) and Kendriya Vidyalaya Sangathan (KVS) in year 2017. Currently, Navoday Vidyalaya and other Government Schools are also part of this ambitious program of Government of India. The major objective of the programme is to expose students with practical activities to get a flavor of research in CSIR-CDRI by extending classroom learning to research and laboratory-based learning at early age.

During 2013, a total of 104 faculties and 1121 students of 30 Kendriya Vidyalaya visited CSIR-CDRI under the aegis of JIGYASA Program.

Students Motivation Programs for various Schools & Colleges

As a part of CSIR's Scientific Social Responsibility, with an aim to promote experimentation and innovativeness in education and bringing confidence to society about relevance of Institute in terms of Social Impact, various motivation programs were organized during the year. Under this program, during the year, about 2500 students and more than 200 faculties from about 69 Schools and colleges across India visited CSIR-CDRI. During the visit, students and faculties are appraised with the Institutes accomplishments in the service of nation, ongoing R&D programs and visits to important facilities and R&D laboratories.

Health Awareness and Outreach Programs

As a part of CSIR's Scientific Social Responsibility, CSIR-CDRI conducts health awareness programme in nearby villages of Lucknow covering different health and diseases of relevance to the locality. During the year, Institute scientists organized following Health Awareness and Outreach Programs:

1. Health awareness and free health check-up camp in Fakharpur, Distt. Bahraich on 30 July 2019 in association with CARE India to sensitize the villagers for health, education and cleanliness during Health Awareness Program and free health check-up.
2. Health awareness program for marginal rural girls from Kasturba Gandhi Balika Vidyalaya Jarbal, district Bahraich

An online Mental Health Awareness survey to evaluate the stressed condition/ mental health of participant and to raise awareness among them has been initiated on the occasion of CSIR Foundation Day.

Research Council

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Dr. Rajiv Modi
Chairman & Managing Director,
Cadila Laboratories, Ahmadabad

Members

Prof. N K Ganguly
Ex-DG ICMR
Visiting Professor of Eminence
Translational Health Science and
Technology (THSTI), Faridabad

Dr. Rajesh Jain
Jt. Managing Director
Panacea Biotech Ltd.
New Delhi

Dr. G N Qazi
Director General
HIMSR
Hamdard Nagar
New Delhi

Dr. Altaf Lal
Senior Advisor Global
Health and Innovation
Sun Pharma
USA

Prof. Gautam R Desiraju
Solid State and Structural
Chemistry Unit
IISc, Bengaluru

Prof. Ashwani Nangia
Director
CSIR-NCL
Pune

Dr. G N Singh
Secretary-cum-scientific director
Indian Pharmacopoeia Commission
Ghaziabad

Dr. Manoj Raje
Director
CSIR-IMTech
Chandigarh

Dr. Vijay Chauthaiwale
Healthcare-Biotech Consultant,
45, South Avenue,
New Delhi

Prof. Tapas Kumar Kundu
Director,
CSIR-CDRI
Lucknow

Dr. Renu Swarup
Secretary,
DBT, New Delhi

Secretary
Dr. Aamir Nazir
Principal Scientist
CSIR-CDRI

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Lucknow – 226 031

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Dr. Anil N Gaikwad
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Pharmacology
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Mr. Naseem Siddiqui
Principal Scientist &
Head, Business Development
CSIR-CDRI
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Dr. Namrata Rastogi
Senior Scientist
Medicinal Process Chemistry Division
CSIR-CDRI
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Dr. Kavita Singh
Senior Technical Officer
SAIF
CSIR-CDRI
Lucknow – 226 031

Mr. I.B. Dixit
Finance & Accounts Officer
CSIR-CDRI
Lucknow– 226 031

Member Secretary
Mr. Pradip Kumar
Administrative Officer
CSIR-CDRI
Lucknow – 226 031

Budget

Rs. in lakh

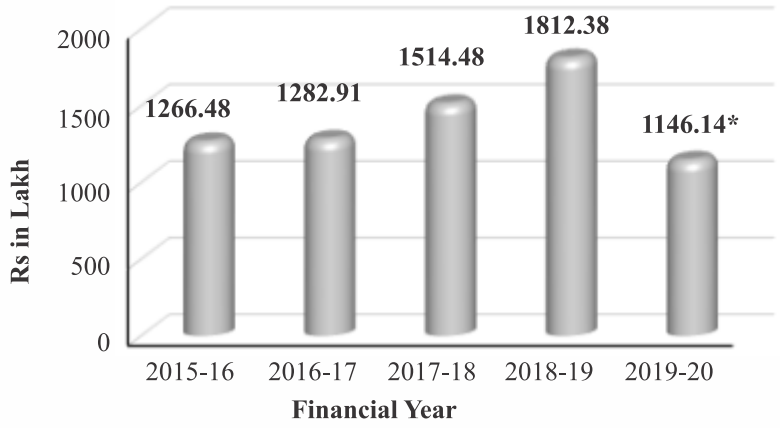
Heads		2015-16	2016-17	2017-18	2018-19	2019-20 (Allocation)
(A)	**Recurring**					
1	Pay and Allowances	4916.152	4920.500	5462.718	5619.670	6179.398
2	Contingencies	1386.000	1018.000	1529.995	1162.348	1328.010
3	HRD	-	0.800	-	-	-
4	Maintenance	732.000	718.000	925.800	1139.564	1018.230
5	Chemical and Consumables	1189.152	1323.000	1329.000	854.501	854.490
	Sub-Total	**8223.304**	**7980.300**	**9247.513**	**8776.083**	**9380.128**
(B)	**Capital**					
1	Works and Services / Electrical Installation	56.547	200.000	80.060	112.246	100.00
2	Apparatus and Equipments/ Computer Equipments	1183.946	1203.000	1084.000	271.000	270.990
3	Office Equipments, Furniture and Fittings	3.825	-	-	-	18.000
4	Library Books and Journals	250.488	75.000	330.186	338.107	162.140
	Sub-Total	**1494.806**	**1478.000**	**1494.246**	**721.353**	**551.130**
	Total (A+B)	**9718.11**	**9458.300**	**10741.759**	**9497.436**	**9931.258**
(C)	**Special Projects HCP/ BSC / CSC / ISC / PSC / NCP / FTT / FBR, etc.**	**3662.966**	**2060.318**	**218.895**	**625.294**	**1257.410**
(D)	**CMM0015 (New CDRI)**	**1097.000**	**-**	**-**	**-**	**-**
(E)	**CSIR-800 (Societal Activities)**	**-**	**100.00**	**-**	**-**	**-**
	Grant Total (A+B+C+D)	**14478.076**	**11618.618**	**10960.654**	**10122.730**	**11188.668**

*Data as on 31-01-2020

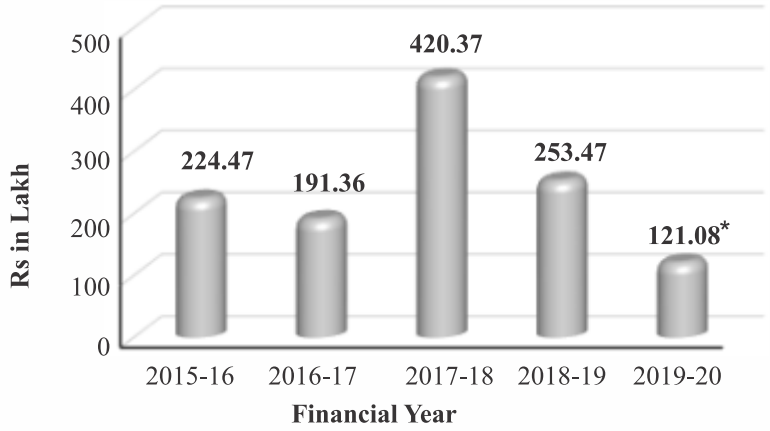
External Budgetary Resources

Rs. in lakh

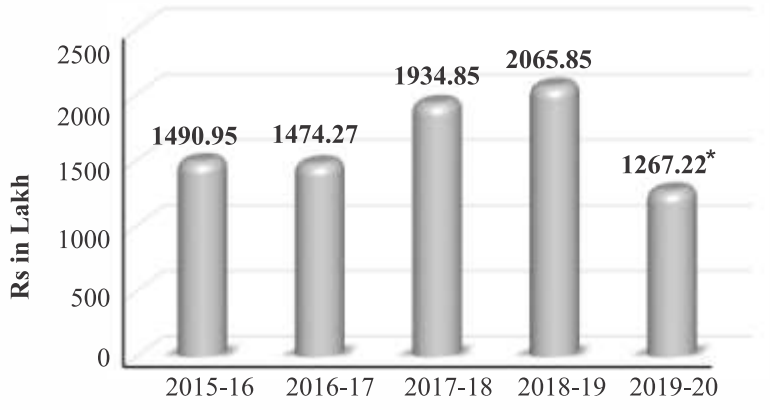
External Cash Flow from Government Agencies & Industries



Lab Reserve Fund Generated



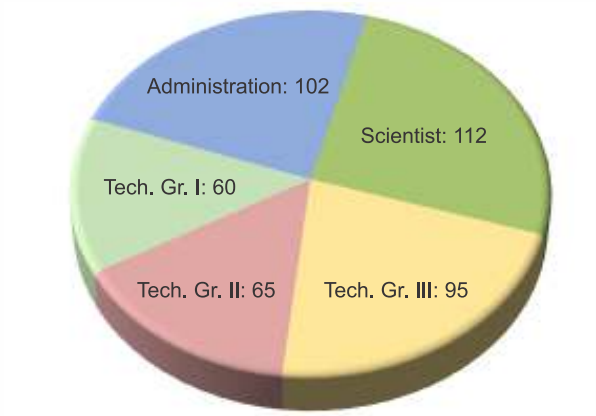
Total External Budgetary Resources (ECF + LRF)



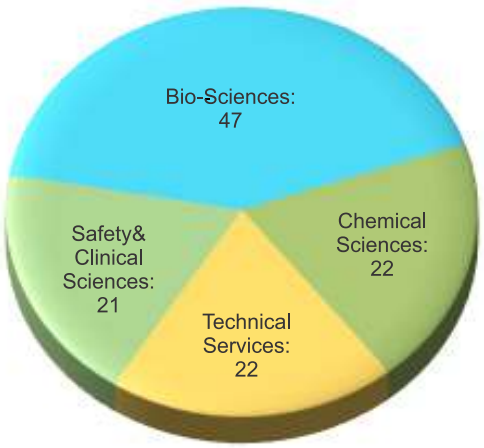
***Data as on 31-01-2020**

Manpower

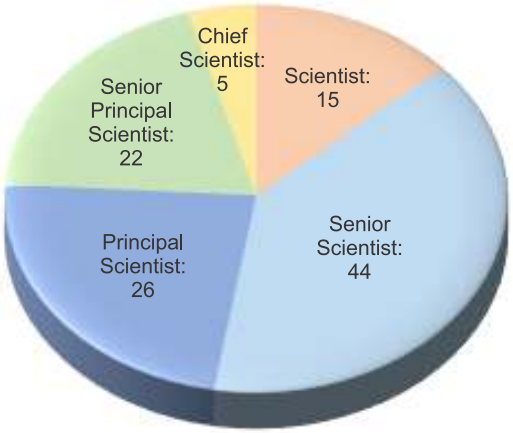
Total Staff (434)



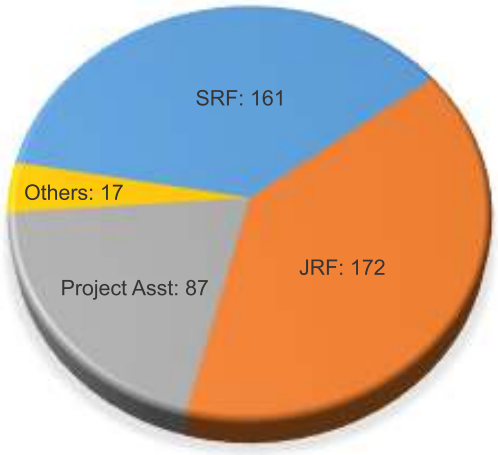
Area-wise Strength of Scientists



Designation-wise Strength of Scientist



Research Fellows and Project Staff (437)

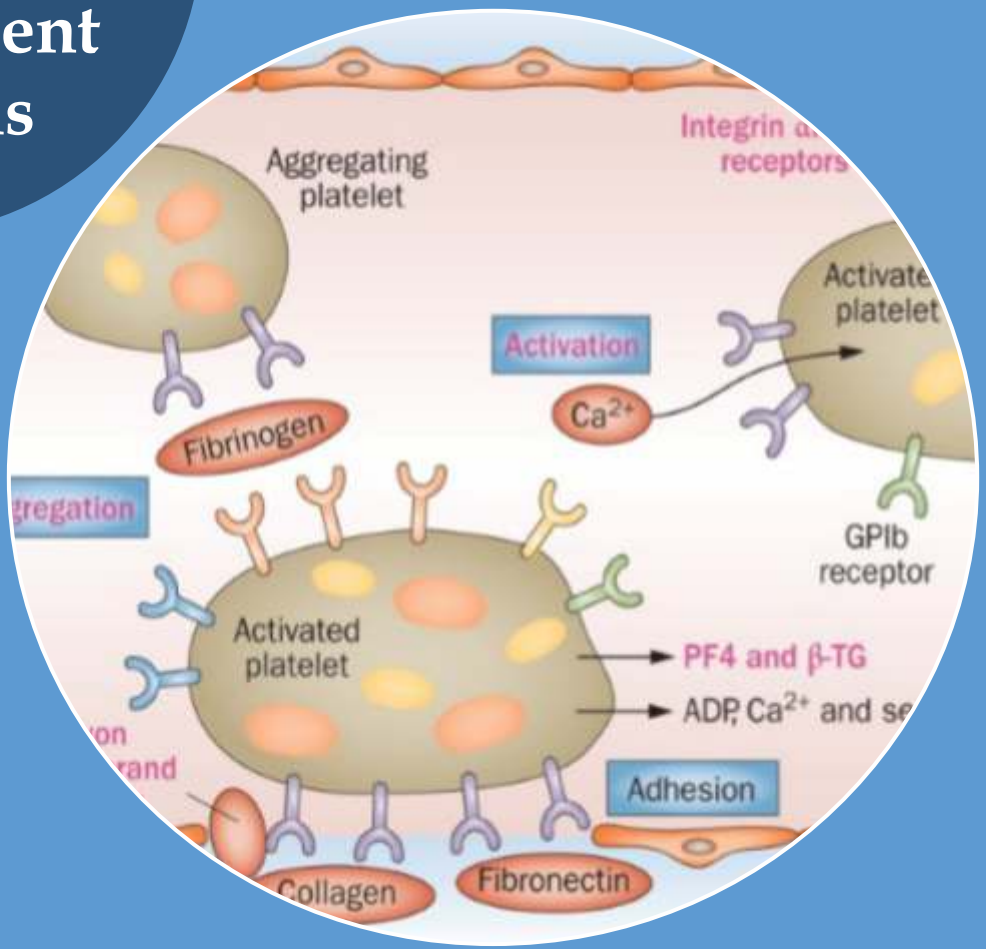


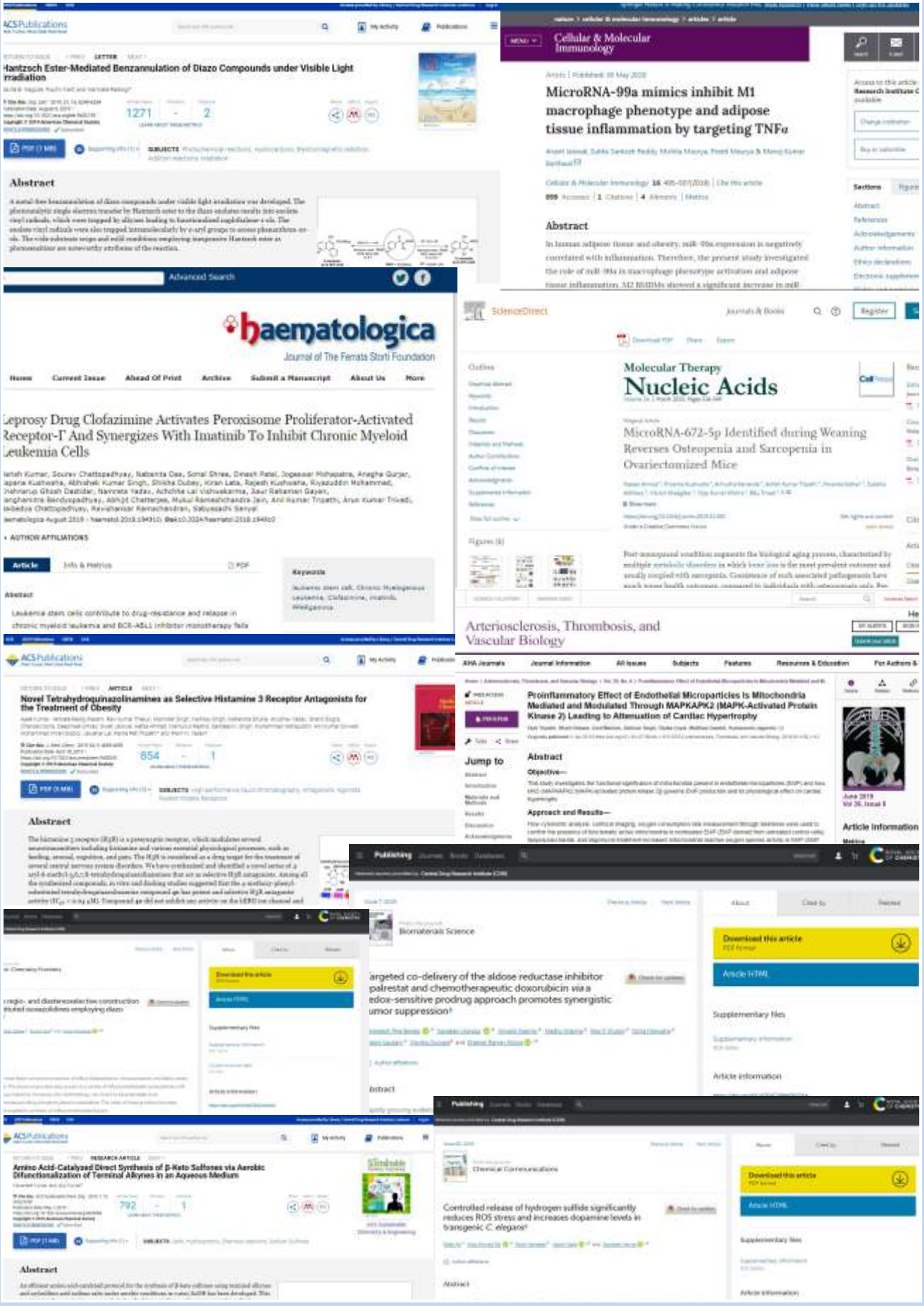
Data as on 01-01-2020

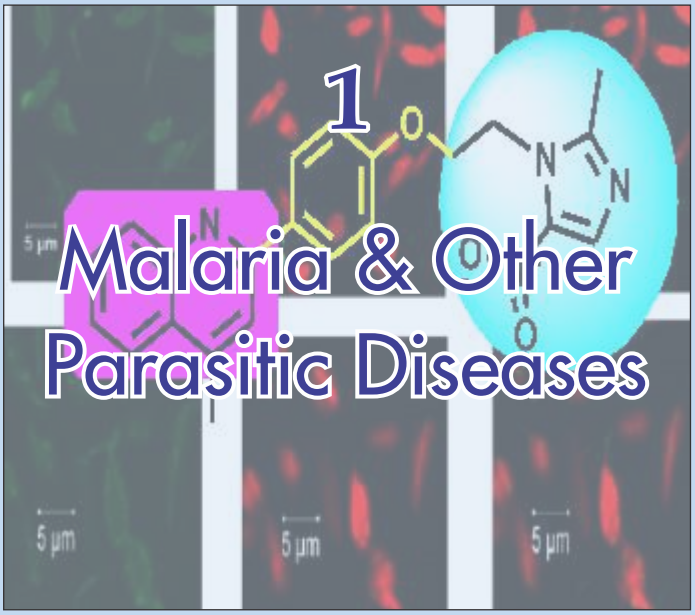
Team CSIR-CDRI

Section
I

Progress in Research & Development Programs




Hantzsch Ester-Mediated Benzannulation of Diazo Compounds under Visible Light Irradiation
MicroRNA-99a mimics inhibit M1 macrophage phenotype and adipose tissue inflammation by targeting TNFα
haematologica
Journal of The Ferrata Storti Foundation
Leprosy Drug Clofazimine Activates Peroxisome Proliferator-Activated Receptor-Γ And Synergizes With Imatinib To Inhibit Chronic Myeloid Leukemia Cells
Molecular Therapy
Nucleic Acids
MicroRNA-672-5p Identified during Weaning Reverses Osteopenia and Sarcopenia in Ovariectomized Mice
Arteriosclerosis, Thrombosis, and Vascular Biology
Novel Tetrahydroquinazolinamines as Selective Histamine 3 Receptor Antagonists for the Treatment of Obesity
Proinflammatory Effect of Endothelial Microparticles Is Mitochondria Mediated and Modulated Through MAPKAPK2 (MAPK-Activated Protein Kinase 2) Leading to Attenuation of Cardiac Hypertrophy
Biomaterials Science
Amino Acid-Catalyzed Direct Synthesis of β-Keto Sulfones via Aerobic Difunctionalization of Terminal Alkynes in an Aqueous Medium
Chemical Communications
Controlled release of hydrogen sulfide significantly reduces ROS stress and increases dopamine levels in transgenic C. elegans



Vision and Goal:

- Development of new drugs/drug combinations as therapeutic interventions for malaria, leishmaniasis and filariasis;
- Identification of unique targets and pathways for future interventions;
- Investigations on parasite biology and host-parasite interactions.

Core Competencies and Activities:

- Design and synthesis of novel molecules as potential parasiticidal agents;
- Bioevaluation of synthetic molecules and natural products for antimalarial, antileishmanial and antifilarial activities against *in vitro* and *in vivo* models;
- Preclinical development of combination therapy regimens with novel compounds/ known drugs;
- Mechanism of drug action / drug resistance;
- Characterization of drug targets using molecular approaches;
- Development of immunoprophylactic modalities;
- Development of improved screening models/drug delivery systems.

1.1 Malaria

1.2 Leishmaniasis

1.3 Filariasis

Area coordinators

1.1 Malaria

1.1.1 YiHA GTPases in biogenesis of organellar ribosomes of the malaria parasite

Apicoplast and mitochondria of the malaria parasite are sites of active protein synthesis but exhibit differences in ribosome composition and translation factor requirement in comparison with organelles of other eukaryotes. *Plasmodium* mitochondria have highly fragmented rRNA and are predicted to carry a reduced ribosomal protein repertoire. Recently was identified two GTPases (EngA and Obg1) and a dimethyltransferase (KsgA1) with a role in biogenesis of parasite mitochondrion. This were identified & extended to investigate another important GTPase identified by us-- *Pf*YihA, that has three nuclear-encoded homologs in *P. falciparum*. Immunofluorescence localization assays using specific antibodies generated against the three proteins revealed that *Pf*YihA1 targeted to the parasite apicoplast, *Pf*YihA2 to the mitochondrion, and *Pf*YihA3 was found in both the apicoplast and cytosol suggesting their roles in biogenesis of organellar and cytosolic ribosomes. The three recombinant *Pf*YihA proteins were active GTPases and interacted with surrogate *E. coli* ribosomes in a nucleotide-independent manner. *In vivo* complexation of *Pf*YihA with organellar and/or cytosolic LSU was confirmed by co-immunoprecipitation. Mitochondrial *Pf*YihA2 carries a large C-ter extension with a strongly positively charged stretch. It was hypothesised that this is important in compensating for the absence of helices 80-88 of the central protuberance in the fragmented rRNA of *Plasmodium* mitoribosomes and may provide additional contact sites to aid in complex assembly. Our results indicate that *P. falciparum* mitochondria assemble ribosomes with the aid of *Pf*EngA, *Pf*Obg1 and *Pf*YihA2 GTPases while apicoplast ribosomes use PfYihA1 and 3 with additional involvement of a putative apicoplast *Pf*RbgA GTPase homolog (***Parasitology 2018, PMID: 29642957***).

(L to R) : Dr. Prem Prakash Yadav, Dr. Ramesh Chintakunta, Dr. Malleswara Rao Kuram, Dr. Ravindra Kumar, Dr. Damodara Reddy N., Dr. Nilanjana Majumdar, Dr. Renu Tripathi, Dr. Saman Habib (coordinator), Dr. Sanjay Batra (coordinator), Dr. Niti Kumar, Dr. Mohammad Imran Siddiqi, Dr. Kishor Mohanan & Dr. Satish Mishra

1.1.2 Organellar base excision repair endonuclease with restricted enzymatic functions

In this study, explored DNA repair mechanism(s) operative within the apicoplast and mitochondrion of *P. falciparum* by mining its nuclear genome for sequences encoding proteins of major DNA repair pathways with predicted targeting to either organelle. Of the panel of enzymes identified for base excision repair (BER), the apurinic/ apyrimidinic (AP) endonuclease *Pf*Apn1- an EndoIV whose homolog is not known in humans was characterized *Pf*Apn1 targeted to the mitochondrion and functioned as an AP-endonuclease requiring both Zn^{2+} and Mn^{2+} ions for maximal activity. Mutation of the critical third metal-binding site residue H542 resulted in loss of Mn^{2+} (but not Zn^{2+}) binding indicating that Mn^{2+} bound *Pf*Apn1 at this site; this was further supported by molecular dynamic simulation. CD spectra analysis further showed requirement of both metal ions for attainment of *Pf*Apn1 β-strand rich optimal conformation. *Pf*Apn1 also functioned as a 3′-phosphatase that would enable removal of 3′-blocks for DNA polymerase activity during BER. Interestingly, unlike *E. coli* and yeast EndoIV homologs, *Pf*Apn1 lacked 3′-5′ exonuclease activity and also did not cleave damaged bases by nucleotide incision repair (NIR). Uncoupling of endonuclease/phosphatase and exonuclease/NIR in *Pf*Apn1 suggested that amino acid residues distinct from those critical for endonuclease function are required for exonuclease activity and NIR. Characterization of a critical mitochondrion-targeted AP endonuclease provided evidence for a functional BER pathway in the parasite organelle (***FEBS Journal 2019, PMID: 31386260***).

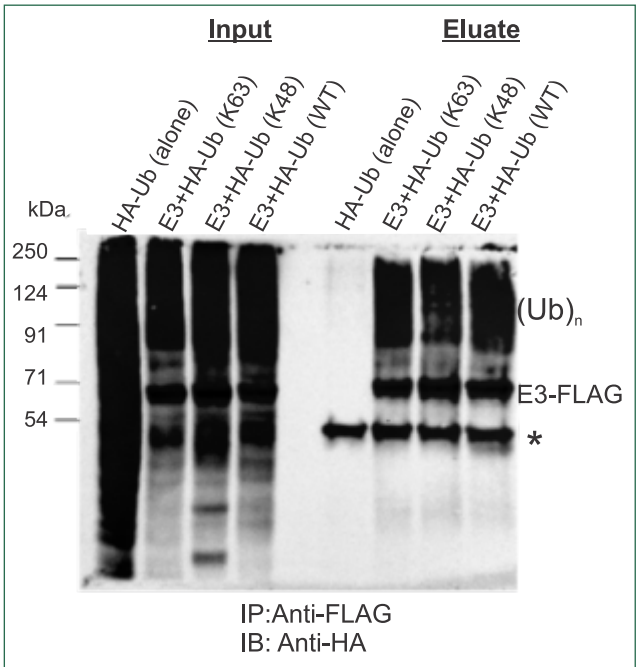


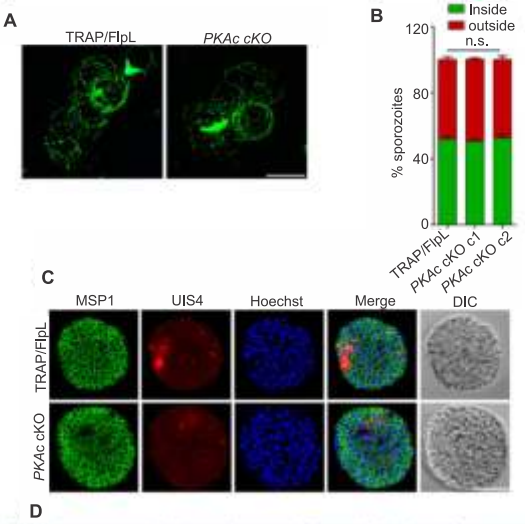
Fig. 1: Ectopic expression of *Pf*-RBR-E3 ligase (FLAG-tagged) alongwith HA-Ub constructs in mammalian cells and immunoprecipitation with FLAG antibody and immunoblotting with HA antibody. * denotes the non-specific signal from heavy chain of antibody

1.1.3 Understanding the role of RBR-E3 Ubiquitin ligase in Human malaria parasite

Human malaria parasite (*P. falciparum*) has evolved versatile protein quality control (PQC) system which includes the protein folding and degradation machinery. Interestingly, the components of PQC machinery have diverged significantly from their human orthologs and have acquired potential moonlighting roles which gives survival advantage to the parasite. The functions of different components of protein folding and degradation machinery were investigated. One of the critical component which facilitates efficient removal of misfolded or aggregated species is E3 ligase family which selectively ubiquitinates protein substrates for various cellular activities. Amongst different E3 ligases, it was found that parasite has only one Ring-Between-Ring (RBR) E3 ligase which is distinct from human ortholog with additional interfaces which may potentially expand its repertoire of interaction. The immunoprecipitation experiment revealed that parasite's RBR-E3 ligase catalyzes both K63 and K48 mediated ubiquitination suggestive of its involvement in diverse cellular processes. Ongoing experiments include mutagenesis experiments to identify catalytic cysteines involved in ubiquitination and immunoprecipitation to identify the substrates or protein interactors of RBR-E3 ligase in parasite.

1.1.4 Protein kinases as potentially novel drug targets against malaria

In order to develop novel strategies against malaria, protein kinases may serve as promising drug targets. The knockouts of two protein kinases in *Plasmodium berghei*, PKAc and STK2 were created & it was found that PKAc is indispensable in malaria blood stages. Due to the essentiality of PKAc in erythrocytic stages, conditional knockout was created by disrupting the PKAc locus in sporozoites using Flp/FRT conditional mutagenesis system. It was found that PKAc cKO sporozoites were able to glide, invade hepatocytes, and mature into hepatic schizonts which developed successfully into merosomes (Fig.2A-C) However, these failed to initiate blood stage infection when injected in mice (Fig.2D) (***Life Science Alliance. 2019; 2: 1-11, PMID: 31142638***)

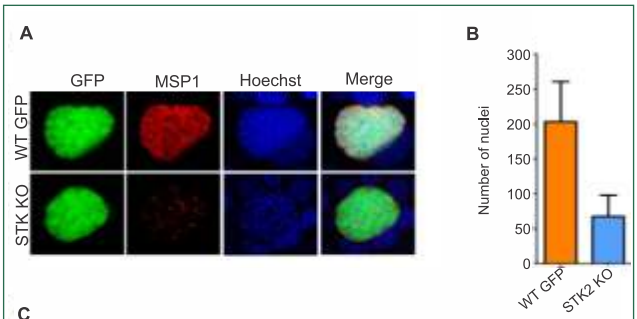


D

Parasite	Number of merosomes injected	Mice positive/mice injected	Pre-patent period (day)
TRAP/FIpL	100	5/5	1.2
PKAc cKO c1	100	5/5	5.2
TRAP/FIpL	100 mr	5/5	1.4
PKAc cKO c1	100 mr	5/5	6.2

Fig. 2. (A) Gliding motility of PKAc cKO sporozoites was similar to the gliding activity observed for TRAP/FIpL parasites. Scale bar, 25 µm. **(B)** Bar graph showing percent sporozoites inside versus outside. **(C)** PKAc cKO merosomes show normal loss of the PV membrane and normal segregation of merozoite membranes. Scale bar, 5 µm. **(D)** PKAc cKO merosomes have impaired infectivity in mice. Swiss mice were inoculated i.v. with the indicated number of merosomes with or without mechanical rupture (mr).

STK2 was dispensable in malaria blood stages and STK2 KO parasites completed normal mosquito stage development. STK2 KO sporozoites were able to successfully invade hepatocytes and developed into EEFs and remain indistinguishable from wild-type until 48 h.p.i. Late EEFs harvested at 62 h.p.i.) showed significant reduction in merozoite development as assessed by MSP1 staining and nuclei count (Fig. 3 A and B). Impairment in merozoites formation in STK KO parasites led to delay in appearance of parasites in blood stages (Fig. 3C) (***Biology Open.* 2019; *PMID: 31444161*).**



C

ParasiteS	Number of sporozoites injected	Mice positive/mice injected	Pre-patent period (day)
WT GFP	1,000	3/3	4
WT GFP	5,000	3/3	3
stk2 KO Cl2	1,000	0/3	NA
stk2 KO Cl2	5,000	3/4	6

Fig. 3. (A) *In vitro* EEF development at 62 h.p.i. revealed significantly reduced MSP1 expression in STK KO parasites. Scale bars: 5 µm. **(B)** Quantification of hepatic merozoite nuclei. **(C)** Analysis of pre-patent period in STK KO parasites.

1.1.5 Deciphering the role of toll-interacting protein during malaria infection

Plasmodium parasite has evolved intricate mechanisms to avoid the development of TLR-mediated effector immune responses. Toll-interacting protein (Tollip), a negative regulator of TLR-signaling plays a prominent role in pathogenesis in visceral leishmaniasis; though, its role during *Plasmodium* infection has yet not been explored. Therefore the role of Tollip in *Plasmodium yoelii* MDR (1×10^6) infected Balb/c mice on days 3-7 post-infection (having 5-40 % blood parasitemia, respectively was investigated). It was discovered that the level of Tollip increases at early time points and then goes down and again flares

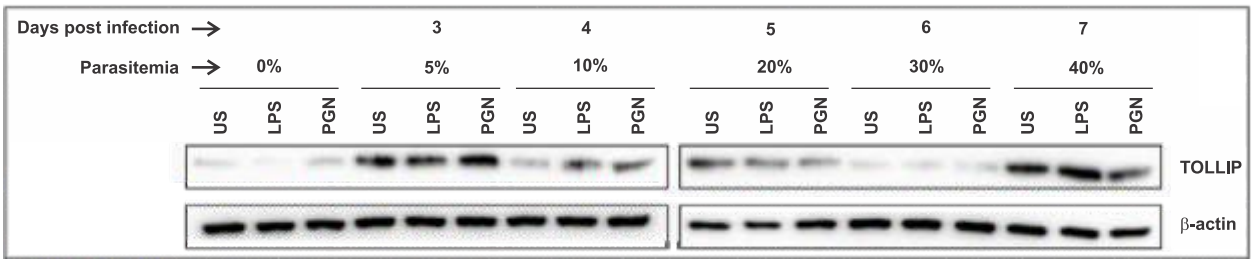


Fig. 4. Expression status of Tollip at different parasitemia

up at later stage when parasitemia was 40% (Fig. 4). This data suggests the dual role of Tollip during early and late malaria infection. During early infection, Tollip regulates excess TLR activation and might help in parasite multiplication. However, at later stage, when pro-inflammatory cytokines up-regulate, Tollip again flares up to control the high inflammation and might play host-protective role. Further, the effect of Tollip expression on cytokine response, parasitemia level and host survival is being validated using Tollip-knockdown mice.

1.1.6 Exploration of antimalarial potential of existing therapeutics

Various existing drugs (anticancer drugs, immunomodulator and antibiotics) were evaluated for their *in vitro* activity against human malaria parasite *Plasmodium falciparum* 3D7 (chloroquine-sensitive strain) and K1 (chloroquine-resistant strain). The IC_{50} values of selected drugs are reported in the Fig. 5. Amongst all tested drugs, 3 drugs (5-Florouracil, Imiquimod and Moxifloxacin) one from each group were selected for further screening in *in vivo* system on the basis of their promising *in vitro* activity. In *Plasmodium yoelii* infected swiss mice, these three drugs showed approximately 82-97% parasitemia suppression along with increased host mean survival time as compared to untreated group (fig. 6).

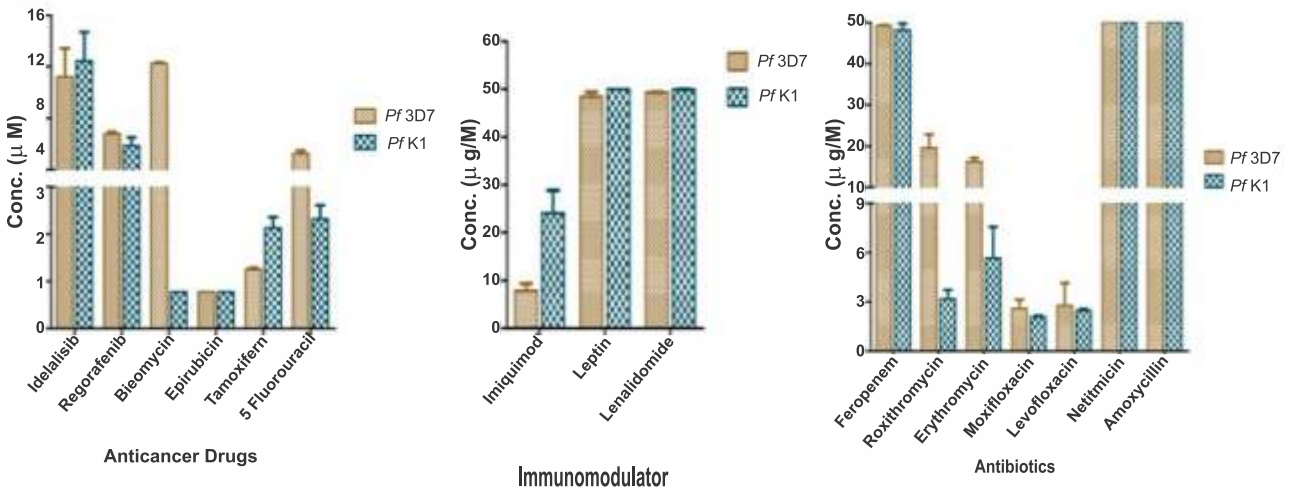


Fig. 5. *In vitro* antimalarial activity of existing drugs

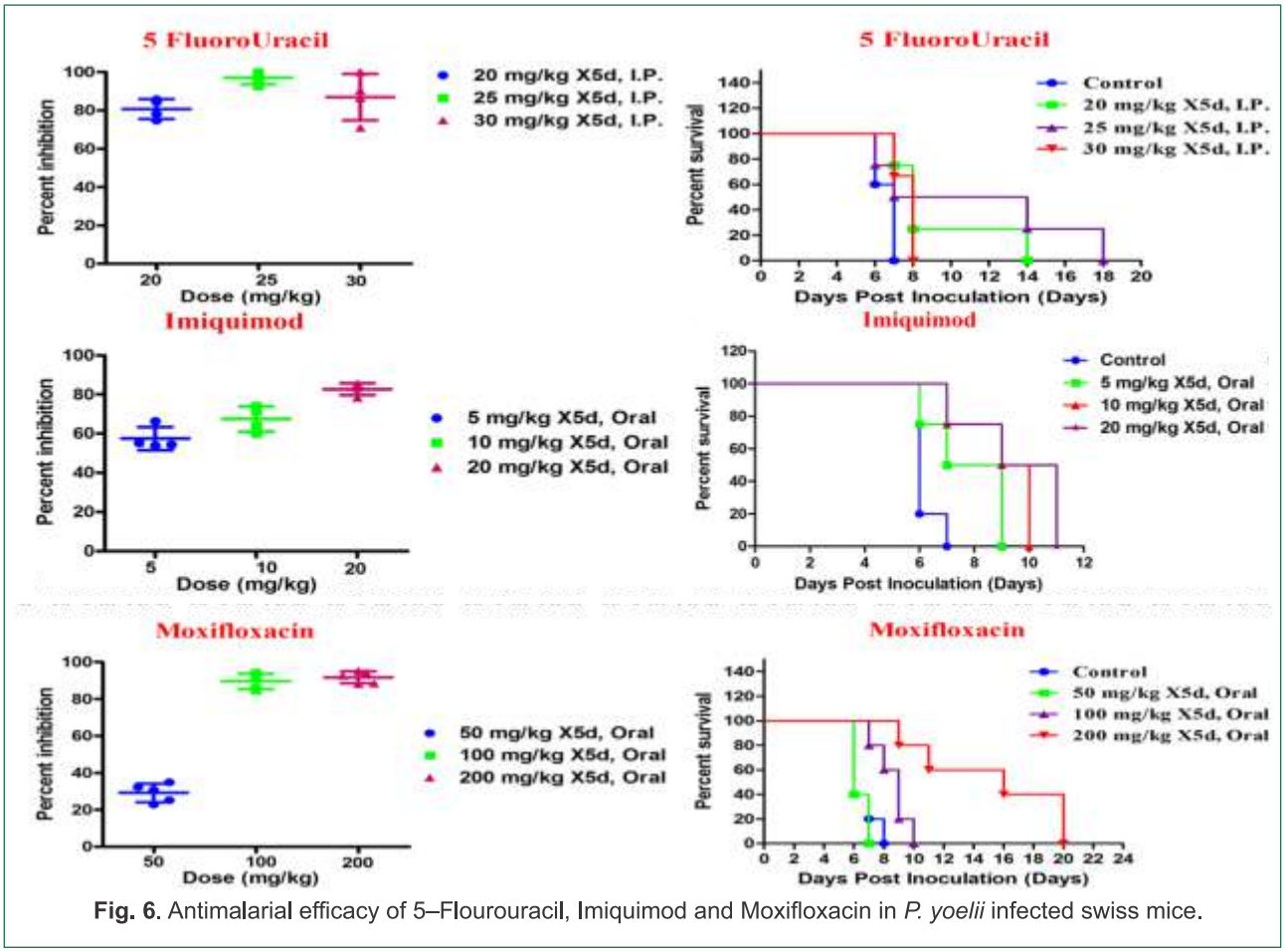
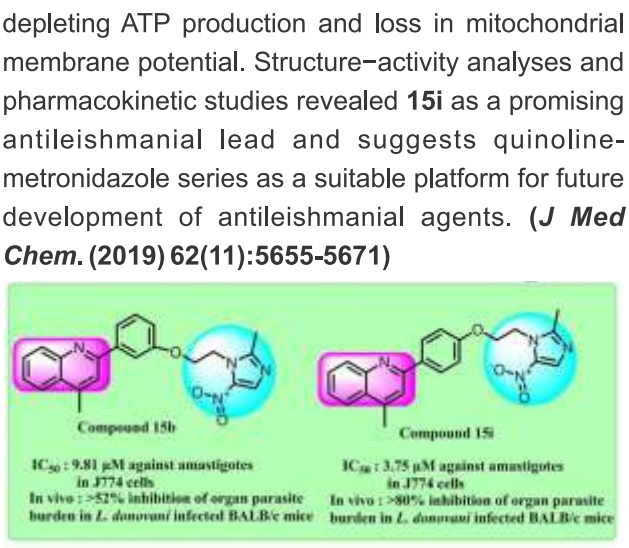


Fig. 6. Antimalarial efficacy of 5–Flourouracil, Imiquimod and Moxifloxacin in *P. yoelii* infected swiss mice.

1.2 Leishmaniasis

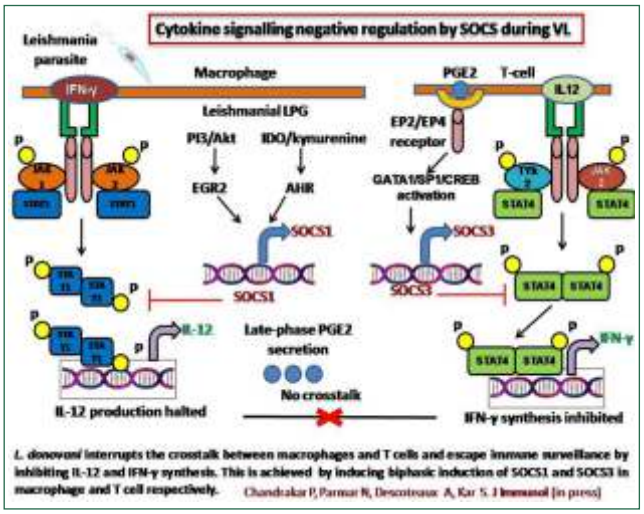
1.2.1 Synthesis, biological evaluation, structure-Activity Relationship and mechanism of action studies of Quinoline-metronidazole derivatives against experimental Visceral Leishmaniasis

To identify novel chemical scaffolds for the development of antileishmanial agents, a series of quinoline-metronidazole was synthesized and tested against murine model of visceral leishmaniasis. Among all synthesized derivatives, **15b** and **15i** showed promising antileishmanial efficacy against both extracellular promastigote (IC_{50} 9.54 µM and 5.42 µM respectively) and intracellular amastigote (IC_{50} 9.81 µM and 3.75 µM respectively) form of *L. donovani* with negligible cytotoxicity towards host (J774 macrophages, Vero cells). However compound **15i** showed better *in vivo* efficacy and effectively eliminated spleen and liver parasite burden (>80 %) in BALB/c mice model of VL. Mechanistic studies revealed that **15i** triggers oxidative stress, induces bioenergetic collapse and apoptosis of the parasite by depleting ATP production and loss in mitochondrial membrane potential. Structure−activity analyses and pharmacokinetic studies revealed **15i** as a promising antileishmanial lead and suggests quinoline-metronidazole series as a suitable platform for future development of antileishmanial agents. (***J Med Chem.*** **(2019) 62(11):5655-5671)**



1.2.2 Differential induction of SOCS isoforms by *Leishmania donovani* impairs macrophage- T cell crosstalk and host defense

Immune evasion strategies adopted by *Leishmania donovani* involve the exploitation of SOCS proteins that are well-known negative regulators of the JAK/STAT pathway. However, the cellular mechanism underpinning the induction of SOCS isoforms and their role in breaching the multilevel regulatory circuit connecting the innate and adaptive arms of immunity are still ambiguous during experimental visceral leishmaniasis. Using bone marrow macrophages (BMMϕs) and CD 4^+ T cells, it was observed that *L. donovani* preferentially upregulates SOCS1 and SOCS3 expression in macrophages and T cells respectively, while SOCS1 level remains consistently high in BMMϕs, SOCS3 expression is pronounced and long-lasting in T cells. Consequently, this inhibits



STAT1 mediated IL-12 induction in macrophages & STAT4 mediated IFN-γ synthesis in T cells. Mechanistically, PI3K/Akt-mediated SRF activation promotes nuclear translocation and binding of Egr2 to SOCS1 promoter for its early induction in infected BMMϕs. Additionally, *L. donovani* activates

Leishmaniasis & Filariasis Research Group

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IDO/kynurenine/AHR signaling in BMMϕs in order to maintain prolonged SOCS1 expression. Later, prostaglandin E2, secreted from infected BMMϕs induces cAMP-PKA pathway by binding to the EP2/EP4 receptor of CD 4^+ T cells, leading to SP1, CREB and GATA1 activation and SOCS3 expression. SiRNA-mediated silencing of SOCS1 and SOCS3 in macrophage and T cells respectively restored IL-12 and IFN-γ cytokine levels and BMMϕs-T cell interaction. Vivo morpholino-mediated silencing of SOCS1 and SOCS3 resulted in protective cytokine responses, thereby reducing organ parasite burden significantly in *L. donovani*-infected Balb/c mice. Collectively, our results imply that *L. donovani* orchestrates different SOCS isoforms to impair macrophage-T cell crosstalk and preserve its own niche. **(*J Immunol*, 2019, PMID: 31882519)**

1.2.3 Effect of overexpression of LdMAPK1 on Leishmania proteome:

Mitogen-activated protein kinases (MAPKs) are well-known mediators of signal transduction of eukaryotes, regulating important processes, like proliferation, differentiation, stress response, and apoptosis. In Leishmania, MAPK1 plays various roles in regulating the critical cellular activities like parasite survival, infectivity and drug resistance. Earlier, it was shown that LdMAPK1 modulates antimony susceptibility by downregulating P-glycoprotein (P-gp) efflux pump and plays a vital role in the post-translational modification and possibly the regulation of heat shock proteins. With an aim to identify LdMAPK1 modulated phosphoproteins by comparative phosphoproteomics analysis of wild type (Dd8+/+), LdMAPK1 over-expressing (Dd8++/++) and LdMAPK1 single deletion (Dd8+/-) mutant parasites, iTRAQ labeled quantitative analysis was carried out. Biological triplicates were run on orbitrap fusion and the protein search was performed against *L. donovani* database down loaded from Uniprot using Proteome Discoverer 2.2 software. Comparatively, iTRAQ labeling based quantitative analysis identified 420, 512, 320 phosphopeptides for 210, 255 and 142 phosphoproteins in biological triplicates of wild type (Dd8+/+), LdMAPK1 over-expressing (Dd8++/++) and single deletion (Dd8+/-) mutant parasites respectively. Out of these, only 8 phosphoproteins namely, acetyl-coenzyme A synthetase, heat shock protein 83-1, serine/threonine-protein phosphatase, elongation factor 1-alpha, nucleolar protein, and 3 uncharacterized protein exhibited >1.5 fold upregulation in LdMAPK1 overexpressing parasites while 7 proteins, (eukaryotic translation initiation factor 5a, eukaryotic release factor-3, glyceraldehydes-3-phosphate dehydrogenase, enolase, heat shock protein 70 and two ribonucleoside diphosphate reductase small chain proteins showed >1.6 fold down-regulation. However, except one (eukaryotic translation initiation factor 5a), none of the either up or down regulated proteins, in overexpressing parasites, exhibited differential expression in single deletion mutant parasites. The study suggested that LdMAPK1 over-expression modulates the expression levels of phosphoproteins related to diverse pathways mostly related to metabolism, signal transduction, translation and molecular chaperones.

1.2.4 Functional characterization of TCP1 of *L. donovani*

As drug target: T-complex polypeptide-1 (TCP1), a group II chaperonin class of protein (HSP60 family) is involved in intracellular assembly and folding of various proteins in eukaryotes. In Leishmania, only the TCP1 subunit has been cloned and characterized from our lab. It forms homo-oligomeric complex and exhibited chaperonin activities. In the present study, the essentiality of LdTCP1γ gene using both molecular and chemical validation strategies was investigated. Gene replacement studies indicate that LdTCP1γ is essential for parasite survival as efforts to generate null mutant failed and single-allele replacement mutants exhibited retarded growth and decreased infectivity in mouse macrophages compared to wild-type parasites. Modulation of LdTCP1γ expression in promastigotes also modulated cell cycle progression. Suramin, initially developed as a treatment for human African sleeping sickness, exhibited significant inhibition of LdTCP1γ refolding activity and

multiplication of amastigotes with low toxicity to mammalian cells. The interaction of suramin with LdTCP1γ was observed both by isothermal titration calorimetry and computational molecular docking studies. The study suggested that LdTCP1γ is an essential gene, hence a potential drug target. It also provides a framework for the development of a new class of drugs.

As immunogen: Treatment of VL is associated with the generation of Th1 type of cellular response and antigens that are involved in Th1 stimulation are considered as a suitable vaccine candidate. Interestingly, the recombinant protein, LdTCP1γ was found to be potent immunogenic in nature as it exhibited strong Th1 type response. It exhibited strong LTT response along with significant NO and ROS production in cure hamsters as compared to untreated infected controls. The study suggested that LdTCPγ is a promising molecule which has to be further evaluated for its prophylactic efficacy.

1.2.5 Characterization of leishmanial dipeptidylcarboxypeptidase as a potential vaccine molecule against visceral leishmaniasis

Peptidase from parasite origin are becoming important as vaccine candidate, among them cell surface metallopeptidase and lysosomal cysteine peptidase have shown immunoprophylactic activity. Earlier, dipeptidylcarboxypeptidase (LdDCP) a zinc metallopeptidase was reported as a potent drug target. In the present study, LdDCP was evaluated for its immunogenicity in cured hamster by XTT, NO and RO production. The study suggested that LdDCP has potential of developing as vaccine candidate against VL infection.

1.2.6 Characterization of RNA Editing Ligase 1 (REL1) of *Leishmania donovani* as drug target

RNA editing is a unique post transcriptional modification of mitochondrial mRNAs that is shared in all trypanosomatid pathogens. Modification of specific editing sites, dictated by complementary guide RNAs (gRNAs), constitutes essential steps to ensure the production of translatable mRNAs that encode essential components of the mitochondrial oxidative phosphorylation system which is indispensible for survival of *Leishmania* parasite inside host. One of the important components of RNA editing is RNA editing ligase 1 (REL1). It was considered to characterize RNA editing pathway, particularly the enzyme, REL1 of *L. donovani* (LdREL1) in the context of parasite survival and infectivity.

LdREL1 was expressed and purified and subsequently preparation over-expression and knock-out construct of LdREL1 to establish its function in *Leishmania* parasites. A 0.8 kb flanking sequence upstream (5′F) and 0.725 kB flanking sequence downstream (3′F) of LdREL1 were PCR-amplified from *L. donovani* g-DNA, cloned in pCR-2.1-TOPO TA vector and then sub-cloned in pX63NEO and pX63HYG vectors in between HindIII and SalI as well as SmaI and BglII sites to generate 5′F-pX63HYG-3′F and 5′F-pX63NEO-3′F constructs respectively. Both of these circular constructs were then digested with HindIII and BglII to generate linear constructs for transfection in *Leishmania* parasites. Transfection of knock-out construct will be started to generate LdRELI deleted parasites to see the effect of this knockout in parasite survival and infection.

To prepare over-expression construct, LdREL1 ORF was PCR amplified from a pCR- 2.1-TOPOTA-LdREL1 construct using primers with restriction sites HindIII and BamHI and cloned into *Leishmania* expression vector pLp-NEO2 in between Hind III and BamHI sites. Clone pLp-NEO2-LdSir2 (ORF in the right orientation) was transfected into Leishmania parasites by electroporation. Transfectants were selected and maintained in the presence of 40 mg/mL G418 and further selected in 80 mg/mL G418. Taking these LdREL1 knockout and over-expression parasites, the role of REL1 in RNA

editing, oxidative phosphorylation, parasite survival and infectivity is planned to be explored in future.

1.2.7 Development of *Leishmania* vaccine

Previously identified 6 Th1 stimulatory proteins are being evaluated for their prophylactic as well as therapeutic efficacy against visceral leishmaniasis (VL). In continuation, enolase was developed a chimeric protein by fusing eldolase and triosephosphate isomerase (TPI) and evaluated its therapeutic efficacy against experimental VL. When compared to the individual proteins, the fusion product showed significantly increased therapeutic efficacy. The suppression of infection was more than 75% when used with BCG as an immune modulator. The immunological parameters such as DTH response, lympho-proliferation as well as cytokine responses for both Th1 type (IFN-γ, TNF-α and IL-12) and Th2 type (IL4 and TGF-β) in the splenic tissue samples as well as in the sera samples indicated inclination towards Th1 response. Development of chimeras of aldolase-enolase and aldolase-TPI is under way.

1.3 Filariasis

1.3.1 Immunobiology of Lymphatic Filariasis: Immunogenicity and protective efficacy of recombinase-A protein of *Wolbachia*, an endosymbiont of filarial nematode *Brugia malayi*.

Filarial parasites cause global morbidity. *Wolbachia*, an endo-symbiotic intracellular bacterium of the filarial nematode helps in their growth and development, regulates fecundity in female worms and contributes to the immunopathogenesis of the disease. It is believed that several genes and proteins of *Wolbachia* are intricately involved in either suppression, diversion, or polarization of the host immune response. However, genes and proteins of *Wolbachia* that may act as putative vaccine candidates are not known. cloned recombinase-A protein of *Wolbachia* from *Brugia malayi* (wBmRecA) The was closed and their its detailed biochemical and immunological characterization was carried out. Bioinformatics analysis, circular dichroism and fluorescence spectral studies showed significant sequence and structural similarities between wBmRecA and RecA of other alpha-proteo- bacterial species (Fig. 7).

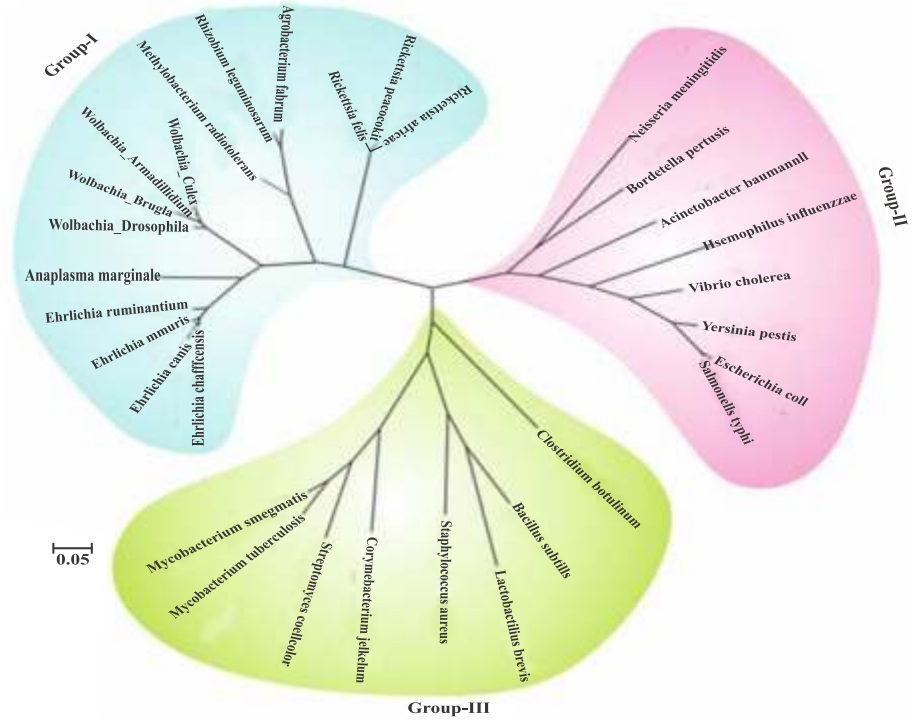


Fig. 7. Evolutionary relationship of wBmRecA among different bacterial species.

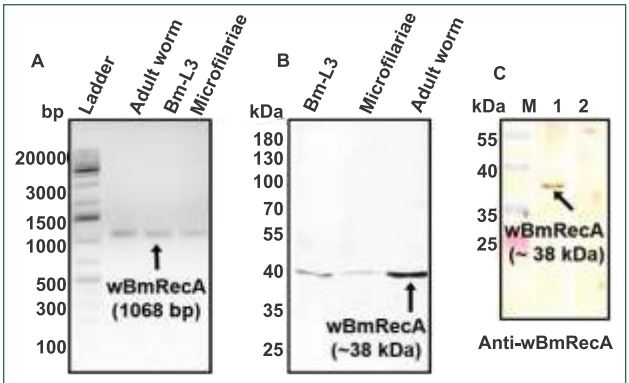


Fig. 8. Expression of wBmRecA in different life stages of B. malayi (A) RT-PCR analysis using cDNA from different stages of *B. malayi*. (B) Protein lysate from different stages of *B. malayi* probed with anti-wBmRecA antibody. (C) Cross reactivity of anti- wBmRecA antibody with excretory-secretory (ES) product from female worms (lane 1). No reactivity was observed in case of control sera (lane 2).

Notably, wBm RecA was ubiquitously expressed in all the three major life stages of *B. malayi*, including excretory-secretory products of the adult worm (Fig. 8A-C).

In silico studies suggested immunogenic potential of wBmRecA, and mice immunized with wBmRecA exhibited elevated levels of immunoglobulins IgG1, IgG2a, IgG2b and IgG3 in their serum (Fig. 9) along with increased percentages of Cd4+, CD8+ T cells and CD19+ B cells in their spleens.

Interestingly, splenocytes from immunized mice showed increased m-RNA expression of T-bet, elevated proinflammatory cytokines IFN-γ and IL-12, while peritoneal MΦs exhibited increased levels of

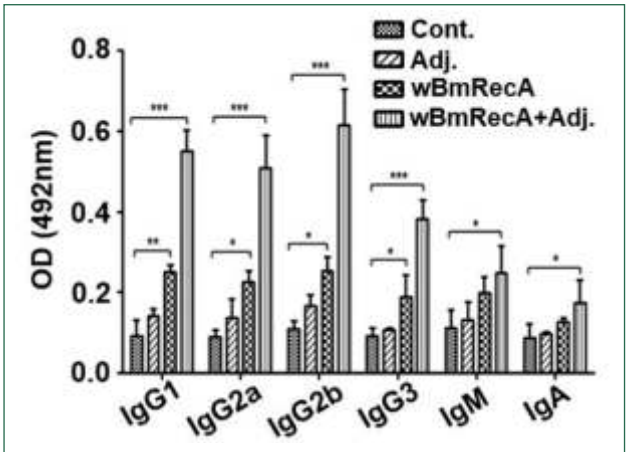


Fig. 9. IgG titers in different experimental groups.

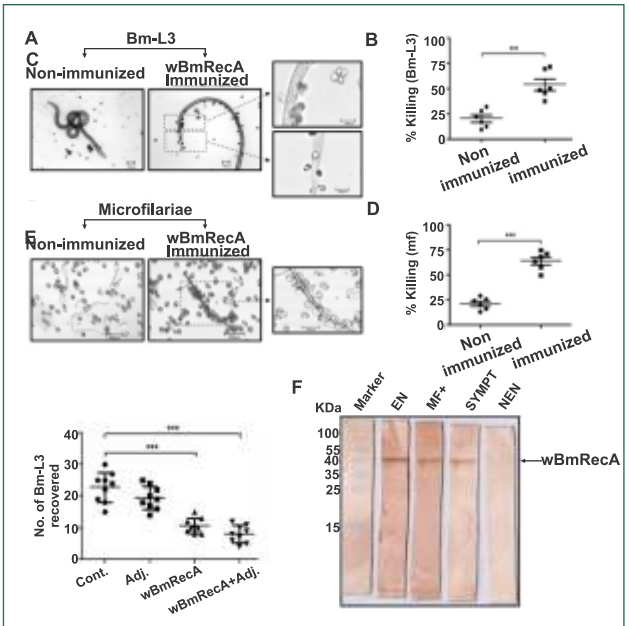


Fig. 10. Host protective nature of wBmRecA. Peritoneal exudate cells from naive mice were separately cultured with (A) Bm-L3 and (C) Mf in the presence or absence of sera from r-wBmRecA immunized animals and (B) Bm-L3 and (D) Mf killing was observed microscopically. (E) Recovery of Bm-L3 in mice from different treatment groups. (F) Sero-reactivity of wBmRecA with human bancroftian serum samples. Lane 1- Protein molecular weight marker; lane 2- serum from endemic normal (EN); lane 3- serum from asymptomatic microfilariaemic carriers (MF+); lane 3- serum from symptomatic microfilariaemic (SYMPT) and lane 4- serum from non-endemic normal (NEN) controls.

iNOS, downregulated Arg-1 and secreted copious amounts of nitric oxide which contributed to severely impaired development of the third stage infective larvae (Bm-L3).

Interestingly, sera from immunized mice promoted significant cellular adherence and cytotoxicity against microfilariae and Bm-L3 (Fig. 10A-E) and wBmRecA demonstrated strong immuno-reactivity with bancroftian sera from endemic normal individuals (Fig. 10F) which suggest that wBmRecA is highly immunogenic, and should be explored further as a putative vaccine candidate against lymphatic filariasis (***Vaccine*, 2019, 37(4), 571-580 https://doi.org/10.1016/j.vaccine.2018.12.015**).

1.4 Medicinal Chemistry

1.4.1 Malaria

Aminopropanols

In continued effort to assess the antiplasmodial efficacy of the aminopropanols, 30 new analogues were synthesized and submitted for activity. The synthesis involved the incorporation of heterocyclic scaffolds in the aminopropanol unit. These compounds displayed significant activity against 3D7 as well as K1 strains of *P. falciparum*. Encouraged by these results, synthesis of a novel class of diaminopropanol compounds by incorporating an additional amino group in the molecule and their derivatives was accomplished. All 10 new compounds of this class, displayed enhanced bioactivity in the range of IC_{50} 0.04-0.250 µM for 3D7 CQS and 0.07-0.91 µM for K1 CQR strains of *P. falciparum*. Two compounds **S-019-190 & S-019-0192** were resynthesized for carrying out the *in vivo* studies. However, the 10 new compounds bearing nitropyridine and 3-aminoquinoline scaffolds were found to eleicit poor biological response.

1-(Arylsulfonyl)pyrrolidine-2-carboxamides

During this period around 20 new 1-(substituted phenylsulfonyl)pyrrolidine-2-carboxamides were prepared and subjected for evaluation as antiplasmodial agent. However the compounds were found to be inactive against the 3D7 CQS strain of *P. falciparum*.

Heterocycles

Compounds belonging to various heterocycles including oxaboroles, triazoles, indolinone, spiroindolinones, pyrazoles, isoxazoles, pyrrolo[1,2-a]isoquinolines, 4-aminoquinolines, phosphorylated naphthalenes were prepared and submitted for evaluation as antiplasmodial agents. Of these a few analogues displayed antiplasmodial efficacy ranging between 2-4 M against 3D7 CQS strain of *P. falciparum*.

1.5 Anti-parasitic screening for drug discovery

1.5.1 Anti-malarial screening

633 compounds were screened against the human malaria parasite, *P. falciparum* (CQ-sensitive PF3D7 and CQ-resistant K1 strain). These compounds belong to diverse chemical classes such as quinoline triazols, oxazenes, oxazole salt, di-aminopropanol, pyrimidine based hetrocyclic derivatives, HDAC inhibitors, spiroindoles, peptidyl hydroxamic and dihydronaphthalene.

Quinoline triazote (20) derivatives (S019-0546, 0547, 0548, 0549, 0550, 0551, 0552, 0553, 0554, 0555, 0556, 0557, 0558, 0559, 0560, 0561, 0562, 0563, 0564 and 0565) had IC_{50} in the range of 0.03 to 0.35 µM against CQ-sensitive (Pf 3D7) and 0.03 to 1.91 µM against CQ-resistant strain (K1). Oxazine class (10) compounds (S019-0472, 0473, 0474, 0475, 0476, 0477, 0478, 0479, 0510 and 0511) exhibited activity with IC_{50} in the range of 0.11 to 0.97 µM against Pf 3D7 and 0.07 to 0.48 µM against K1. Oxazole salt derivatives (23) (S019-0129, 0131, 0132, 0133, 0134, 0135, 0136, 0137, 0139, 0140, 0141, 0142, 0156, 0157, 0158, 0159, 0160, 0161, 0163, 0164, 0165, 0168, 0169) showed activity with IC_{50} values between 0.24 to 0.97 µM against Pf 3D7 and 0.23 to 2.34 µM against K1 strain. Di-aminopropanols (10) compounds (S019-0117, 0118, 0119, 0120, 0182, 0184, 0187, 0190, 0192 and 0212) exhibited antimalarial effect with IC_{50} values of 0.04 to 0.25 µM against Pf 3D7 and 0.24 to 1.96 µM against K1. Aminopropanol derivatives (S018-0507, 0251 and 0509) exhibited IC_{50} ranging from 0.12 -0.78 µM against Pf 3D7 and <0.07 - 2.94 µM against K1 strain. Compounds (S019-0464, 0065 and 0067) belonging to pyrimidine class exhibited activity in the range of 0.17 and 0.46 µM (IC_{50} values) against Pf 3D7 and 0.24 to 0.61 µM against K1. Compound designed based on HDAC inhibitor (S019-0077) had IC_{50} values of 0.22 µM against 3D7 and 0.66 µM against K1. Spiroindole derivatives (S018-0309 and S018-0312) showed IC_{50} of 0.88 and 0.48 µM against Pf 3D7 and 1.47 and 3.11 µM against K1 strain. Peptidyl hydroxamic acid (2)

derivatives (S018-0396 and 0411) had IC_{50} values of 0.94 and 0.59 µM, respectively, Pf 3D7 strain and 0.81 and 0.54 µM, respectively against K1 strain. Indole based scaffold, S019-0010 had IC_{50} values of 1.04 µM against Pf 3D7 and 0.62 µM against K1. Dihydronaphthalene derivatives (S018-0489, 0490 and S017-0670) exhibited IC_{50} values 0.97, 0.03 and 0.72µM respectively, against Pf 3D7 and 0.63, 0.02 and 3.99 µM respectively, against K1. Furan based compound (S018-0485) exhibited IC_{50} at 0.86 µM against Pf 3D7 and 0.91 µM against K1 strain. Imidazopyridine class compound (S019-0019) showed IC_{50} at 0.60 µM against Pf 3D7 and 0.15 µM against K1 strain. S019-0124, S019-0200, S019-077 and S019-0608 showed antimalarial activity in the range of 0.2-0.5 µM in CQ-sensitive and resistant strains. These compounds were evaluated for cytotoxic profile against Vero cell line and were found to have minimal or no cytotoxicity.

1.5.2 *In vitro* antimalarial activity report of compounds received under DBT Twinning project

During the reported period, 40 compounds were received under DBT Twining project and were screened against Pf 3D7 and K1 strains. Out of these, 10 compounds namely SKQ-1C, 1D, 1E, 2C, 2D, 2E, 3B, 3C, 3D and 3E have shown IC_{50} as 0.05, 0.04, 0.35, 0.14, 0.05, 0.04, 0.17, 0.14, 0.07 and 0.08 µM against Pf3D7 chloroquine sensitive and 0.99, 0.94, 0.31, 0.34, 0.79, 0.28, 0.38, 0.63, 0.22 and 0.29 µM against PfK1 chloroquine resistant strain, respectively. These molecules were also evaluated for cytotoxic profile in Vero cell line and found to be safe.

1.5.3 *In vitro* antimalarial activity report of plant extracts received from across the country

During the reporting period, two plant extracts received from other research institutes were screened against the *P. falciparum*. Both plant extracts, namely RMRC-001 & RMRC-002 have shown antimalarial activity with their IC50 values of 27.45 and 19.65 µg/ml against CQ sensitive Pf3D7 strain and 5.10 & 36.85 µg/ml against CQ resistant PfK1 strain, respectively. These molecules are found to be safe in Vero cells.

1.5.4 *In vivo* antimalarial profile of CSIR-CDRI compounds against P. yoelii nigeriensis N67 (CQ resistant)

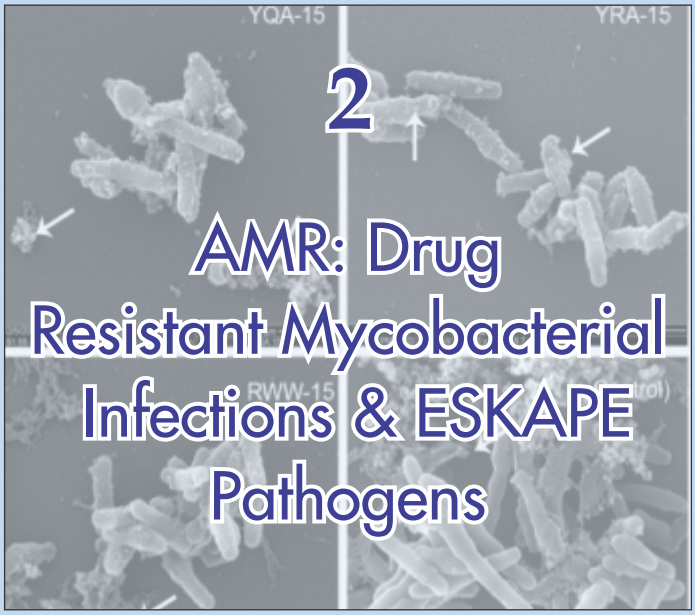
Four compounds, namely S018-0248 (aminopropanol class), S017-0383 (Nitropyridine class), S019-0065 and S019-0067 (pyrimidine based hetrocyclic class) were administered for 4 days, at 100 mg/kg in swiss mice infected with *P. yoelii* nigeriensis N67 infected. Out of these, only S018-0248 showed 38.34% parasite suppression on day 4 post treatment but was not curative on day 28. S018-0485 (furan derivatives), S018-0490 and S018-0489 (dihydronaphthalene derivatives) were dosed for 4 consecutive days, at 100 mg/kg which resulted in 18.87, 21.60 and 0%, respectively, parasite suppression on day 4. S018-0248 (aminopropanol class) was also tested at the same dose and showed 38.34% parasite suppression on day 4. S017-0383 (nitropyridine) was dosed for 4 consecutive days (100 mg/kg) and it did not show any parasite suppression on day 4.

1.5.5 Anti-leishmanial screening

Novel synthetic moieties representing several prototypes viz., quinoline-imidazole hybrids, pyrolo quinolinone, chalcones, stilbenes, phenyl allylindole, imidazo pyrolo quinolone derivatives, quinoline tetrahydropyrimidine etc. were synthesized and tested for their efficacy against experimental model of visceral leishmaniasis. Total sixty seven synthetic compounds were evaluated at 25 µM and 12.5 µM concentrations respectively against *in vitro* macrophage-amastigote model for lead identification. Compounds belonging to pyrimidine-based heterocyclic derivates (S-018-0699, S-018-0701) series showed significant anti-amastigote activity (>80% inhibition of amastigote multiplication and SI >5). Half-maximal inhibitory concentrations (IC50) of S-018-0699 and S-018-0701 were found to be 9.28 µM and 8.77 µM respectively against intracellular amastigotes. S-018-0699 and S-018-0701 will be further evaluated for their anti-leishmanial activity in L. donovani- golden hamster model.

153 Novel synthetic moieties representing several prototypes viz., Isoxazide, Triazol, Nitropyridine, Aminothiophenol, Aminopyridine, Naphthol Hetrocyclic, Isoxazole, Oxazoline, Benzofuran Nitropyridine, Oxazoline, Isoxazole, Isoxazide amide, Dihydroxy-hex-2-en-1-one, and 16 analogues of lead compound 96/261 were screened *in vitro* against promastigotes and amastigotes. Out of these 27 compounds exhibited IC50 < 10µM and SI index > 5.

Six compounds were evaluated for their *in vivo* efficacy in *L. donovani* / Hamster model at 50mg/Kg I.P or 100mg/Kg oral dose. Only one compound (analogue of 96/261) showed >70% anti-leishmanial efficacy in *L. donovani* golden hamster model at 100mg/Kg oral dose for 5 days.



Vision and Goal:

The World Health Organization(WHO) has defined Antimicrobial resistance (AMR) as the ability of a microorganism to stop an antimicrobial from working against it. As a result, standard treatments become ineffective, infections persist and may spread to others. It has further stated "AMR is of particular concern in developing nations, including India, where the burden of infectious disease is high and healthcare spending is low. The country has among the highest bacterial disease burden in the world. Antibiotics, therefore, have a critical role in limiting morbidity and mortality in the country." WHO in the 2017 report categorically states that tuberculosis and infections caused by ESKAPE (*Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa*, and Enterobacter species) pathogens fall in the highest critical priority category and have to be treated with utmost urgency.

The global objectives of CSIR-CDRI program:

i) Drug discovery studies against drug-resistant mycobacterial infections and ESKAPE pathogens

ii) Discovery of new therapeutic strategies/interventions/ diagnostic approaches by Advancing Knowledge Frontiers

Core Competencies and Activities:

The AMR team uses several cutting edge drug discovery platform technologies involving screening, molecular & structural biology, chemistry, computational biology and allied areas. The team has characterized several novel targets and has identified several new scaffolds through early target discovery and research that feeds into the drug discovery pipeline of the institute.

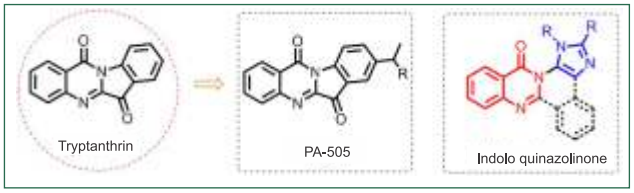
Area coordinators

2.1 New Drug Discovery

2.1.1 Design and synthesis

2.1.1.1 Natural product tryptanthrin derivatives as new antitubercular agents

Our research interest involves the design of novel molecules based on biologically active natural products. Since the natural product tryptanthrin and its derivatives were exemplified with potent *in vitro* activity against *Mycobacterium tuberculosis* (*Mtb*), we have designed new derivatives of tryptanthrin for the synthesis and biological evaluation. Currently, novel methods have been designed and optimization of conditions are under progress.

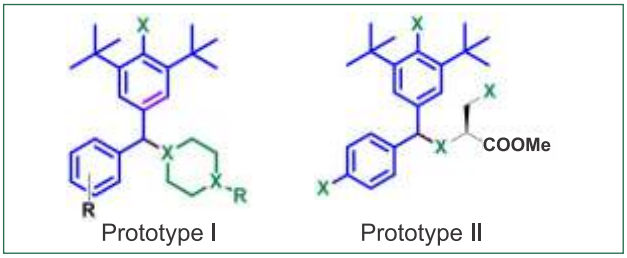


2.1.1.2 Synthesis of unnatural antimicrobial peptide hybrids

Chemically synthesized linear antimicrobial peptides are limited by their low biostability, high clearance, poor membrane permeability and solubility and the difficulty of being orally administered. To improve bioavailability of antimicrobial peptides, we proposed and synthesized various structurally modified peptides by incorporating D-amino acids, N-alkylation and fused heterocycles. Several compounds have been synthesized and are being evaluated.

2.1.1.3 Chemical diversity around diaryl methyl amines

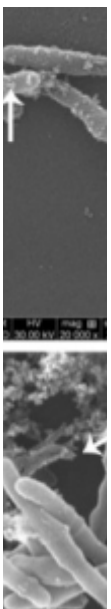
Several compounds of the family were synthesized and evaluated for anti-bacterial activity including against selected ESKAPE pathogens. Initially promising leads are being investigated further.



Front row (L to R) : Dr. Damodara Reddy N., Dr. Atul Kumar (Coordinator), Dr. Vinita Chaturvedi, Dr. Y. K. Manju, Dr. Mohammad Imran Siddiqi, Dr. Ravishankar Ramachandran (Coordinator)

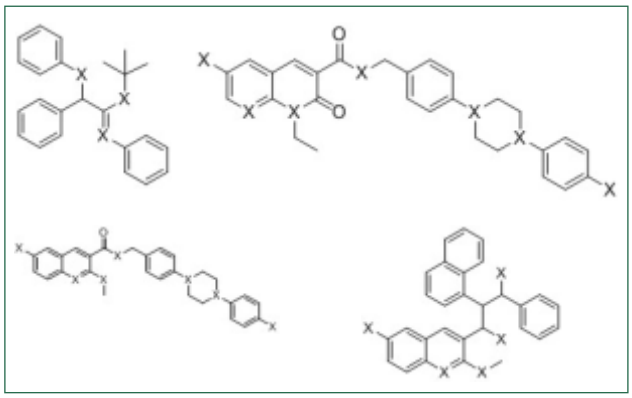
Middle row (L to R) : Dr. Sudheer Kumar Singh, Dr. Arunava Dasgupta, Dr. Tejender S. Thakur, Dr. B.N. Singh, Dr. Ashish Arora,

Back row (L to R) : Dr. Sidharth Chopra, Dr. Nayan Ghosh, Dr. Mukesh Pasupuleti & Dr. Malleswara Rao Kuram



2.1.1.4 Trisubstituted methanes, naphthyridines and quinoline containing compounds as antitubercular agents

The following compounds were designed and synthesized. Also 13 compounds were evaluated and their cytotoxicity is under evaluation.



2.1.1.5 Corannulene derived hydrogelators as possible Cationic Antimicrobial Peptides (CAPs)

The combination of promptly functionalized amine and carboxyl groups stick to a chiral central core along with one potentially diverse molecule having bowl shape and greater hydrophobicity provides a unique three-dimensional structure with high attention. Apart from amino acids, no other readily available building block contains two orthogonal functional groups that can be modified by convenient chemistry. In this endeavor we have for the first time designed and synthesized four novel kinds of corannulene containing unnatural amino acids and their peptides

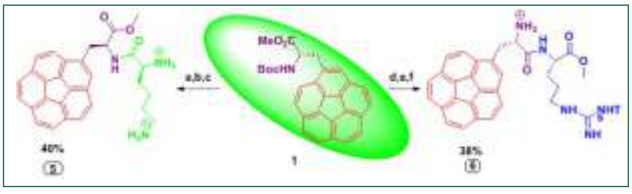
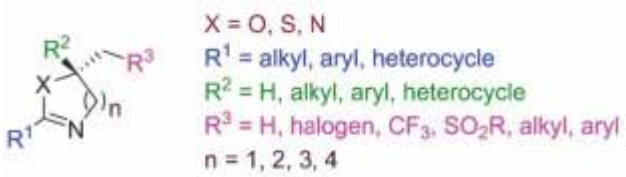


Fig 1. Scheme for preparation of corannulene amino acid containing peptide

2.1.1.6 Thiocyanated oxazoline and thiazoline derivatives

The synthetic routes for accessing thiocyanated oxazoline and thiazoline derivatives have been developed and proposed structures for further study are based on the schematics depicted below:



2.2 Biological screening

2.2.1 Assay summary of compounds screened against *Mycobacterium tuberculosis*

Compounds Received	Activity (µM)				
	> 50	50	25	12.5	6.25
265	226	35	03	01	00

Compounds with activity are being further optimized to improve efficacy.

2.2.2 Assay summary of compounds screened against ESKAPE pathogens

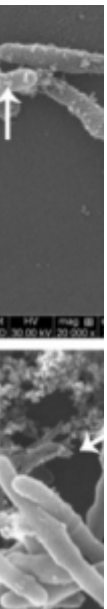
Compounds with activity are being further optimized to improve efficacy.

	Total received	Total screened	Pending	Hits in ESKAPE
CBRS	187	187	7	36
MOES	0	0	0	0
Maybridge	3 plates	3 plates	0	14

2.3 Advancing Knowledge Frontiers

2.3.1 *Mycobacterium bovis sigF* mutant exhibits altered surface phenotype and compromised pathogenesis

Sigma factor F (SigF) is an alternate sigma factor, widely conserved in pathogenic and non-pathogenic mycobacteria, suggesting its larger role in addition to regulation of virulence genes. We generated a Δ*sigF* mutant in *M. bovis* which displayed distinct colony morphotype suggestive of deficiency in surface properties (Fig 2A and 2B). The loss in phenotype was restored in the complemented Δ*sigF*



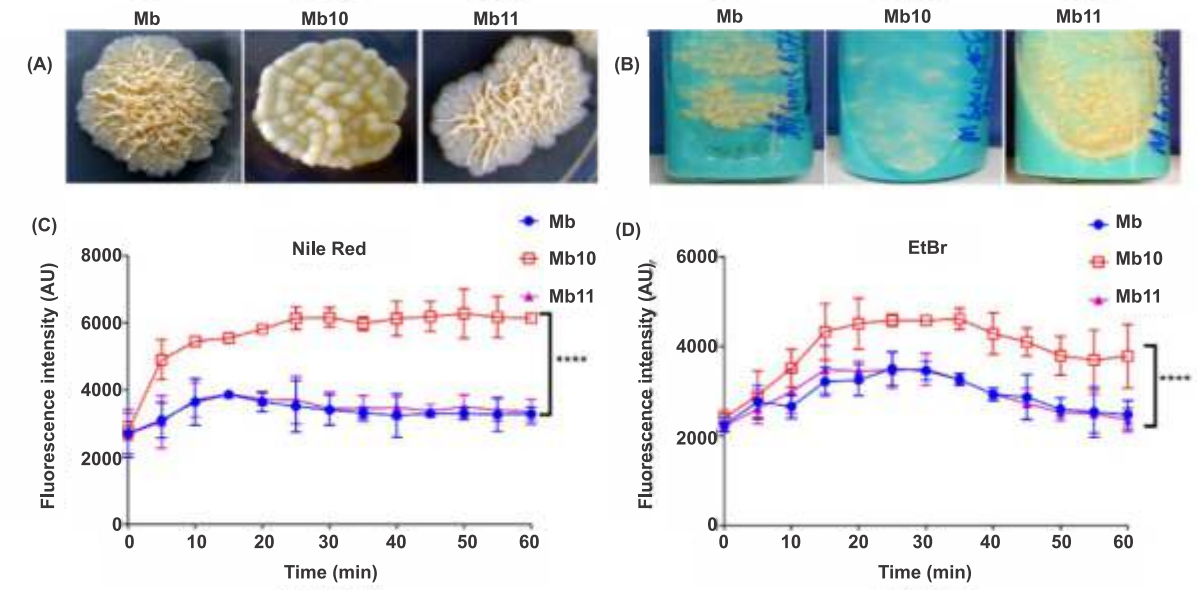


Fig. 2. Colony morphotypes of *M. bovis* wild-type (Mb), Δ*sigF* mutant (Mb10) and complemented strain (Mb11). (A) The Δ*sigF* mutant colonies appear smooth. (B) Appearance of *M. bovis* strains on LJ slants. Accumulation of Nile red 2 µM (C) and EtBr 6 µM (D) by *M. bovis* wild-type (Mb), Δ*sigF* mutant (Mb10) and complemented strain (Mb11) were measured by fluorescence spectroscopy. The data are mean ± SD from three independent experiments (**** p <0.0001).

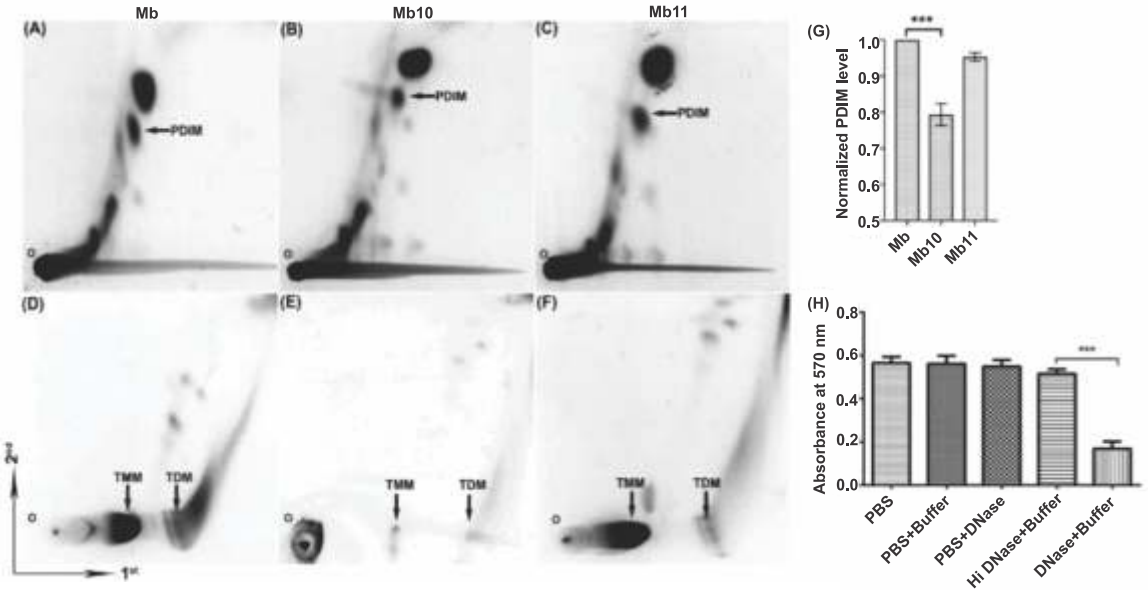
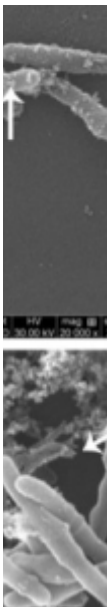


Fig. 3. 2D-TLC analysis. Nonpolar lipids from *M. bovis* wild-type (A), Δ*sigF* mutant (B) and complemented strain (C). Polar lipids from *M. bovis* wild-type (D), Δ*sigF* mutant (E) and complemented strain (F). The arrows indicate the differential lipids content. PDIM, TMM and TDM refer to Phthiocerol dimycocerosate, Trehalose monomycolate and Trehalose dimycolate, respectively. **(G)** Shows the quantitation of the PDIM levels in different strains using image analysis software (GE Healthcare). The data were normalized to those for the wild-type strain and represent mean ± SD of three independent experiments (*** p <0.001). (H) DNase treatment of *M. bovis* biofilms. *M. bovis* wild-type biofilms were incubated with PBS, PBS and buffer (reaction buffer), PBS + DNase, heat inactivated (HI) DNase and buffer + DNase. Biofilms were quantified via crystal violet staining. Data represent mean ± SD of three independent experiments (*** p <0.001).



mutant (Fig 2A and 2B). The Δ*sigF* mutant showed marked depletion in key cord forming lipids, trehalose 6-6'-dimycolate, trehalose 6-monomycolate and phthiocerol dimycocerosate (Fig 3B and 3E). Comparative proteomics revealed diminished level of several proteins predicted to have roles in cell surface properties, stress response and virulence associated functions. Proteome analysis of *M. bovis* biofilms highlighted the role of SigF regulated proteins in biofilm formation as several of them appeared at lower levels in the Δ*sigF* mutant. One of them was a key metabolic enzyme, malate synthase G (Mb1868c). Consistent with its pleiotropic role, the diminished level of Mb1868c in the Δ*sigF* mutant resulted in reduced adherence of the mutant bacilli to lung epithelial cells. In summary, we report novel morphotypes of the *M. bovis* Δ*sigF* mutant and provide rationale for their *in vitro* and *in vivo* phenotypes, which improve our understanding of the role of SigF in mycobacterial biology.

2.3.2 Identification of fragment inhibitors of *Mycobacterium tuberculosis* NAD$^+$-dependent DNA Ligase A that target 'serial-remodeling'

The NAD$^+$-dependent DNA ligase (LigA) is a multi-domain, essential, bacterial enzyme that functions as the principal replicative ligase. Differences between the human ATP-dependent DNA Ligase-I (Lig1) and LigA makes the latter an attractive antibacterial target. We solved co-crystal structures with NMN, AMP and inhibitors identified from fragment-screening. Inhibitors reported previously mainly compete with AMP and bind to the 1B sub-domain of the adenylation domain. We recently screened a fragment library against the NMN-binding pocket and identified 2 fragments that inhibit LigA activity with IC_{50} in the low μM range. Experiments involving *E. coli* GR501 strain that harbors its own temperature-sensitive LigA, rescued with *Mtb* LigA, show that the fragments inhibit bacterial growth by targeting *Mtb* LigA *in vivo*. Additionally, the experiments showed that the inhibitors can distinguish between NAD$^+$- and ATP-dependent ligases. The NMN binding pocket on subdomain 1A has been shown to be a druggable target site for developing anti-LigA therapeutic strategies.

2.3.3 Development of novel antimycobacterial peptides using database filtering and three-dimensional modeling approach

The cell wall of *Mycobacterium tuberculosis* (*Mtb*) provides a major defensive mechanism from antibiotics, phagocytic vesicles in macrophages and desiccation in dry sputum. Host defense peptides (HDPs), our "natural antibiotics", are major component of innate immunity and are evolutionary conserved, host defense molecules, having a direct action on microbial membranes with a low risk of resistance development. The peptides which have potential to assume helical structure in liquid cultures do have antimicrobial activity. Also, the moderately short cationic and hydrophobic peptides derived from the conserved domains of various proteins have antimicrobial activity under physiological conditions without any toxicity issues. However, the composition of the mycobacterial membrane differs significantly from that of bacteria, and it cannot be concluded that all AMPs, which have been identified as pore/ lesion-forming HDPs against bacteria, also induce lesions in mycobacteria. We predicted that the helical domains of Glutathione s-transferase, (GST)-theta might have antimycobacterial activity or could give us templates for further optimization. So in this work, we designed potent HDPs than those found in nature, to construct a random *in silico* peptide library. Then by using “database filtering” and three-dimensional (3D) modeling approach peptide sequences were selected for the synthesis, followed by *in vitro* analysis. We explored peptides derived from the GST for antimycobacterial activity. The candidate peptides, shown in wheel diagram representations (Fig 4), were

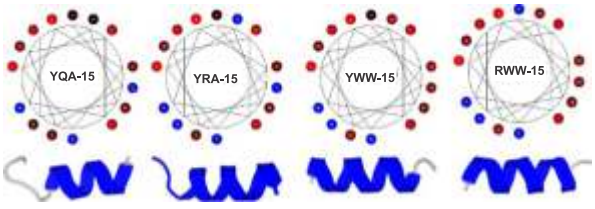
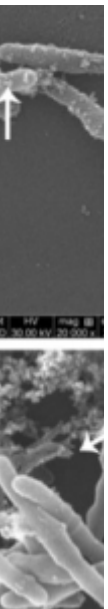


Fig. 4: Helical wheel projection (upper) and 3D model (lower) of the hit molecules.



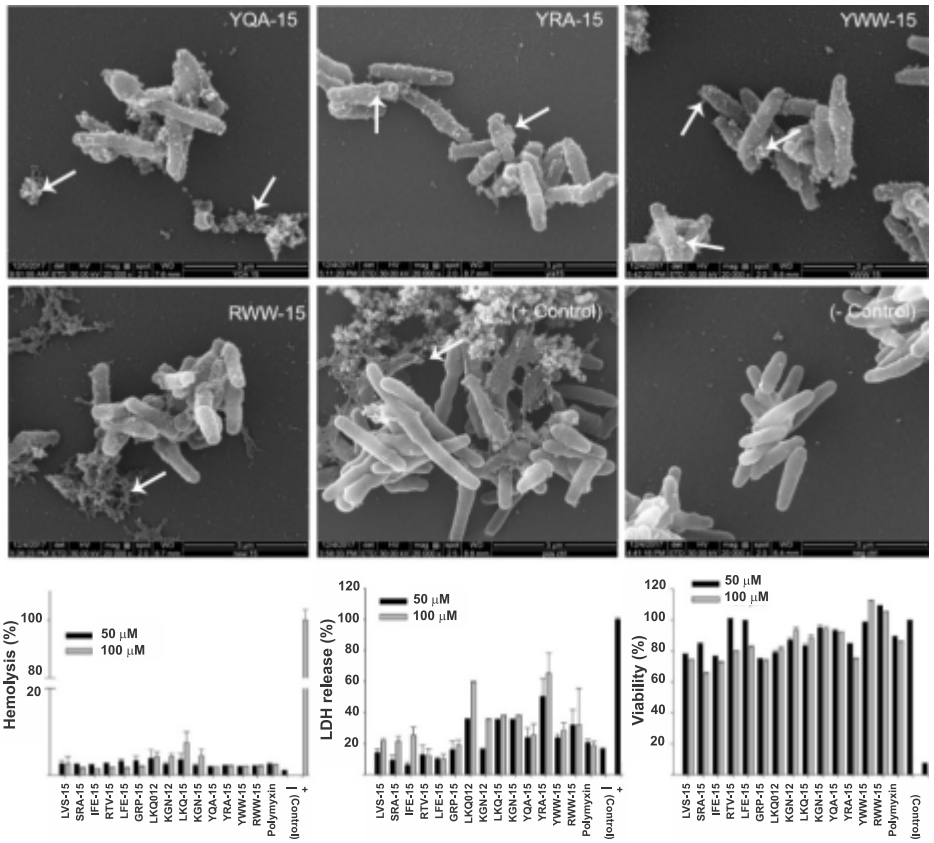


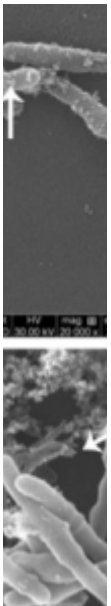
Fig. 5. Scanning electron microscopy images showing the mode of action of the peptides (upper) and cytotoxicity profile (lower) of hit molecules.

developed. The helical wheel diagrams demonstrate the amphipathic nature of peptides and in order to see the effect of peptides on membranes, we did a scanning electron microscopy study with peptides at 2X MIC concentrations (Fig. 5).

The results show that all the tested peptides induced cytoplasmic condensation and cell wall modification (thinning and budding) (YRA-15 and YWW-15) or destruction (RWW-15 and YQA-15). The cytotoxicity studies indicated that the peptides were not toxic to the human cells. In the optimized series, peptide with higher charge but lower hydrophobicity, showed signs of toxicity at the lowest concentration (50 μM), whereas the peptides with lower charge and higher hydrophobicity showed lower toxicity (Fig 5). Among all the peptides four peptides showed significant gain in the activity. This study indicates that peptide to be active against *Mycobacterium tuberculosis* H37Ra should have a charge of +4 and hydrophobicity > 60% and less than 70%.

2.3.4 Nef regulates protein trafficking in HIV Pathogenesis

HIV-1 Nef regulates several cellular functions in an infected cell. The molecular mechanism(s) underlying Nef-dependent cellular function(s) are unable to define how the events are coordinately regulated in the host cell. In this study, our laboratory deciphered the role of Nef on Rab GTPases - dependent complex vesicular trafficking. Expression profiling of Rabs in Nef-expressing cells showed that Nef differentially regulates the expression of individual Rabs in a cell-specific manner. Further analysis of Rabs in HIV-1_{NL4-3} or ΔNef infected cells demonstrated that Nef protein was responsible for variation in Rabs expression. Using a panel of competitive peptide inhibitors against Nef, we identified the critical domain of HIV-1 Nef involved in modulation of Rabs



expression. The molecular function of Nef-mediated up-regulation of Rab5 and Rab7 and down-regulation of Rab11 increased the transport of SERINC5 from the cell surface to lysosomal compartment. Moreover, Nef-dependent increase in Rab27 expression assists its own release via exosomes. Reversal of Rabs expression using competitive inhibitors against Nef reduced viral release and infectivity of progeny virions. Overall, this study uncovers a new paradigm that Nef differentially regulate the expression of Rabs protein in infected cells to hijack the host intracellular trafficking, which augments viral replication and HIV-1 pathogenesis.

2.3.5 A long-term lipid only diet can convert *Mycobacterium tuberculosis* to hard-to-grow persisters

The differentially detectable (DD) persisters, of *Mycobacterium tuberculosis* (*Mtb*), are persisters that fail to form colonies on agar media when de-stressed. Since in the host, *Mtb* primarily survives by utilizing lipids, we used a long-term lipid diet model to induce DD persisters of *Mtb*. Persisters were induced by replacing the dextrose-containing medium with one containing fatty acids (FAM). After 2, 4 or 6 weeks, CFU and most probable number assays were performed; the difference between the two gave an estimate of DD persisters (Fig. 6). Since rifampicin has been shown to induce formation of DD persisters *in vitro*, one set of FAM cultures were also given short- term rifampicin stress after 2, 4 or 6 weeks.

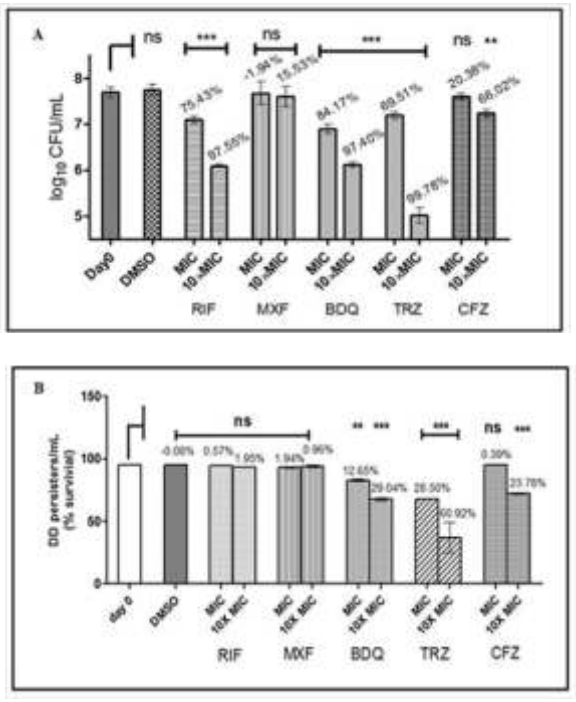
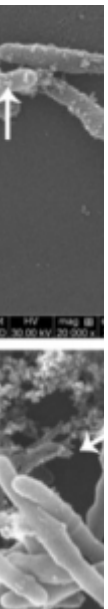
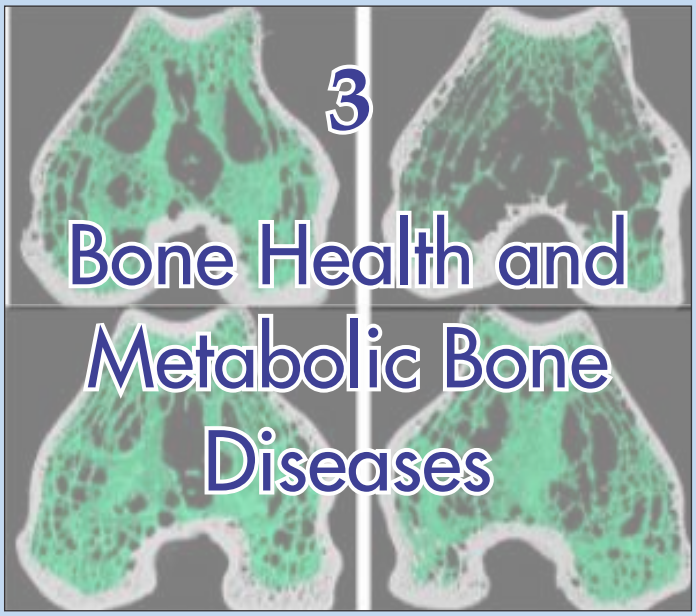


Fig. 6. The fraction of DD persisters increased with time and rifampicin treatment enhanced the effect of fatty acids, at 2 and 4 weeks. At six weeks, even in the absence of rifampicin, approximately 95 % cells were DD persisters. The DD persisters (Fig. panel B) were found to be more drug tolerant than the colony forming persisters (Fig. panel A) under the similar culture conditions. The DD persisters were vulnerable to drugs interfering with bacterial respiration such as thioridazine (TRZ), bedaquiline and clofazimine (Figure), but were tolerant to rifampicin and moxifloxacin. The study indicates potential formation of DD persisters of *Mtb* in a lipid-rich microenvironment in the host even before antibiotic therapy.





Vision and Goal:

- Development of novel agents for fracture healing and management of osteoporosis through modern drug design, scientific validation of traditional remedies and generation of new knowledge.

Core Competencies and Activities:

- Design, synthesis and bioevaluation of novel molecules/isolates from natural sources for new lead generation and/or development of agents for the management of osteoporosis, and bone related disorders
- Scientific validation of traditional remedies
- Therapeutic repurposing
- Molecular mechanism of action of promising agents;
- Advancing in knowledge frontiers

3.1 New Drug discovery & development, and therapeutic repurposing

3.2 Advancing Knowledge Frontiers

Area coordinators

3.1 Progress in New drug discovery and development

The screening program is actively carrying out osteogenic, anti-resorptive and dual action screenings of synthetic and phytochemicals and standardized extract from Indian medicinal plants. Current status of major developments out of this effort is summarized below:

3.1.1 Compound S011-341

Compound S011-341 and its diastereomers S-016-969 and S-016-970 were found to have osteoprotective effects. Further, two enantiomers from each of the diastereomers have been isolated. Further studies are in progress.

3.1.2 Compound S016-1436

Compound S016-1436 has been evaluated for bone forming activity in female osteopenic Sprague Dawley rat model and compound exhibits osteoprotective effect at dose of 5mg/kg body weight. Further studies in combination with PTH are in progress.

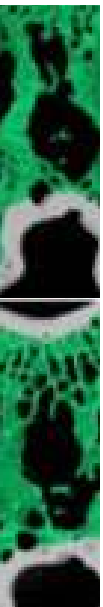
3.1.3 S007-1500: Fracture healing agent

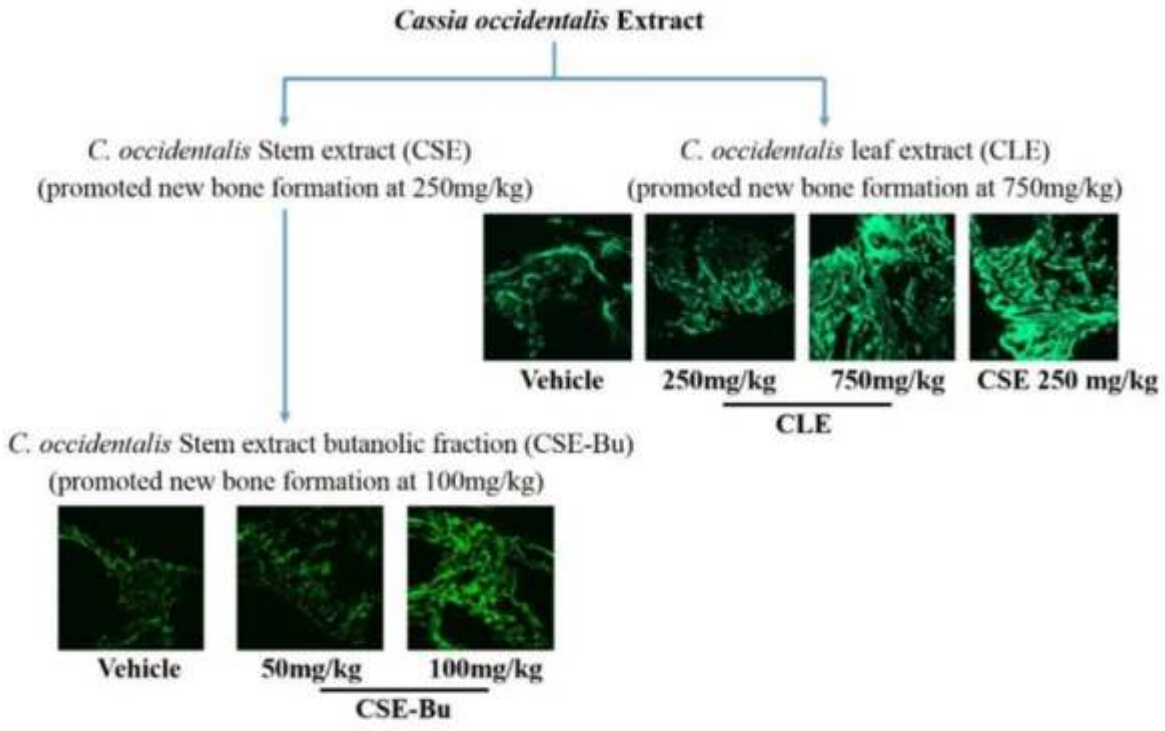
GPCR liability studies for S007-1500 were carried out at CEREP Eurofins, France. Compound had no GPCR liability. 30-DAY repeat dose oral toxicity and toxicokinetic study in Beagle dogs with 14-day recovery period have been completed and compound is safe. Future plans include submission of IND application dossier.

3.1.4 Development of a standardized extract from stem of *Cassia occidentalis* L. for mitigating glucocorticoid-induced bone loss

Cassia occidentalis L. (belongs to *Caesalpiniaceae* family) is an annual plant. Pursuing a lead from a folk practice prevalent since the late nineteenth century in Andhra Pradesh, we have not only confirmed its fracture healing activity but also demonstrated efficacy in preventing glucocorticoid-induced osteoporosis (GIO), the commonest form of medication-induced bone loss caused chiefly due to impairment of bone formation.

(L to R) : Dr. Durga Prasad Mishra, Dr. Atul Kumar, Dr. T. Narender, Dr. Sabyasachi Sanyal, Dr. Prabhat Ranjan Mishra, Dr. Divya Singh, Dr. Wahajuddin, Dr. Ritu Trivedi, Dr. Naibedya Chattopadhyay (Coordinator), Dr. Rabi Sankar Bhatta, Dr. Prem Prakash Yadav, Dr. K.V. Sashidhara, Dr. Arun Kumar Trivedi & Dr. Atul Goel (Coordinator).





- CSE at 250mg/kg and CSE-Bu at 100mg/Kg prevent glucocorticoid-induced osteopenia

Parameter	Vehicle (control)	MP	MP+ CSE (250mg/kg)	MP+ CSE-Bu (100mg/kg)
Femur metaphysis (μCT)				
BMD (gm-HA/cm^3)	0.383±0.016	0.281±0.015***	0.347±0.012	0.342±0.014
BV/TV (%)	25.04±1.32	18.33±0.96***	21.66±0.86*,a	21.84±0.77*,a

*P < 0.05, **P <0.01 and ***P <0.001 versus vehicle. and aP< 0.05 versus MP

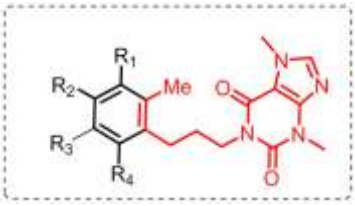
Our study found that standardized extract of an ethanolic extract and its butanolic fraction from the stem of *Cassia occidentalis* has bone anabolic as well as anti-catabolic effects on skeleton, resulting in the protection against glucocorticoid-induced bone loss. As many as six osteogenic compounds were isolated out of which apigenin-6*C*-glucopyranoside was most effective *in vitro*. Our results contribute towards validation of the traditional use of *Cassia occidentalis* in fracture healing and also suggest its beneficial use in GIO. (***J Ethnopharmacol* PMID: 30703497**)

Presently, the standardized extract of the *Cassia occidentalis* stem is undergoing IND-enabling studies for filing phase I clinical trial approval to DCG(I) under the recently launched Phyto-pharmaceutical mode. To this effect all regulatory studies in rats have been submitted and IND compilation is in process.

3.1.5 Synthesis of Pentoxifylline derivatives for postmenopausal osteoporosis

Pentoxifylline (PTX),a derivative of theobromine, a methylated xanthine has been investigated from last three decades because of its primary pharmacological actions on hemorheology and other anti-inflammatory effects. It was approved in 1984 for the prevention of intermittent claudication in chronic occlusive arterial disease. It has salutary

effects in segmental bone defect and fracture healing, as well as stimulation of bone formation (Pal et al. Bone 123 (2019) 28–38). Therefore, in view of the potential fracture healing and osteogenic properties of PTX, derivatives of pentoxifylline were designed and synthesized by treating pentoxifylline with different derivatives of 2H-pyran-2-ones to afford functionalized benzene-cored pentoxifyllines in good yields.



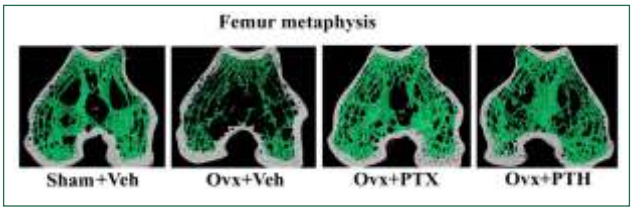
3.1.6 Synthesis of Fluorescent Medicarpin derivatives for deciphering anti-osteoporosis activity

Fluorescent probes have been highly attractive and versatile analytical and imaging tools because of their inherent unique characteristics. Researchers are now routinely tagging the non-fluorescent molecules of interest with a fluorescent moiety for visualization. It can be used to identify the mechanism of action, localization, target identification, and quantification of molecules in living cells and organisms. Medicarpin was found to be active for the treatment of osteoporosis. Now in order to identify its target and mechanism of action, fluorescent derivatives of Medicarpin have been designed and synthesized by tagging fluorescein/phenothiazine moiety as a fluorophore.

3.1.7 Therapeutic repurposing

3.1.7.1 Pentoxifylline restores bone mass and quality in osteopenic rabbits by an osteogenic mechanism: A comparative study with human parathyroid hormone

The non-selective phosphodiesterase inhibitor, pentoxifylline (PTX) belongs to methylxanthine class and is used for the treatment of intermittent claudication due to artery occlusion. Previous studies reported salutary effect of PTX in segmental bone defect and fracture healing in rats and stimulation of bone formation in mice. We studied the effect of orally dosed PTX in skeletally mature OVX rabbits with established osteopenia. EC_{50} of PTX in rabbit bone marrow stromal cells was 3.07±1.37nM. Plasma PTX level was 2.05±0.522nM after a single oral dosing of 12.5 mg/kg, which was 1/6th adult human dose of PTX. After daily oral dosing for four months at 12.5 mg/kg to osteopenic rabbits, PTX restored BMD, bone mineral content (BMC), micro-architecture and bone strength to the level of sham operated (ovary intact) group. These effects were observed at both axial and appendicular bones. Furthermore, similar to PTH, PTX had no effect on bone resorption. Taken together, PTX completely restored bone mass, bone strength and bone biomaterial properties by an anabolic mechanism, and hold the potential for becoming the first oral osteogenic drug for the treatment of post-menopausal osteoporosis. (***Bone***: **PMID: 30858147**).



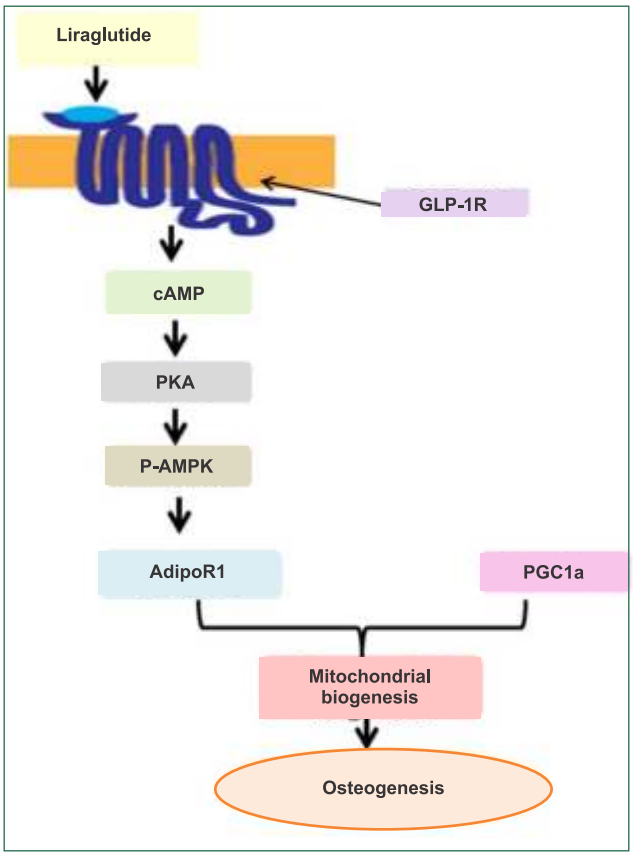
3.1.7.2 Daflon has osteogenic and anti-resorptive effects and enhances the skeletal effect of teriparatide: evidence of estrogen receptor in mediating skeletal effects of the drug

Flavanone glycoside containing drug, daflon^{R} (diosmin/hesperidin, 9:1 combination) is in clinical use for the treatment of chronic venous insufficiency for many years. Here, we showed that at the human equivalent dose daflon promoted bone regeneration at the osteotomy site and peak bone accrual in rat models. Daflon restored trabecular bones and strength with attendant increases in surface referent bone formation parameters and serum osteogenic marker in osteopenic OVX rats. Daflon also suppressed bone resorption in OVX rats and OVX rats treated with teriparatide [human parathyroid hormone (PTH 1-34), TDPD] without inhibiting the osteoanabolic effect of TDPD. Moreover, the combination of daflon and TDPD

showed greater skeletal effect than the monotherapies. PK studies revealed that oral administration of daflon resulted in the formation of diosmetin, the aglycone form of diosmin. Subsequent studies showed that diosmetin specifically activated estrogen receptor- (ER) resulting in the stimulation of osteoblast differentiation and suppressed the anti-osteoblastogenic factor, sclerostin. Our findings of osteoanabolic effect of daflon accompanied by its ability to enhance the skeletal effect of TDPD could lead to a new class for anti-osteoporosis therapy through therapeutic repurposing (***Biomed Pharmacother*** **PMID: 31306971)**

3.1.7.3 The osteogenic effect of liraglutide involves enhanced mitochondrial biogenesis in osteoblasts

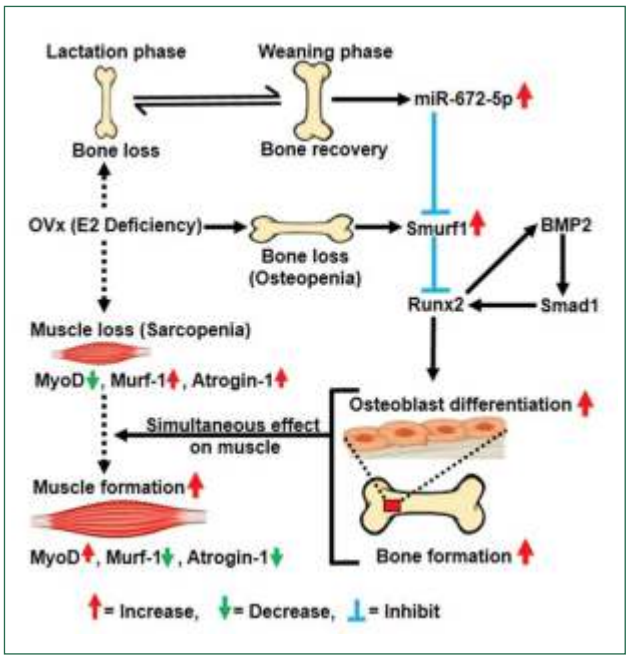
Liraglutide (Lira), a long-acting glucagon-like peptide 1 receptor (GLP-1R) agonist reduces glycosylated hemoglobin in type 2 diabetes mellitus patients. Here, we investigated the osteoanabolic effect of Lira and studied the underlying mechanism. In established osteopenic OVX rats, Lira completely restored bone mass and strength comparable to parathyroid hormone (PTH). The serum levels of osteogenic surrogate pro-collagen type 1 N-terminal pro-peptide (P1NP) and surface referent bone formation parameters were comparable between Lira and PTH. GLP-1R, adiponectin receptor 1 (AdipoR1) and peroxisome proliferator-activated receptor gamma coactivator 1-alpha (PGC1) levels in bones were downregulated in the OVX group but restored in the Lira group whereas PTH had no effect. In cultured osteoblasts, Lira time-dependently increased GLP-1R, AdipoR1 and PGC-1. In osteoblasts, Lira rapidly phosphorylated AMP-dependent protein kinase (AMPK), the cellular energy sensor. Exendin 3, a selective GLP-1R antagonist and PKA inhibitor H89 blocked Lira-induced increases in osteoblast differentiation, and expression levels of AdipoR1 and PGC-1. Lira increased mitochondrial number, respiratory proteins and respiration in osteoblasts *in vitro* and *in vivo*, and blocking mitochondrial respiration mitigated Lira-induced osteoblast differentiation. Taken together, our data show that Lira has a strong osteoanabolic effect which involves upregulation of mitochondrial function.(***Biochem Pharmacol*** **PMID: 30885766**)



3.2 Progress on advancing in knowledge frontiers

3.2.1 MicroRNA-672-5p identified during weaning reverses osteopenia and sarcopenia in ovariectomized mice

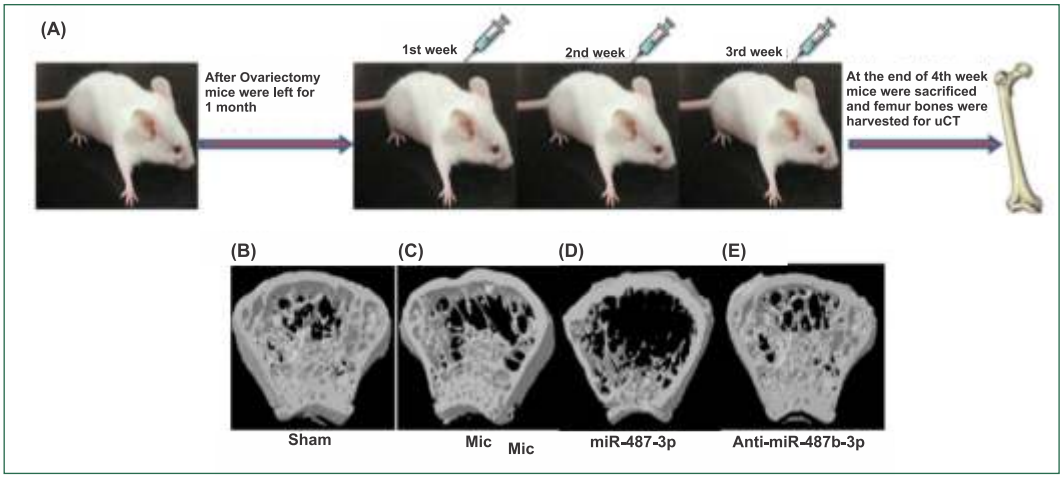
Post-menopausal condition augments the biological aging process, characterized by multiple metabolic disorders in which bone loss is the most prevalent outcome and usually coupled with sarcopenia. Coexistence of such associated pathogenesis have much worse health outcomes, compared to individuals with osteoporosis only. Pre- and post-natal bone development demands calcium from mother to fetus during pregnancy and lactation leading to a significant maternal skeletal loss. It follows



an anabolic phase around weaning during which there is a notable recovery of the maternal skeleton. Here, we have studied the therapeutic effect of microRNA-672-5p identified during weaning when it is predominantly expressed, in ovariectomized mice for both osteopenia and sarcopenia. miR-672-5p induced osteoblast differentiation and mineralization. These actions were mediated through inhibition of Smurf1 with enhanced Runx2 transcriptional activation. *In vivo*, miR-672-5p significantly increased osteoblastogenesis and mineralization, thus reversing bone loss caused by ovariectomy. It also improved bone-mineral density, load-bearing capacity, and bone quality. Sarcopenia was also alleviated by miR-672-5p, as we observed increased cross-sectional area and Feret's diameter of muscle fibers. We hypothesize that elevated miR-672-5p expression has therapeutic efficacy in estrogen-deficiency-induced osteopenia along with sarcopenia. (***MolTher Nucleic Acids*** **PMID: 30769134)**

3.2.2 MiR-487b-3p impairs osteoblastogenesis by targeting Notch-regulated ankyrin-repeat protein

The study reports the role of miR-487b-3p in regulation of osteoblast functions. Over-expression of miR-487b-3p leads to inhibition of osteoblastic differentiation. Using in silico approaches, Nrarp was found to be the direct target of miR-487b-3p which was further validated by luciferase 3′ UTR reporter assay. Nrarp inhibits Notch-1 signaling and promotes Wnt signaling by stabilization of LEF-1. Protein levels of Nrarp, RUNX-2, Lef1 and β catenin were reduced in osteoblasts cells transfected with miR-487b-3p whereas protein levels of Notch1, Hes1 and P- β catenin were up regulated when osteoblast cells were transfected with miR-487b-3p. These outcomes were reversed after treating cells with anti-miR-487b-3p. Further silencing of miR-487b-3p in neonatal and Ovx Balb/c mice attenuated all the inhibitory actions of miR-487b-3p on osteoblast differentiation. Overall, miR-487b-3p negatively regulates osteogenesis by suppressing Nrarp expression, which in turn,



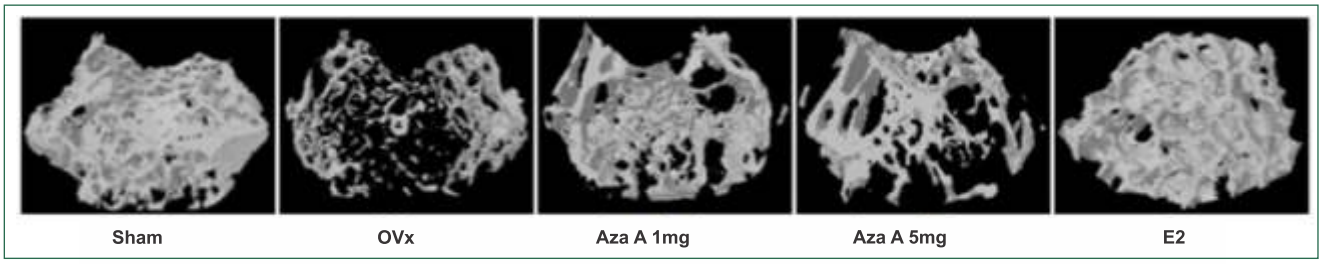
suppresses Runx-2 and Wntsignalling, both of which play a pivotal action in osteoblast differentiation. (***J Endocrinol*. 2019;241(3):249-263.**).

3.2.3 Increased bone marrow-specific adipogenesis by clofazimine causes impaired fracture healing, osteopenia and osteonecrosis without extra-skeletal effects in rats

Mycobacterium leprae infection causes bone lesions and osteoporosis, however, the effect of anti-leprosy drugs on the bone is unknown. We, therefore, set out to address it by investigating osteogenic differentiation from bone marrow derived mesenchyme stem cells. Out of seven anti-leprosy drugs, only clofazimine (CFZ) reduced MSCs viability (IC_{50} ~1M) and their osteogenic differentiation but increased adipogenic differentiation on a par with rosiglitazone, and this effect was blocked by a peroxisome proliferator-activated receptor gamma(PPARγ) antagonist, GW9662. CFZ also decreased osteoblast viability and resulted in impaired bone regeneration in a rat femur osteotomy model at 1/3rd human drug dose owing to increased callus adipogenesis as GW9662 prevented this effect. In adult rats, CFZ caused osteopenia in long bones marked by suppressed osteoblast function due to enhanced adipogenesis and increased osteoclast functions. A robust increase in marrow adipose tissue (MAT) by CFZ did not alter hematologic parameters but likely reduced BM vascular bed leading to osteonecrosis (ON) characterized by empty osteocyte lacunae. From these data, we conclude that CFZ has skeletal toxicity and could be used for creating a rodent ON model devoid of extra-skeletal effects. (***ToxicolSci PMID: 31393584***)

3.2.4 Estrogen receptor activation in response to Azadirachtin A stimulates osteoblast differentiation and bone formation in mice

In this study, it was seen that a natural pure compound Azadirachtin A (Aza A) isolated from *Azadirachta indica* binds selectively to a site in the estrogen receptor, identifying itself to be a selective tissue modifier. Using computational and medicinal chemistry, Aza A was shown to bind electively to estrogen receptor□α (ERα) as compared with ERβ. This preferential binding of Aza A to ERα with good pharmacokinetic distribution in the body forms metabolites, showing that it is well absorbed. In in vivo estrogen deficiency models for osteoporosis, Aza A at a much lower dose enhances new bone formation at both sites of the trabecular and cortical bone with increased bone strength and presents with no hyperplastic effect in the uterus. (***J Cell Physiol*PMID:31225646**)



Vision and Goal:

- Development of novel therapeutic agents for CVS, CNS and related disorders, cancer, fertility regulation (male/female) and management of endocrine disorders through modern drug design, scientific validation of traditional remedies.
- Basic research to delineate the molecular mechanisms of these pathologies / abnormalities so as to identify suitable targets for drug discovery, as well as to analyze the possible mechanism(s) of action of the candidate drugs.
- Creation of appropriate platform for interdisciplinary collaborative research;

Core Competencies and Activities:

- Development of experimental models of hypertension, dyslipidemia, thrombosis, myocardial ischemia and athero-thrombosis, to identify hypolipidemic, anti-thrombotic and anti-ischemic drugs and identification of the mechanism of action of test substances;
- Design, synthesis and bio-evaluation of novel molecules/isolates from natural sources for new lead generation for:
  - atherosclerosis, dyslipidemia, obesity, hypertension mycordial infarction, major depression, cognitive impairments and aging.
  - Female and male contraceptives,
  - Breast, cervical, oral, prostate and blood cancers
- Scientific validation of traditional remedies for CVS, CNS, cancer and reproductive health disorders;
- Molecular mechanism of action of promising agents;
- New knowledge generation in the area of neurobiology, cardio vascular biology, reproductive endocrinology, fertility regulation, endocrine disorders and Cancer.

Area coordinators

4.1 Cardiovascular Biology

4.1.1 Summary of drug discovery and development activities

During the reporting period several compounds were synthesised and evaluated for cardiovascular activities in cell culture and in animal models. Around 87, 73, 80, 80, 216 compounds were submitted for Anti-Inflammatory, Anti-hyperlipidemic, Anti-Angiogenic, Anti-NAFLD and Anti-adipogenesis activities, respectively. 12, 8 and 2 interesting hits were obtained in the anti-hyperlipidemia, anti-angiogenic and anti-adipogenic screens respectively which are being further validated in the respective laboratories. Furthermore, about 600 NCEs and natural products were submitted for GPCR profiling during last one year and several preliminary hits were identified that are being consolidated. Besides these, several standardized extracts like CDR267F018 were evaluated for cardiovascular activities under CSIR's Phytomission.

4.1.2 New initiatives in the areas of CVS disorders

Several new dimensions were added to the area of cardiovascular research with the joining of new faculty in the Pharmacology department. A new area for the identification of novel theranostic targets in heart diseases was initiated. Cardiovascular diseases are the leading cause of mortality in India as well as globally. According to the recent data from Global Burden of Diseases, in India, cardiovascular diseases contributed to more than twenty-six percent of deaths in 2017. Heart failure characterized by inability of the heart to pump enough blood to the body, is the end-result of various pathological events collectively termed as cardiac remodelling. Morphologically, cardiac remodelling involves cardiomyocyte hypertrophy/atrophy, apoptosis, deregulated autophagy and interstitial fibrosis. Therefore, it is hypothesized that better understanding of cardiac remodelling process will help in identification of novel theranostic target, which might reduce cardiovascular disease burden. New studies are initiated on the exploration of novel RNA-binding proteins and circular RNAs as theranostic target. Researchers aim to utilize viral gene therapy approach like adeno-associated virus to inhibit and increase the expression of these genes in diseased heart.

(L to R) : Dr. Ajay Kumar Srivastava, Dr. Baisakhi Mohrana, Dr. A.K. Tamrakar, Dr. Shashi Kumar Gupta, Dr. Sachin Kumar, Dr. Kashif Hanif, Dr. Manoj K. Barthwal (Coordinator), Dr. T. Narender, Dr. K.V. Sashidhara, Dr. Kumaravelu Jagavelu, Dr. Amit Lahiri, Dr. Rabi Sankar Bhatta, Dr. Shrikant R. Mulay, Dr. Anil Gaikwad

4.1.1 Advancing Knowledge frontiers

4.1.1.1 Augmentation of iNOS expression in myeloid progenitor cells expedites neutrophil differentiation

Neutrophils play an important role in immunity and inflammation through diverse mechanisms. Herein, studied the role of NO generated from iNOS in the neutrophil differentiation by using iNOS-overexpressing K562 cells (K562iNOS) and iNOS-deficient murine progenitor cells (lineage negative cells; lin-ve). It was observed that iNOS overexpression led to increased neutrophilic differentiation in K562 cells; more specifically an early and accelerated neutrophilic differentiation was spotted in K562iNOS. These observations were further validated using iNOS knockout lin-ve cells or hematopoietic progenitor cells that exhibited delayed neutrophil differentiation in comparison to its wild-type counterpart. In addition, a significant increase in the gene expression of iNOS during neutrophilic differentiation of CD34+ hematopoietic stem and progenitor cells derived from human bone marrow further substantiates importance of iNOS in neutrophil differentiation. Moreover, a significant increase in NO generation during neutrophil differentiation was observed and enhanced neutrophil differentiation with NO donor was also observed, implying the importance of NO in neutrophil differentiation. Collectively, using alternative approaches, it is demonstrated that neutrophil differentiation is significantly influenced by iNOS or NO, suggesting the possibility of exploiting this novel link for therapeutic aspects of NO generated from iNOS and neutrophil differentiation in hematopoiesis-related disorders. ***(J Leukoc Biol. 2019; 106(2): 397-412)***.

4.1.1.2 Role of P47^{phox} in Angiotensin II induced cardiac hypertrophy and fibrosis in mice

Herein, investigated the role of phagocytic NADPH oxidase enzyme system in cardiac remodelling induced by AngII in young adult (2-3 months old) male mice deficient in p47^{phox}, a cytosolic subunit of the NADPH oxidase (KO, n=13) and age-matched wild-type littermates (WT, n=9). AngII treatment in WT and KO mice showed prominent alterations in echocardiographic measurements with no changes in E/A, EF and FS. However, KO mice showed aggravated cardiac hypertrophic response Histologically, AngII infused KO mice also showed increased cardiomyocyte diameter compared to AngII infused WT mice. Further, AngII infused KO mice showed elevated immune cell infiltration, which were positive for Mac-3 staining compared to AngII infused WT mice. Besides, AngII infused KO mice showed augmented interstitial fibrosis, thick collagen fibres deposition compared to AngII infused WT mice. Moreover, AngII infused KO mice also showed upregulated gene expression of hypertrophic and fibrotic markers, including Nppa, Nppb, Acta1, Myh6, TGF-β1, collagen (I and III) and α-sma compared to AngII infused WT mice. Together, these data suggest that NADPH oxidase and its subunit p47^{phox} play a pivotal role in AngII induced LVH by regulating fibrotic machinery and macrophage infiltration ***(Hypertension, 2019; Vol. 74, No. Suppl-1)***.

4.1.1.3 Temporal immmunometabolic profiling of adipose tissue in HFD-induced obesity: Manifestations of mast cells in fibrosis and senescence

Herein, carried out temporal immunometabolic profiling of adipose tissue from C57BL/6 mice fed a high-fat diet (HFD) for 4, 8, 12, 16, and 20 weeks. Clodronate sodium liposomes (CLODs) were used to deplete macrophages and disodium cromoglycate sodium liposomes (DSCGs) to stabilize mast cells. In the temporal HFD settings, mice showed progressive glucose intolerance, insulin resistance, and adipose tissue senescence. Histochemical analysis of epididymal white adipose tissue (eWAT) using picro-sirius red and Masson's trichrome staining showed extensive collagen deposition in the 16th and 20th weeks. Flow cytometry analysis of the stromal vascular fraction (SVF) from eWAT revealed T-cell subsets as early-phase components and pro-inflammatory macrophages, as well as mast cells as the later phase components during obesity

progression. In this therapeutic strategy, macrophage depletion by CLOD and mast stabilization by DSCG attenuated obesity, adipose tissue fibrosis, and improved whole-body glucose homeostasis. In addition, mast cell stabilization also attenuated senescence (p53 and X-gal staining) in eWAT, signifying the role of mast cells over macrophages during obesity. The study emphasizes on the new-generation mast cell stabilizers that can be exploited for the treatment of obesity-associated metabolic complications *(**Int J Obes (Lond). 2019; 43(6): 1281-1294).***

4.1.1.4 Pro-inflammatory effect of EMP is dysfunctional mitochondria mediated and modulated through MAPKAPK2 leading to attenuation of cardiac hypertrophy

This Study showed the functional significance of mitochondria present in EMP and how MK2 (MAPKAPK2) governs EMP production and its physiological effect on cardiac hypertrophy. Flow cytometric analysis, confocal imaging, OCR measurement through Seahorse were used to confirm the presence of functionally active mitochondria in non-treated EMP (c-EMP), LPS and oligomycin treatment increased mitochondrial ROS activity in EMP (l- and o-EMP, respectively). The dysfunctional mitochondria contained in l- and o-EMP induced the expression of pro-inflammatory mediators in the target endothelial cells leading to the augmented adhesion of THP-1 monocyte cells on EA.hy926 cells. Multiphoton real-time imaging detected the increased adherence of o-EMP at the site of carotid artery injury as compared to c-EMP. MK2-deficient EMP reduced the E-selectin and ICAM-1 expression on target endothelial cells leading to reduced monocyte attachment and reduced cardiac hypertrophy in mice. In conclusion MK2 promotes the pro-inflammatory effect of EMP mediated through dysfunctional mitochondria. MK2 modulates the inflammatory effect induced during cardiac hypertrophy through EMP. *(**Arterioscler Thromb Vasc Biol. 2019 Jun; 39(6): 1100-1112**).*

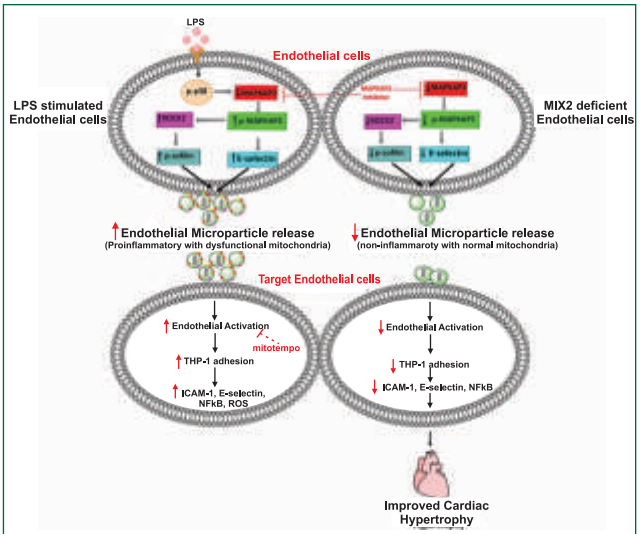


Fig 01: Cartoon depicting how dysfunctional mitochondria loaded EMP regulates pro-inflammatory mediators via MAPKAPK2

4.1.3.5 Involvement of fatty acid synthase in right ventricle dysfunction in pulmonary hypertension

In this study, delineated the mechanism of protective effect of FAS inhibition on RV dysfunction associated with PH. siRNA mediated inhibition of FAS reduced FAS expression, hypertrophy, inflammation, apoptosis, autophagy and improved the glucose oxidation, mitochondrial membrane potential and ATP level in hypoxic cardiomyocytes. In monocrotaline (MCT) treated rats, FAS inhibition by C75 (2 mg/kg, i.p., once a week from 21 to 35 days) decreased the

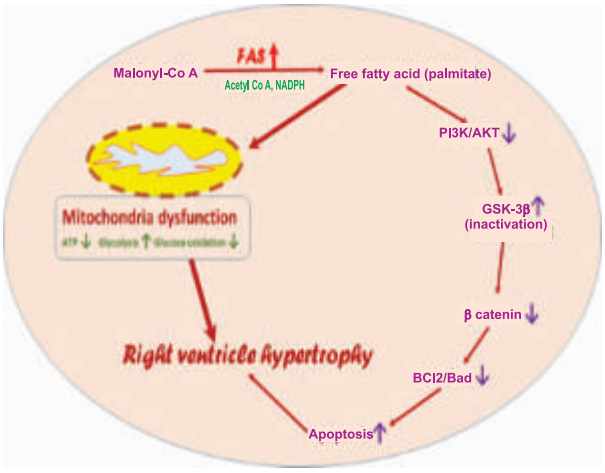


Fig 02: Cartoon depicting how Fatty Acid Synthase alters metabolism and regulates right ventricle hypertrophy associated with pulmonary hypertension

expression and activity of FAS and palmitate level. C75 also improved cardiac functions and mitochondrial membrane potential leading to decreased apoptosis in RV of MCT treated rats. In conclusion, this study reveals that inhibition of FAS decreases RV hypertrophy and improves cardiac function associated with PH by perking up metabolic functions. ***(Experimental Cell Research 2019; 383 (2); 111569)***

4.1.3.6 Multifactorial functions of the inflammasome component NLRP3 in pathogenesis of chronic kidney diseases

The NLRP3 inflammasome plays a central role in necroinflammation by sensing danger signals and releasing proinflammatory cytokines and regulating pyroptosis. Inflammasome activation mainly in the renal mononuclear phagocytes but also in the renal parenchymal cells results in the release of proinflammatory cytokines, IL-1b and IL-18, which sets up renal inflammation during chronic kidney disease (CKD). Therefore, propose the inflammasome –IL-1/IL-18 axis as a promising therapeutic target for CKD. In addition, recent data emphasize the inflammasome-independent roles of NLRP3 in nonimmune cells of the kidney. Especially, the inflammasome-independent proapoptotic and profibrotic functions of NLRP3 and ASC contribute to kidney disease pathogenesis. Thus, also propose NLRP3 and ASC as putative targets to combat renal fibrosis during CKD progression, especially given the multifactorial functions of NLRP3. The kidney comprises a variety of cells, each with specified functions. However, functions of the NLRP3 inflammasome and its components in individual renal cells and their contribution to CKD remain to be explored. Therefore, studies using cell type – specific inflammasome related protein knockout mice for CKD animal models are needed in the future. ***(Kidney Int. 2019; 96(1): 58-66.)***

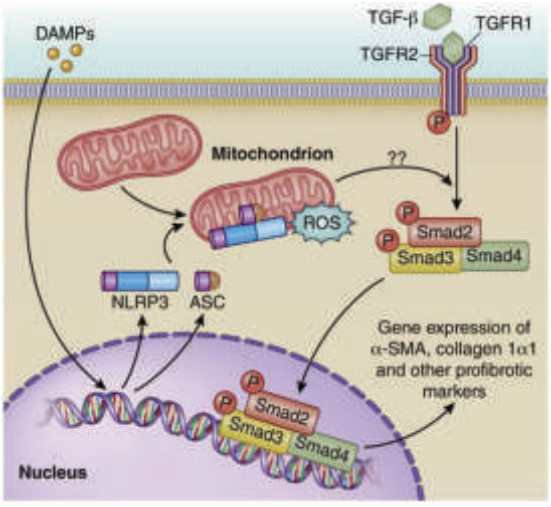


Fig 03: Inflammasome-independent NLRP3-mediated renal fibrosis.

4.1.3.7 Mitochondrial dynamics and immune regulation during inflammatory disorders

Mitochondria have recently emerged as an important organelle that regulates antibacterial and antiviral immune pathways and these functions are intimately linked to their morphology. Cellular mitochondria constantly undergo fusion, fission, directed movement in the cell and mitophagy mediated clearance-collectively termed as **'mitochondrial dynamics'**. Studies have demonstrated decreased mitochondrial electron transport chain complexes in the IBD patients and a

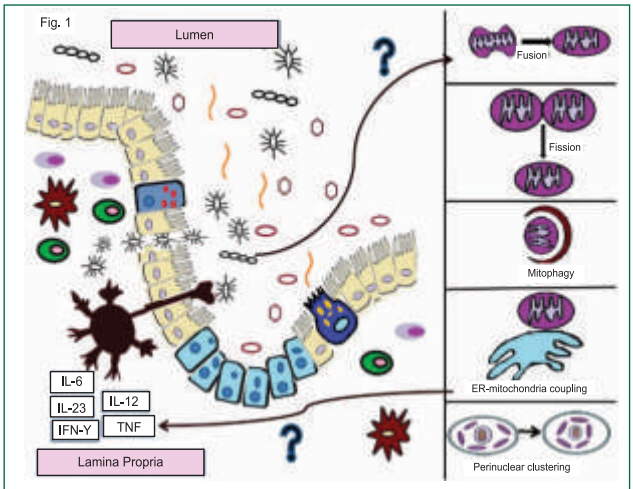


Fig 04: Role for mitochondrial dynamics in regulation of immune response in IBD.

dysregulated release of mitochondrially-derived reactive oxygen species (MT-ROS) suggesting dysfunctional mitochondria. There are multiple proteins that coordinate to regulate the mitochondrial dynamics. This preliminary data indicate a strong role for mitochondrial dynamics components in regulating immune response and tampering with the mitochondrial localization altered the clinical outcome in the IBD animal model.

4.1.3.8 Fructose-induced AGEs-RAGE signaling in skeletal muscle contributes to impairment of glucose homeostasis

Herein, investigated the impact of high fructose on AGEs accumulation in skeletal muscle and its causal role in impaired glucose homeostasis. In L6 rat skeletal muscle cells, chronic exposure to fructose induced AGEs accumulation and the cellular level of the receptor for AGEs (RAGE) and the effect was prevented by pharmacological inhibition of glycation. Under *in vivo* settings, Sprague Dawley rats exposed to 20% fructose in drinking water for 16 weeks, displayed increased fasting glycemia, impaired glucose tolerance, decreased skeletal muscle Akt (Ser-473) phosphorylation, and enhanced triglyceride levels in serum, liver and gastrocnemius muscle. It was also observed a high level of AGEs in serum and gastrocnemius muscle of fructose-supplemented animals, associated with methylglyoxal accumulation and up regulated expression of RAGE in gastrocnemius muscle. Treatment with aminoguanidine inhibited fructose-induced AGEs accumulation and normalized the expression of RAGE and Dolichyl-Diphosphooligo saccharide-Protein Glycosyltransferase (DDOST) in gastrocnemius muscle. Inhibition of AGEs-RAGE axis counteracted fructose-mediated glucose intolerance without affecting energy metabolism. These data reveal diet-derived AGEs accumulation in skeletal muscle and the implication of tissue specific AGEs in metabolic derangement, that may opens new perspectives in pathogenic mechanisms and management of metabolic diseases. ***(The Journal of Nutritional Biochemistry (2019); 71:35-44).***

4.1.3.9 Chronic exposure of Cigarette smoke (CSE) expedites lung tumor progression and motor activity impairment in aged rat: Targeting TNF-α/ TNF-R1/NF-κβ and β-catenin/wnt3 signalling cascade

This study demonstrates that chronic cigarette smoke exposure involves the transition of COPD (emphysema) like phenotype to tumorous characteristics progression in lung of the aged rat and tried to explore the underlying molecular mechanism. Performed plethysmography, neuro-behavioural study, histopathological analysis, RT-PCR and western blot analysis, for confirmation of results. Results indicate that chronic exposure of CSE leads to respiratory disability, tumor formation and fibre deposition in the lung. Tumor formation initiation and progression occurs due to increased inflammation which is regulated through TNF-α/TNFR1/NF-kβ pathway and mediated by β- catenin/wnt3 and ERK signalling cascade. In conclusion, chronic CSE exposure leads to the increased lung inflammation, tumor formation and impaired motor activity in the aged rat.

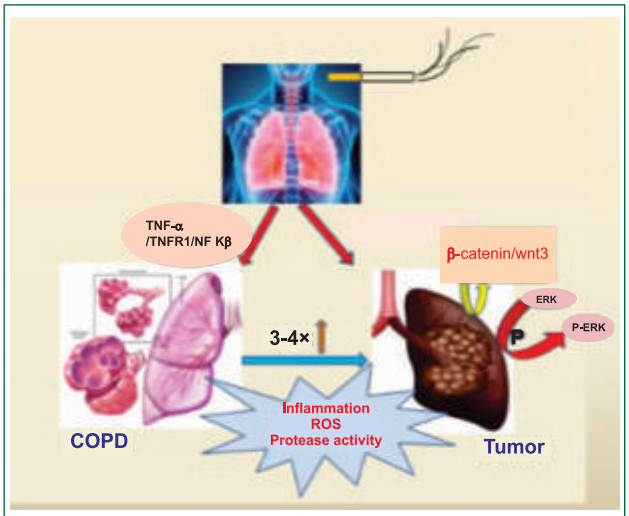


Fig 05: Cartoon depicting the fundamental mechanism of CSE induced tumor initiation and progression.

4.2 Neuroscience and Ageing Biology

4.2.1 Summary of drug discovery and development activities

Around 600 NCEs and natural products were submitted for GPCR profiling during last one year and several preliminary hits were identified that are being consolidated. Besides these, several standardized extracts like *Tinospora cordifolia* were evaluated for cognitive enhancement activities under CSIR's Phytomission.

4.2.2 Advancing Knowledge frontiers

4.2.2.1 Controlled release of hydrogen sulfide studied towards significantly reducing ROS stress and increasing dopamine levels in transgenic *C. elegans*

Hydrogen sulfide, an endogenous signalling molecule, is known to ameliorate dopaminergic neuronal degeneration in neurotoxin-induced Parkinson's disease models. The rapid volatilization of H_2S from spontaneously releasing sulfide salts being a challenge, we describe peptide conjugates which exhibit tris(2-carboxyethyl) phosphine mediated "slow and sustained" H_2S release. It is known that H_2S is a reducing agent that increases the levels of intracellular glutathione, which in turn decreases the oxidative stress. Such an effect, specifically in dopaminergic neurons, would prevent damage to the dopaminergic system thus augmenting the levels of dopamine. An important hallmark of PD is the inflammatory response; studies employing *in vitro* systems have reported that monoamine oxidase B (MAO-B), an enzyme primarily responsible for the oxidative degradation of neurotransmitter dopamine, is inhibited by H_2S releasing moieties. Hence, in the present study, the observed dopamine enhancing effects could be attributed to the anti-oxidant and anti-inflammatory effects of H_2S. The properties of conjugate III in leading to slow and sustained release of H_2S probably result in its superior efficacy *vis-à-vis* countering dopamine decline. In conclusion, a peptide-based system was developed which releases hydrogen sulfide in a controlled manner. These conjugates self-assembled into fibres or spherical structures as a result of self-assembly, and they release hydrogen sulfide at a slower rate compared to ADT-COOH. These conjugates also significantly reduce ROS generated by hydrogen peroxide suggesting their promising antioxidant properties. Interestingly, conjugate III significantly increased the dopamine content, an important neurotransmitter crucial for transporting neuronal signals, which is pivotal for reward-motivated behavior and motor control through dopaminergic signaling ***(Chem Comm 2019; 55(68): 10142-10145)***

(L to R) : Dr. Nayan Ghosh, Dr. Shubha Shukla, Dr. Namrata Rastogi, Dr. Atul Goel, Dr. Durga Prasad Mishra, Dr. Aamir Nazir, Dr. Prem N. Yadav (Coordinator), Prof. Tapas Kumar Kundu (Director), Dr. Sanjay Batra, Dr. Prem Prakash Yadav, Dr. Mohammad Imran Siddiqi, Dr. Ajay Kumar Srivastava, Dr. Damodara Reddy N., Dr. Sarika Singh, Dr. Ravindra Kumar, Dr. Malleswara Rao Kuram & Dr. Ramesh Chintakunta

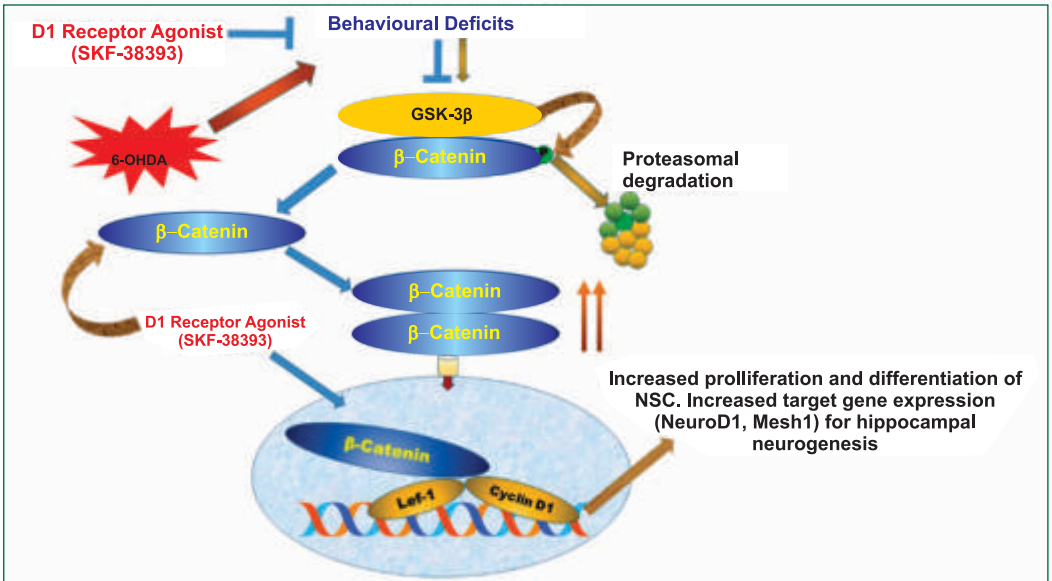


Fig 06: Dopamine D1 receptor mediated activation of hippocampal neurogenesis in Parkinsonian rats.

4.2.2.2 Dopamine D1 receptor activation improves adult hippocampal neurogenesis and exerts anxiolytic and antidepressant-like effect in rat model of Parkinson's disease

Parkinson's disease (PD) is primarily characterized by midbrain dopamine depletion. Reduced hippocampal neurogenesis associated with dopamine depletion has been demonstrated in patients with PD. However, the precise mechanism to regulate multiple steps of adult hippocampal neurogenesis by dopamine receptor(s) is still unknown. This study tested whether pharmacological agonism and antagonism of dopamine D1 and D2 receptor regulate nonmotor symptoms, neural stem cell (NSC) proliferation and fate specification and explored the cellular mechanism(s) underlying dopamine receptor (D1 and D2)- mediated adult hippocampal neurogenesis in rat model of PD-like phenotypes. It was found that single unilateral intra-medial forebrain bundle administration of 6-hydroxydopamine (6-OHDA) reduced D1 receptor level in the hippocampus. Pharmacological agonism of D1 receptor exerts anxiolytic and antidepressant-like effects as well as enhanced NSC proliferation, long-term survival and neuronal differentiation by positively regulating Wnt/β-catenin signaling pathway in hippocampus in PD rats. shRNA lentivirus mediated knockdown of Axin-2, a negative regulator of Wnt/β-catenin signaling potentially attenuated D1 receptor antagonist induced anxiety and depression-like phenotypes and impairment in adult hippocampal neurogenesis in PD rats. These results suggest that improved nonmotor symptoms and hippocampal neurogenesis in PD rats is controlled by D1-like receptors and involve the activation of Wnt/β-catenin signaling (***Neurochem Int. 2019; 122:170-186***).

4.2.2.3 Novel Tetrahydroquinazolinamines as selective Histamine 3 receptor antagonists for the treatment of obesity

The histamine 3 receptor (H3R) is considered as a drug target for the treatment of several central nervous system disorders. In this study, synthesized and identified a novel series of 4-aryl-6-methyl-5,6,7,8-tetrahydroquinazolinamines that act as selective H3R antagonists. Among all the synthesized compounds, *in vitro* and docking studies suggested that the 4-methoxy-phenyl-substituted tetrahydro-quinazolinamine compound 4c has potent and selective H3R antagonist activity (IC_{50} < 0.04 μM). Compound 4c did not exhibit any activity on the hERG ion channel and pan-assay interference compounds liability. Pharmacokinetic studies showed that 4c crosses the blood brain barrier, and *in vivo* studies demonstrated that 4c induces anorexia and weight loss

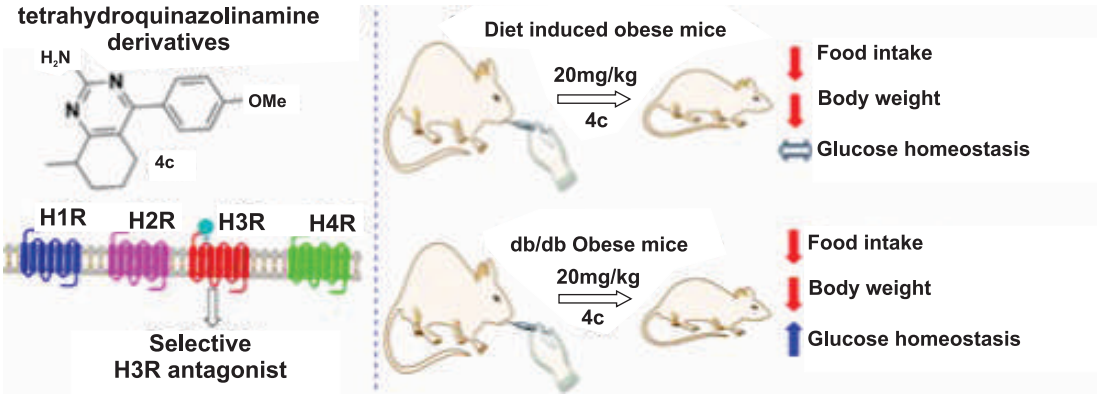


Fig 07: illustration of novel H3R antagonist induced anti-obesity effects in various mouse models of obesity

in obese, but not in lean mice. These data reveal the therapeutic potential of 4c as an anti-obesity candidate drug via antagonizing the H3R.

4.3 Reproductive Health Research

4.3.1 The dynamics of gene expression during and post meiosis sets the sperm agenda

Meiosis is the defining event of spermatogenesis. Spermatocytes undergo meiosis to give rise to round spermatids, which in turn metamorphose to flagellated spermatozoa that mature in the epididymis. To characterize the dynamics of gene expression during these important stages of spermatogenesis, undertook transcriptome analysis in >90% pure pachytene spermatocytes and round spermatids, and pure mature sperm of rat by massive parallel deep sequencing. The study has identified 10,719 total transcripts expressed in meiotic and post-meiotic cells, out of which 7,641 were present in all the three cell types. Most abundant transcripts were related to gametogenesis in spermatocytes and spermatids, and mitochondrial energy metabolism in sperm. Importantly, 108 transcripts were specific to spermatocytes, including Cpeb2, Dpf3, H2afy, Haus7, Plcb1, Taf9, and Tdrd7 strongly linked with meiosis. Similarly, 323 transcripts unique to round spermatids included Arpc5, Apoa1, Cntrob, Dcaf17, Ift88, and Ly6k that play essential roles in spermiogenesis. Likewise, 178 transcripts unique to sperm included Camta1, Hoxb1, and Prdx6 having assigned roles in fertility and/or embryonic development. Levels of ~16% transcripts declined from spermatocytes to sperm while two (Cd300e and Ddx17) increased. New candidate genes with possible roles in meiosis (91), spermiogenesis (298), and sperm function (171), have been identified. This study has provided new potential targets for contraception and/or treatment of male infertility. ***(Mol Reprod Dev, 2019; doi: 10.1002/mrd.23278)***

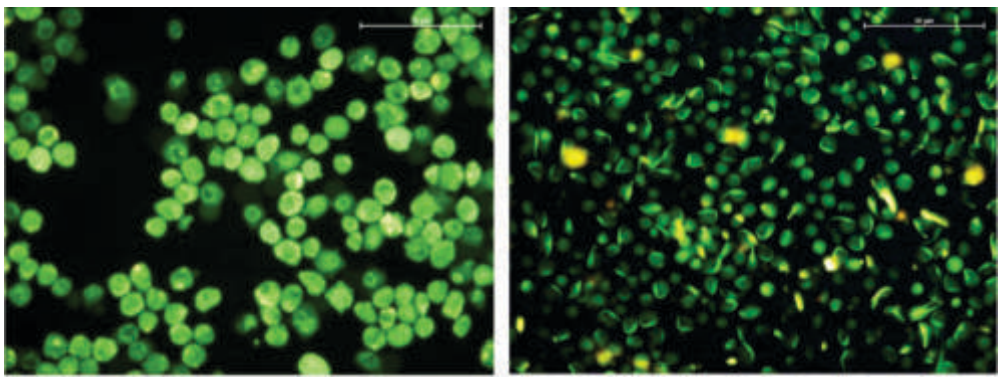


Fig-08: Purified pachytene spermatocytes (left) and round spermatids (right) from rat testis

4.3.2 Peripheral blood DNA methylation profiling reveals differential methylation in male infertility

Peripheral blood differential DNA methylation was studied in oligozoospermic infertile men in comparison with normozoospermic fertile controls in a case-control study. Blood samples were obtained from azoospermic and oligozoospermic infertile patients (n = 6) and normozoospermic fertile controls (n = 6) in the discovery phase, and oligo/asthenozoospermic infertile men (n = 11) and normozoospermic fertile controls (n = 10) in the validation phase followed by DNA isolation and methylation analysis. DNA methylation values were analyzed using genome wide methylation 450K BeadChip array, followed by deep sequencing of selected regions for methylation analysis in the neighborhood regions of differentially methylated CpGs. 329 differentially methylated CpG spots were identified, out of which 245 referred to the genes, representing 170 genes. Deep-sequencing analysis confirmed the methylation pattern suggested by 450K array. A thorough literature search suggested that 38 genes play roles in spermatogenesis (PDHA2, PARP12, FHIT, RPTOR, GSTM1, GSTM5, MAGI2, BCAN, DDB2, KDM4C, AGPAT3, CAMTA1, CCR6, CUX1, DNAH17, ELMO1, FNDC3B, GNRHR, HDAC4, IRS2, LIF, SMAD3, SOD3, TALDO1, TRIM27, GAA, PAX8, RNF39, HLA-C, HLA-DRB6), are testis enriched (NFATC1, NMNAT3, PIAS2, SRPK2, WDR36, WWP2), or show methylation differences between infertile cases and controls (PTPRN2, RPH3AL). This study conclude a statistically significant correlation between peripheral blood DNA methylation and male infertility, raising the hope that epigenome-based blood markers can be used for screening male infertility risk. The study also identified new candidates for spermatogenesis and fertility ***(FertilSteril. 2019; 112(1): 61-72.e1).***

4.3.3 Genome-wide differential methylation analyses identify methylation signatures of male infertility

Methylation changes in a number of genes have been correlated with reduced sperm count and motility. To discover whether methylation changes in sperm DNA correlate with infertility, this case-control study used spermatozoal DNA from 38 oligo-/oligoastheno-zoospermic infertile patients and 26 normozoospermic fertile men. Genome-wide

Front row (L to R) : Dr. Wahajuddin, Dr. Rabi Sankar Bhatta, Dr. Gopal Gupta, Dr. Prabhat Ranjan Mishra
Back row (L to R) : Dr. T.Narender, Dr. Rajesh Kumar Jha, Dr. Monika Sachdev, Dr. Rajender Singh (Coordinator) & Dr. Durga Prasad Mishra

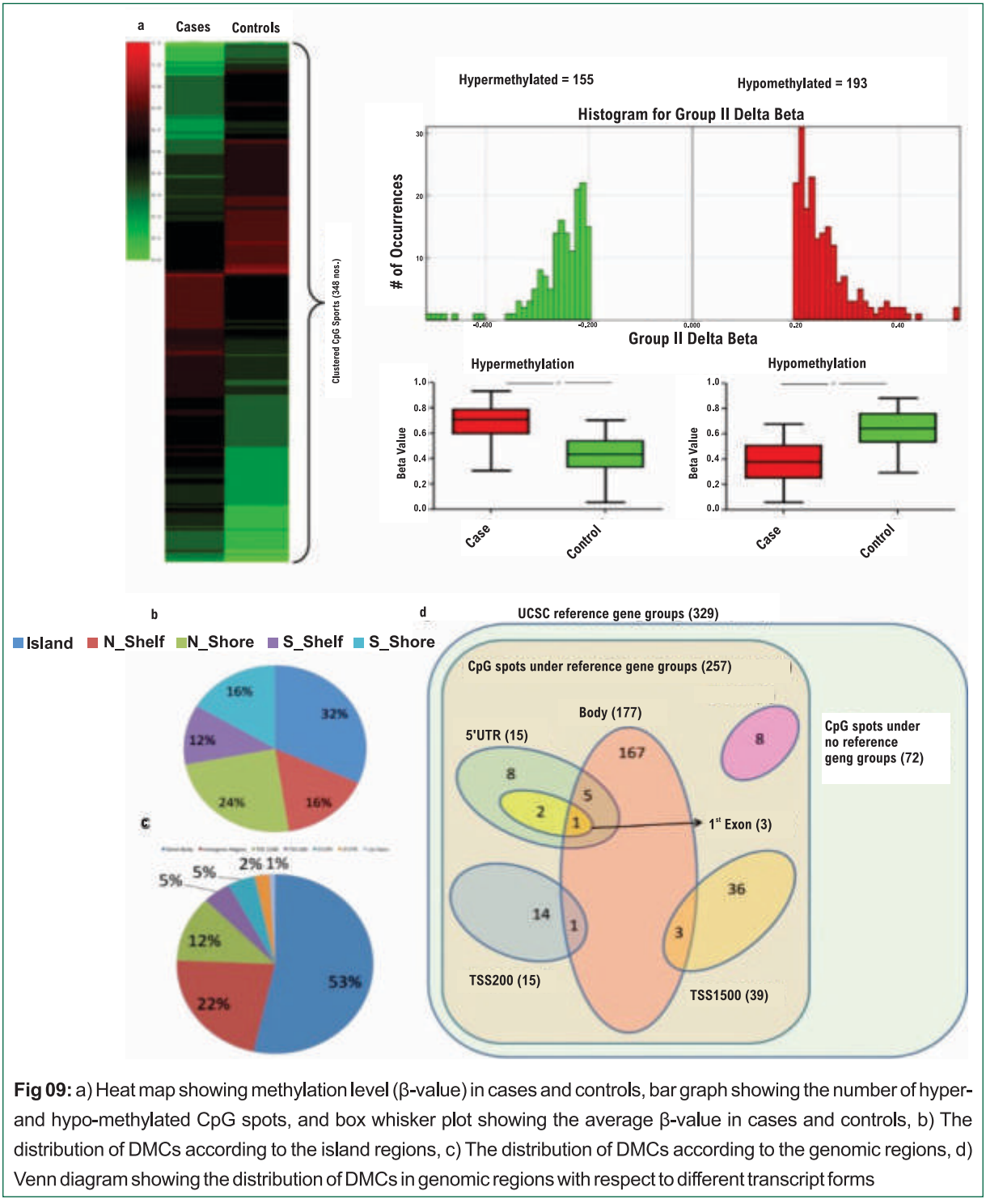


Fig 09: a) Heat map showing methylation level (β-value) in cases and controls, bar graph showing the number of hyper- and hypo-methylated CpG spots, and box whisker plot showing the average β-value in cases and controls, b) The distribution of DMCs according to the island regions, c) The distribution of DMCs according to the genomic regions, d) Venn diagram showing the distribution of DMCs in genomic regions with respect to different transcript forms

methylation analysis was undertaken using 450 K Bead Chip on spermatozoal DNA from six infertile and six fertile men to identify DMCs. This was followed by deep sequencing of spermatozoal DNA from 32 infertile patients and 20 fertile controls. Loss of spermatogenesis and fertility was correlated with 1680 differentially-methylatedCpGs (DMCs) across 1052 genes. A total of 1680 DMCs were identified, out of which 1436 were hypermethylated and 244 were hypomethylated. Classification of DMCs according to

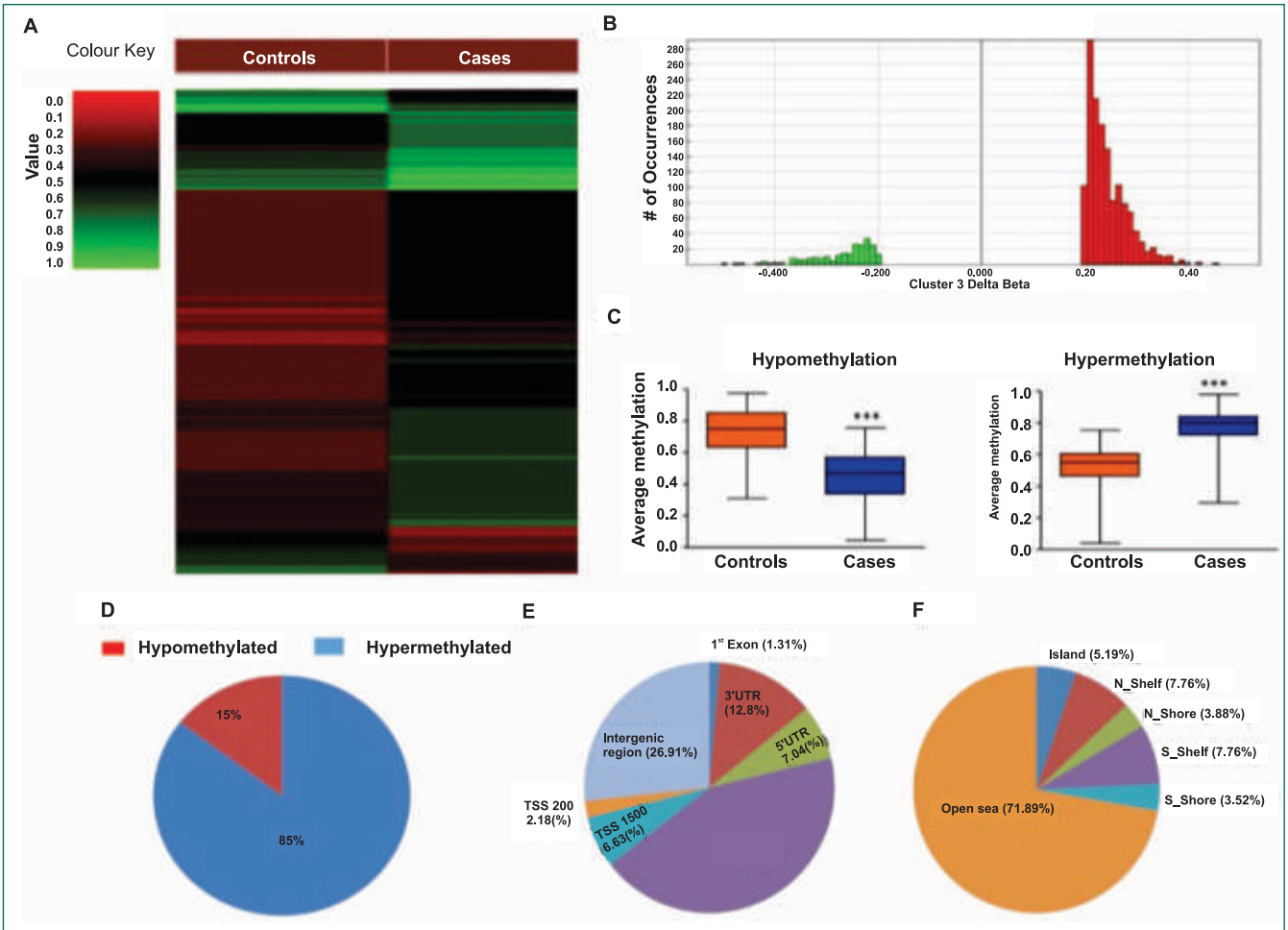


Fig. 10: (**A**) Heat map of genome-wide DNA methylation. (**B**) Histogram showing the number of differentially-methylated CpGs (DMCs) across various β-values. (**C**) Box plot comparing mean β-values for hypermethylated and hypomethylated DMCs between cases and controls. (**D**) Percentage of DMCs showing hypermethylation and hypomethylation. (**E**) Distribution of DMCs on the basis of organization of gene transcript structure. (**F**) Distribution of DMCs on the basis of CpG island and neighborhood regions.

the genes identified BCAN, CTNNA3, DLGAP2, GATA3, MAGI2 and TP73 among imprinted genes, SPATA5, SPATA7, SPATA16 and SPATA22 among spermatogenesis-associated genes, KDM4C and JMJD1C, EZH2 and HDAC4 among genes which regulate methylation and gene expression, HLA-C, HLA-DRB6 and HLA-DQA1 among complementation and immune response genes, and CRISPLD1, LPHN3 and CPEB2 among other genes. Genes showing significant differential methylation in deep sequencing, i.e. HOXB1, GATA3, EBF3, BCAN and TCERG1L, are strong candidates for further investigations. The role of chance was ruled out by deep sequencing of select genes. DMCs can serve as markers for inclusion in infertility screening panels, particularly those in the genes showing differential methylation consistent with previous studies. The genes validated by deep sequencing are strong candidates for investigations of their roles in spermatogenesis ***(Hum Reprod. 2018; 33(12): 2256-2267).***

4.3.4 Poly(ADP-ribose)polymerase-2 is essential during endometrial receptivity for blastocyst implantation and regulated by the Caspase-8 dependent manner

Endometrial receptivity for embryo implantation is one of the critical events to modulate the pregnancy establishment. Understanding of endometrial receptivity molecular signaling may be helpful for contraception target exploration to control the undesired pregnancy at the same time, facilitating the assisted reproductive technologies (ART) to achieve the pregnancy in infertile individuals. We have been mapping the endometrial receptivity regulating factors, molecules since past few years; however, endometrial receptivity is a very complex process. One of the important aspects of pregnancy establishment is endometrial receptivity, where several molecular-signaling, including caspases and PARPs, are involved. In previous reports, observed PARP-1 involvement during the acquisition of the endometrial receptivity, which expression was seen in an endometrial receptivity dependent manner (Joshi et al., 2014). It has been found that PARP-1 can act together with PARP-2 in cellular functions. Therefore, investigated the PARP-2 roles during endometrial receptivity acquisition. Using the mouse model, observed PARP-2 prominent expression in the implantation region during the receptivity phase of the endometrium. The pseudopregnancy stage of endometrium presents the basal level of PARP-2 expression. However, in the contrary, the PARP-2 known regulator Caspase-8 expression and activity suppressed during the endometrial receptivity phase and remain high during the pseudopregnancy in the mouse model, suggesting the down regulation of caspase-8 to maintain the PARP-2 activity for the acquisition of endometrial receptivity. Functional intraluminally PARP-2 activity inhibition renders the poor blastocyst implantation due to poor endometrial receptivity, although, the hatched blastocysts were seen unaffected.

Further, in humanoid embryo implantation assay, found that PARP-2 activity inhibited endometrial epithelial cells resulted in the reduced outgrowth of mouse blastocyst, suggesting one of the essential functions of PARP-2 in the endometrial receptivity for blastocyst implantation. Since the caspase-8 activity was negatively regulated and PARP-2 expression was upregulated during the endometrial receptivity phase, determined whether Caspase-8 activity leads to PARP-2 downregulation (cleavage). Interestingly, in the human endometrial epithelial cells inhibition of Caspase-8 activity, the PARP-2 expression was upregulated, confirming the caspase-8 dependent negative regulation of PARP-2 during the non-receptive stage of the endometrium. Overall, caspase-8 expression and activity downregulate in result the PARP-2 expression remains stabilized to acquire the endometrium receptivity for blastocyst implantation.

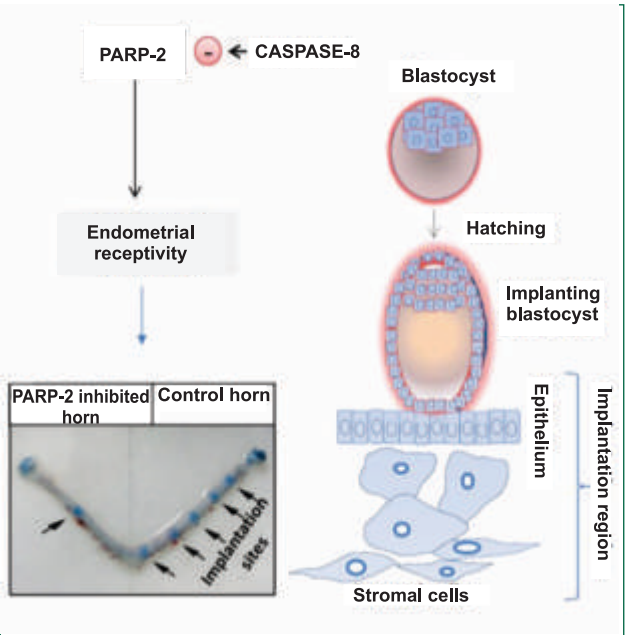


Fig 11: ARP-2 is essential for the endometrial receptivity acquisition and caspase-8 control the PARP-2 activity in the endometrium.

4.3.5 Replenishment of ovarian reserve

Infertility is one of the serious adult concerns globally, common in both men and women. The major causes for female infertility are gonadal insufficiency as well as developmentally incompetent oocyte maturation. In order to understand gonadal insufficiency, clinically relevant mouse model was established with dysfunctional gonads through chemotherapeutic interventions. Chemotherapeutic agents are used for the treatment of cancer patients but frequently cause damage to the ovary due to germ cell toxicity that leads to infertility in females. Further, this model was validated by checking the expression of oocyte maturation marker namely oocyte expressed protein (OOEP) both at transcriptional as well as translational level.

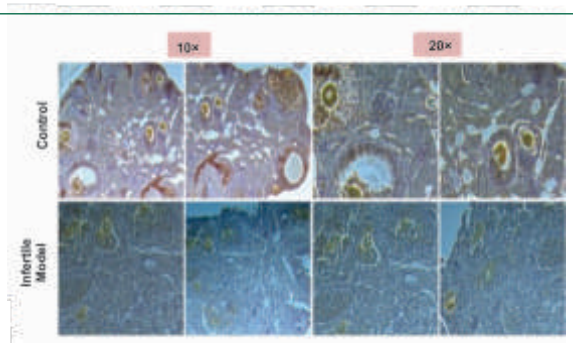


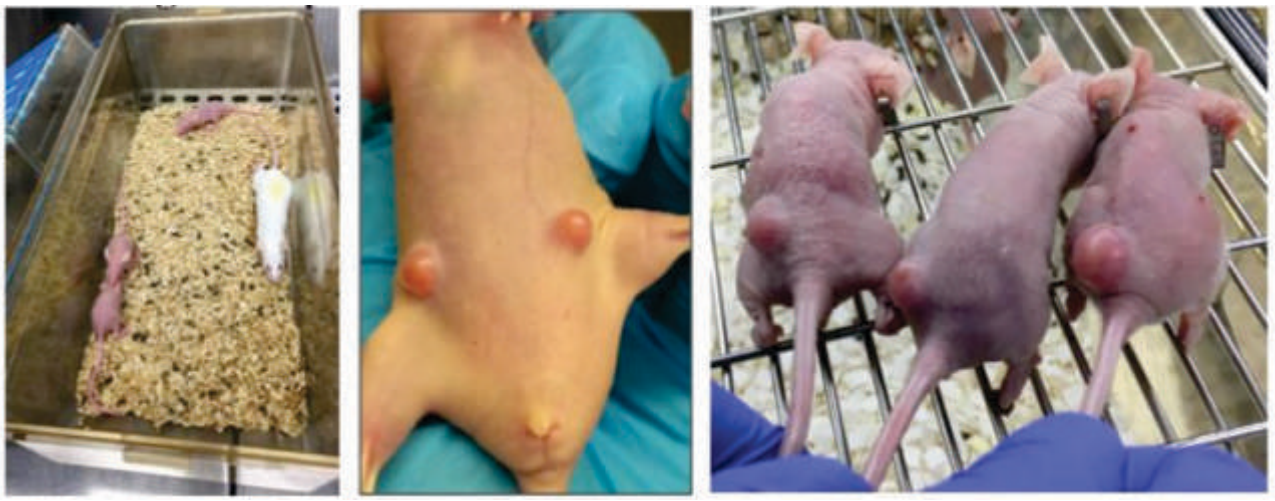
Fig. 12: Immune-histochemistry analysis of OOEP in the ovaries of normal and induced infertile mouse models.

4.4 Cancer Biology

4.4.1 Facilities and Recent Development

CDRI cancer biology area repository has more than 30 cancer cell lines mouse and human origin covering most of the solid tumors and blood cancers. Like NCI-60, initial hits can be tested in CDRI-30 cancer cell line panel. Recently, created Nude mice facility as an integral part of cancer drug discovery program. Utilizing this facility, different xenograft and allograft tumor models of breast and colon cancers have been developed. Now, CDRI has live animal imaging facility where we can visualize cancer metastasis to other organs via an orthotopic breast cancer model. Institute also have a novel Smac mimetic as one of advanced leads in cancer area. Unique medicinal chemistry twist results this targeted synthesis of IAP inhibitor which is active against drug resistant cancer and has parallel or even better efficacy than current Phase-II Smac mimetic clinical trial molecules.

(L to R) : Dr. Dibyendu Banerjee, Dr. Jayanta Sarkar, Dr. Durga Prasad Mishra, Dr. Atul Goel, Dr. Ravindra Kumar, Dr. Namrata Rastogi, Dr. Monika Sachdev, Prof. Tapas Kumar Kundu (Director), Dr. Atul Kumar, Dr. Dipak Datta (Coordinator), Dr. Mohammad Imran Siddiqi, Dr. Arun Kumar Trivedi, Dr. Smrati Bhadauria, Dr. Damodara Reddy N., Dr. Nayan Ghosh



Nude Mice breeding Facility and different Xenograft tum or models

4.4.2 Leprosy drug Clofazimine activates peroxisome proliferator-activated receptor-γ and synergizes with Imatinib to inhibit chronic myeloid leukemia cells

Leukemia stem cells contribute to drug-resistance and relapse in chronic myeloid leukemia and BCR-ABL1 inhibitor monotherapy fails to eliminate them, thereby necessitating alternate therapeutic strategies. Peroxisome proliferator-activated receptor-γ (PPARγ) agonist pioglitazone downregulates signal transducer and activator of transcription 5 (STAT5) and in combination with imatinib induces complete molecular response in imatinib-refractory patients by eroding leukemia stem cells. Thiazolidinediones like pioglitazone however, are associated with severe side effects. To identify alternate therapeutic strategies for chronic myeloid leukemia, screened FDA-approved drugs in K562 cells and identified the leprosy drug clofazimine as an inhibitor of viability. It is showed that clofazimine induces apoptosis in chronic myeloid leukemia patient-derived blood mononuclear cells, with particularly robust effect in imatinib-resistant cells. Clofazimine also induced apoptosis in CD34+38- progenitors and quiescent CD34+ cells from chronic myeloid leukemia patients but not healthy donor-derived hematopoietic progenitors. Mechanistic evaluation revealed that clofazimine via physical interaction with PPARγ induced nuclear factor kB-p65 proteasomal degradation, which led to sequential MYB and peroxiredoxin 1 downregulation and concomitant induction of reactive oxygen species-mediated apoptosis. Clofazimine also suppressed STAT5 expression and consequently downregulated stem cell maintenance factors hypoxia-inducible factor -1α and -2α and Cbp/P300 Interacting Transactivator with Glu/Asp rich Carboxy-Terminal Domain 2. Combining imatinib with clofazimine caused a far superior synergy than pioglitazone where clofazimine reduced imatinib's IC50 by >4 logs and remarkably eroded quiescent CD34+ cells. In a K562 xenograft study clofazimine and imatinib co-treatment showed more robust efficacy than individual treatments. We propose clinical evaluation of clofazimine in imatinib-refractory chronic myeloid leukemia. ***(Haematologica 2019; pii: haematol.2018.194910. doi: 10.3324/haematol.2018.194910).***

4.4.3 CDK2 destabilizes tumor suppressor C/EBPα expression through ubiquitin-mediated proteasome degradation in acute myeloid leukemia

Deregulation and functional inhibition of C/EBPα, a key transcription factor of myeloid lineage leads to development of myeloid leukemia. It was shown that CDK2 negatively regulates C/EBPα protein levels in myeloid leukemia cells. Overexpression of CDK2 inhibited C/EBPα both in a heterologous HEK293T and U937 myeloid leukemia cells. On the contrary, CDK2 depletion enhanced endogenous C/EBPα protein levels. CDK2 mitigated C/EBPα levels by promoting its ubiquitin-mediated proteasome degradation. It is further showed that although CDK2 interacted with C/EBPα, direct interaction of CDK2 with C/EBPα is not involved in C/EBPα downregulation. CDK2-dependent phosphorylation of C/EBPα on its widely reported phosphorylatable amino acid residues is apparently not required for C/EBPα degradation by CDK2. Furthermore, This data demonstrate that CDK2-driven C/EBPα inhibition mitigates its transactivation potential and cellular functions such as ability to promote myeloid differentiation and growth arrest *(**J Cell Biochem. 2019; doi: 10.1002/jcb.29516**)*.

4.4.4 Direct physical interaction of active Ras with mSIN1 regulates mTORC2 signaling

The mechanistic (or mammalian) target of rapamycin (mTOR), a Ser/Thr kinase, associates with different subunits forming two functionally distinct complexes, mTORC1 and mTORC2, regulating a diverse set of cellular functions in response to growth factors, cellular energy levels, and nutrients. The mechanisms regulating mTORC1 activity are well characterized; regulation of mTORC2 activity, however, remains obscure. While studies conducted in Dictyostelium suggest a possible role of Ras protein as a potential upstream regulator of mTORC2, definitive studies delineating the underlying molecular mechanisms, particularly in mammalian cells, are still lacking. Protein levels were measured by Western blotting and kinase activity of mTORC2 was analyzed by in vitro kinase assay. In situ Proximity ligation assay (PLA) and co-immunoprecipitation assay was performed to detect protein-protein interaction. Protein localization was investigated by immunofluorescence and subcellular fractionation while cellular function of mTORC2 was assessed by assaying extent of cell migration and invasion. Earlier, presented experimental evidence in support of the role of Ras activation as an upstream regulatory switch governing mTORC2 signaling in mammalian cancer cells. Herein, report that active Ras through its interaction with mSIN1 accounts for mTORC2 activation, while disruption of this interaction by genetic means or via peptide-based competitive hindrance, impedes mTORC2 signaling. This study defines the regulatory role played by Ras during mTORC2 signaling in mammalian cells and highlights the importance of Ras-mSIN1 interaction in the assembly of functionally intact mTORC2 *(**BMC Cancer. 2019; 19(1):1236**)*.

4.4.5 7-hydroxyfrullanolide, isolated from *Sphaeranthus indicus*, inhibits colorectal cancer cell growth by p53-dependent and -independent mechanism

Sphaeranthus indicus Linn. is commonly used in Indian traditional medicine for management of multiple pathological conditions. However, there are limited studies on anticancer activity of this plant and its underlying molecular mechanisms. An active constituent, 7-hydroxyfrullanolide (7-HF) was isolated from the flowers of this plant, which showed promising chemotherapeutic potential. The compound was more effective in inhibiting *in vitro* proliferation of colon cancers cells through G2/M phase arrest than other cancer cell lines that were used in this study. Consistent with *in vitro* data, 7-HF caused substantial regression of tumour volume in a syngeneic mouse model of colon cancer. The molecule triggered extrinsic apoptotic pathway, which was evident as upregulation of DR4 and DR5 expression as well as induction of their downstream effector molecules (FADD, Caspase-8). Concurrent activation of intrinsic pathway was demonstrated with loss of $\Delta\Psi m$ to release pro-apoptotic cytochrome c from mitochondria and activation of downstream caspase cascades

(Caspase -9, -3). Loss of p53 resulted in decreased sensitivity of cells towards pro-apoptotic effect of 7-HF with increased number of viable cells indicating p53-dependent arrest of cancer cell growth. This notion was further supported with 7-HF-mediated elevation of endogenous p53 level, decreased expression of MDM2 and transcriptional upregulation of p53 target genes in apoptotic pathway. However, 7-HF was equally effective in preventing progression of HCT116 p53+/+ and p53-/- cell derived xenografts in nude mice, which suggests that differences in p53 status may not influence its *in vivo* efficacy. Taken together, these results support 7-HF as a potential chemotherapeutic agent and provided a new mechanistic insight into its anticancer activity *(**Carcinogenesis. 2019; 40(6): 791-804**)*.

4.4.6 Microtubule disrupting agent mediated inhibition of cancer cell growth is associated with blockade of autophagic flux and simultaneous induction of apoptosis

Given that autophagy inhibition is a feasible way to enhance sensitivity of cancer cells towards chemotherapeutic agents, identifying potent autophagy inhibitor has obvious clinical relevance. In this study, investigated ability of TN□16, a microtubule disrupting agent, on modulation of autophagic flux and its significance in promoting *in vitro* and *in vivo* cancer cell death. The effect of TN 16 on cancer cell proliferation, cell division, autophagic process and apoptotic signalling was assessed by various biochemical (Western blot and SRB assay), morphological (TEM, SEM, confocal microscopy) and flow-cytometric assays. *In vivo* anti tumour efficacy of TN□16 was investigated in syngeneic mouse model of breast cancer. TN 16 inhibited cancer cell proliferation by impairing late stage autophagy and induction of apoptosis. Inhibition of autophagic flux was demonstrated by accumulation of autophagy specific substrate p62 and lack of additional LC3 II turnover in the presence of lysosomotropic agent. The effect was validated by confocal micrographs showing diminished autophagosome lysosome fusion. Further studies revealed that TN 16–mediated inhibition of autophagic flux promotes apoptotic cell death. Consistent with *in vitro* data, results of this *in vivo* study revealed that TN 16–mediated tumour growth suppression is associated with blockade of autophagic flux and enhanced apoptosis. This data signify that TN 16 is a potent autophagy flux inhibitor and might be suitable for (pre) clinical use as standard inhibitor of autophagy with anti-cancer activity ***(Cell Proliferation. 2019; in Press**)*

4.4.7 Androgen deprivation upregulates SPINK1 expression and potentiates cellular plasticity in prostate cancer

Emergence of aggressive neuroendocrine prostate cancer (NEPC) associated with androgen-deprivation therapy (ADT) has been known. Despite its adverse clinical effects, majority of advanced-stage prostate cancer (PCa) patients including SPINK1-positive subtype are subjected to ADT. It was shown that androgen receptor (AR) and its corepressor, REST, functions as transcriptional-repressor of SPINK1, and AR-antagonists alleviate this repression leading to SPINK1 upregulation. Moreover, increased SOX2 levels during NE-trans-differentiation transactivates SPINK1, a critical player in maintenance of NE-phenotype. Additionally, SPINK1 elicits epithelial-mesenchymal-transition, stemness, drug-resistance and cellular-plasticity. Conversely, pharmacological Casein Kinase-1 inhibition stabilizes the REST levels, which in cooperation with AR conjures SPINK1 transcriptional-repression and impedes SPINK1-mediated oncogenesis. Notably, elevated levels of SPINK1 and NEPC markers were observed in tumors of AR-antagonists treated mice xenograft models, and in a subset of NEPC patients. Collectively, these findings provide a plausible explanation to the paradoxical clinical-outcomes of ADT, possibly due to SPINK1 upregulation, and offers strategy for adjuvant-therapies *(**Nat. Comm. 2020; 11(1); 384**)*

5 Translational Research and Drug Development

Vision and Goal:

- Pre-clinical and clinical development of drug substances and drug products for diseases of national importance, international relevance and public health needs;
- Provision of services to the pharmaceutical industry, especially micro, small and medium enterprises and public sector manufacturers in areas of clinical trials, regulatory toxicology, safety pharmacology, pharmaceutics and pharmacokinetics;
- Continued engagement with drug regulation and pharmaceutical policymaking in India as well as internationally

Core Competencies and Activities:

- Analytical and bioanalytical method development, quality assurance and stability studies on drug substances and drug products;
- Preclinical pharmacokinetics and metabolism of synthetic compounds and natural products in rodents, small animals and monkeys;
- Bioanalysis and pharmacokinetic modelling for clinical pharmacokinetics and metabolism including bioequivalence and bioavailability studies for generic medicines;
- Pre-formulation, 'Quality by Design' (QbD) formulation and process development for conventional and novel drug substances;
- Safety pharmacology of CSIR-CDRI candidate drugs under certified "good lab practices" (GLP);
- Preclinical toxicology and toxicokinetics of candidate drugs as per international guidelines under GLP;
- Preparation of dossiers on new candidate drugs for regulatory filings;
- Protocol design, trial monitoring and coordination for Phase I to Phase IV clinical trials;
- Generation of information on mechanisms of action, toxicity and metabolism of drugs and deployment of alternative model systems for assessing the efficacy of new chemical entities;
- Development of better drug delivery systems for CSIR-CDRI candidate drugs as well as known drugs;

Translational Research Team

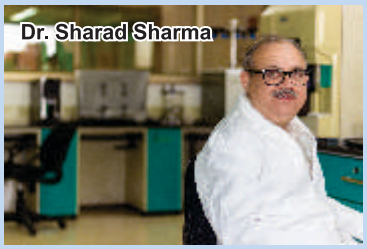
Chairperson


Prof. Tapas K. Kundu

Members


Dr. N. Chattopadhyay


Dr. Atul Kumar


Dr. Sharad Sharma


Dr. SK Rath


Dr. Amit Misra


Dr. Manoj Barthwal

5.1 Pharmaceutics

5.1.1 Generation and compilation of data required for regulatory approval

Documentation of the physicochemical properties of drug candidates and formulations was carried out in the format specified by the New Drugs and Clinical Trial Rules, 2019. Regulatory data on specifications of physico-chemical properties (Chemistry, Manufacturing and Controls) of four CSIR-CDRI candidate drugs: S007-867, S-007-1500 and S-011-1793 were compiled. Investigational New Drug Applications to the Drugs Controller General of India for clinical testing of these candidate drugs are being prepared before submission.

5.1.2 Development, validation and deployment of methods of pharmaceutical analysis

Analytical methods were developed and validated according to the New Drugs and Clinical Trials Rules, 2019, for several new as well as known drugs. This year, pharmaceutical analysis of 23 different kinds of samples of synthetic compounds, plant products and industrial production batches were analysed; about half the samples analysed in the previous year. Another set of about 1000 samples were analysed for drug content, content uniformity, drug release, stability and impurity profiling in formulation development activities. There are 14 different active projects on pharmaceutical analysis in progress currently. The average time from receipt of sample to filing an analytical report this year was 36 days, up from 27.9 days in the previous year.

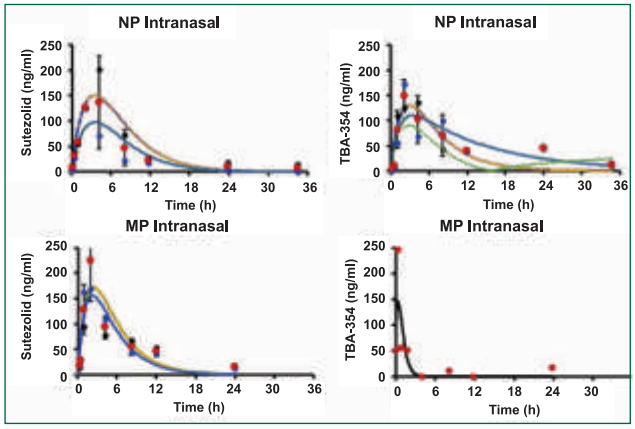
5.1.3 Inhalable particles containing anti-tuberculosis agents

The grant application for funds required for a Phase-1 b was reviewed and revised as per expert comments. The clinical testing plan has been submitted to the Institutional Ethics Committees of CSIR-CDRI and King George's Medical University. The trial has objectives of determining safety, pharmacokinetics and early measurement of drug activity.

(L to R) : Dr. Wahajuddin, Dr. Amit Misra, Dr. Prabhat Ranjan Mishra, Dr. Manish Kumar Chourasia, Dr. Rabi Sankar Bhatta & Dr. Jiaur Rahaman Gayen

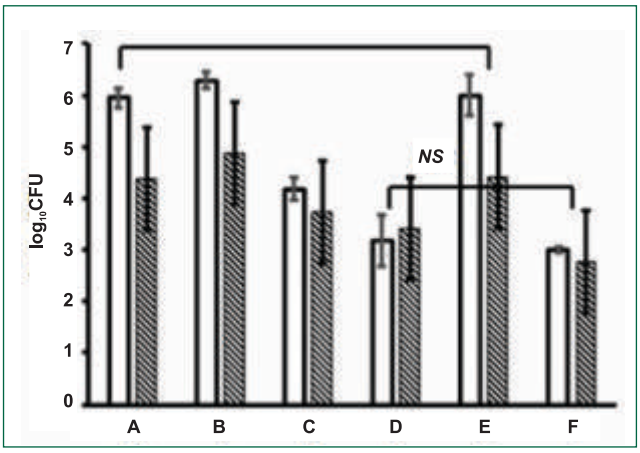
5.1.4 Inhalable particles containing drugs used in multi-drug resistant (MDR) tuberculosis

Collaboration with Prof. Gareth W Griffiths at the University of Oslo, Prof. Andrew Thompson from The University of Auckland, inhalable particles containing sutezolid, TBA-354 and Compound 32625 were prepared and evaluated against *M. tuberculosis* strain H37Rv in THP-1 derived macrophages. Pharmacokinetics following inhalation of micron-sized particles and intranasal instillation of nanoparticles of identical composition were established in Guinea pigs. Evaluation in a mouse model of tuberculosis is in progress at National JALMA Institute of Leprosy and Other Mycobacterial Diseases, Agra.



5.1.5 Inhalable D-cycloserine and ethionamide to overcome pharmacokinetic interaction and impart bactericidal efficacy to drugs considered as bacteriostatic agents

Pharmacokinetics and efficacy of a combination of D-cycloserine (DCS) and ethionamide (ETO) via oral and inhalation routes were studied in mice. The plasma $t_{1/2}$ of oral ETO at human-equivalent dose reduced from 4.63±0.61 h to 1.64±0.40 h when DCS was co-administered. $AUC_{(0-t)}$ reduced to one-third. Inhalation overcame the interaction, restoring primary pharmacokinetic parameters to expected values. Inhalation, but not oral doses reduced lung CFU/g of *Mycobacterium tuberculosis* H37Rv from 6 to 3 log10 in four weeks, indicating bactericidal activity of inhaled combination; whereas the two drugs are classified as bacteriostatic agents by the WHO.



5.1.6 Transient transfection of the respiratory epithelium with gamma interferon to provide host-directed therapy in pulmonary tuberculosis

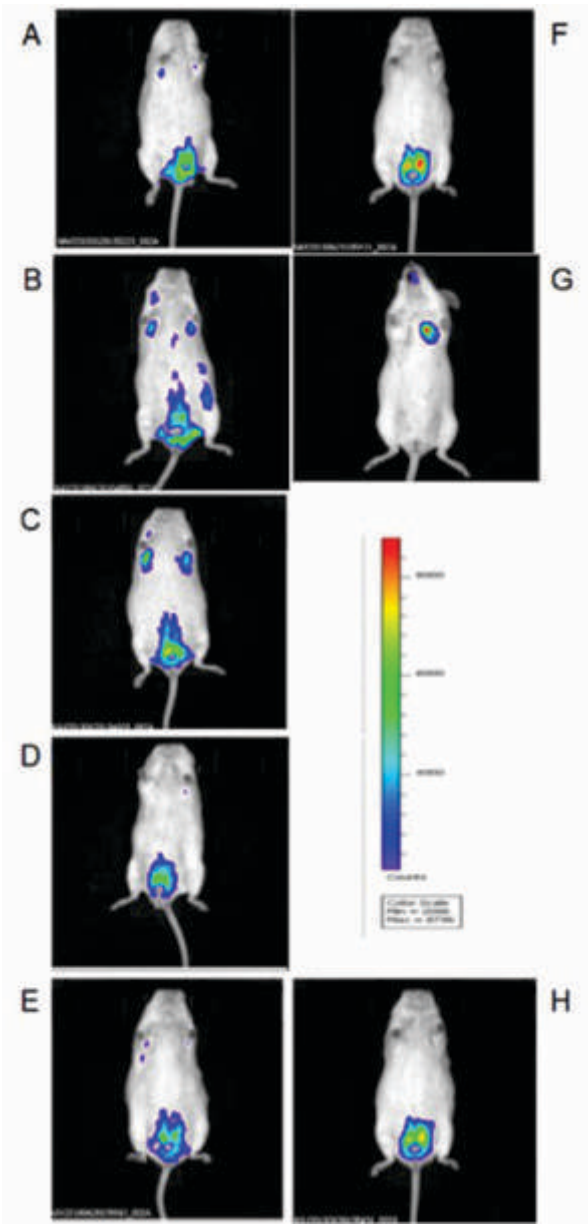
Pulmonary tuberculosis (PTB) is caused by intracellular pathogens like *Mycobacterium tuberculosis* (Mtb) and congeners in a fraction of the population that is infected by the bacteria. Nebulized gamma interferon (IFN-) has shown clinical efficacy against multiple drug resistant (MDR) PTB. Because IFN- protein is expensive, thermolabile and requires a cold chain for field deployment, it is not suitable for limited resource settings. We prepared a dry powder for inhalation (DPI) containing DNA constructs polyplexed with *poly* (ethyleneamine) (PEI) to permit transient transfection of the lung and airway epithelium with IFN-γ or with fluorescent proteins to enable imaging. The median diameter of the DPI particles by electron microscopy was 1.2 µm and the mass median aerodynamic diameter (MMAD) was 2.85±1.8 µm GSD. DNA incorporated in the particles remained intact. A549 cells exposed to particles showed transient expression of green fluorescent protein (GFP) from 6-24 h, after which the protein was observed to co-localize with lysosomes. Mice receiving inhalations were live imaged for red

fluorescent protein and expression of IFN- in bronchio-alveolar lavage fluid. Both signals peaked at about 24h after inhalation and declined by about 36h. Particles inhaled by Mtb-infected mice bearing granulomatous lesions induced extensive autophagy. We concluded that the formulation provides controlled release of functional IFN- in a time-window suitable for investigation of preclinical efficacy and safety as a host-directed therapy of pulmonary TB.

5.1.7 Formulations and Targeted Delivery

5.1.7.1 Targeted co-delivery of the aldose reductase inhibitor epalrestat and chemotherapeutic doxorubicin via a redox-sensitive prodrug approach promotes synergistic tumor suppression

Rapidly growing evidence suggests a strong dependence of a polyol pathway enzyme Aldose Reductase (AR) in cancer progression and invasion. Thus, inhibiting the AR through therapeutic inhibitors has a potential application in cancer treatment. Epalrestat (EPR) is the only marketed AR inhibitor with proven safety and efficacy in the management of complications like diabetic neuropathy. However, its short half-life and highly hydrophobic nature restrict its use as an anticancer agent. In the present study, we first developed a redox-sensitive prodrug of EPR by conjugating Tocopherol Polyethylene Glycol Succinate (TPGS) which can form a self-assembled micellar prodrug (EPR-SS-TPPGS). Subsequently, to achieve synergistic chemotherapeutic efficacy Doxorubicin (Dox) was co-loaded into the EPR-SS-TPGS micelles where the system is disrupted in a tumor redox environment and co-delivers Dox and EPR in a ratiometric manner. We then employed TPGS conjugated vitamin-B6 as a targeting moiety and prepared the mixed micelles to facilitate VTC receptor-mediated uptake. The encapsulation of Dox and EPR with the developed prodrug approach showed significant synergies with increased intracellular accumulation and redox triggered release in MDA-MB-231 and 4T1 cell lines leading to superior cell cycle arrest, mitochondrial membrane potential, and apoptosis. Prolonged circulation half-life and tumor site bioavailability were achieved for both the drugs with the developed approach. Surprisingly, EPR and Dox combination significantly down-regulated the CD44 receptor expression which is the main contributing factor of tumor metastasis. Furthermore, in vivo evaluation demonstrated a significant reduction in Dox-induced cardiotoxicity. In summary, this nanoencapsulation paradigm of AR inhibitors with chemotherapeutic agents lays the foundation of new opportunities in combination chemotherapy. ***Biomater. Sci., 2019, 7,*** **2889**



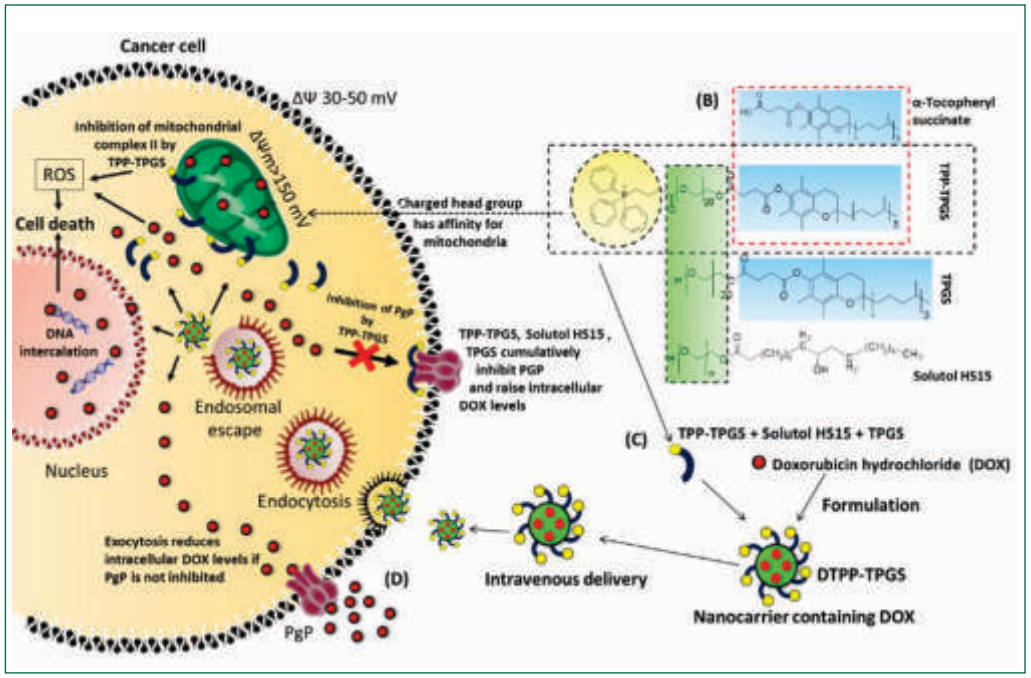
In- vivo imaging of mice at different time intervals after inhalation of plasmid bearing RFP under CMV promoter. (*A-D*): 6h; 12h, 18h, 24h after inhalation. (*F*): Animal that received control particles without DNA at 6h. (*G*): One animal showed signal only in the left lung at 12 h (corresponding to Panel *C*). (H): Control animal at 48h.

5.1.7.2 Induction of mitochondrial cell death and reversal of anti-cancer drug resistance mediated via nanocarrier composed of triphenylphosphonium derivative of TPGS

We have devised a nanocarrier using "tocopheryl polyethylene glycol succinate (TPGS) conjugated to triphenylphosphonium cation" (TPP-TPGS) for improving the efficacy of doxorubicin hydrochloride (DOX). Triphenylphosphonium cation (TPP) has affinity for an elevated transmembrane potential gradient (mitochondrial), which is usually high in cancer cells. Consequently, when tested in molecular docking and cytotoxicity assays, TPP-TPGS, owing to its structural similarity to mitochondrially directed anticancer compounds of the "tocopheryl succinate" family, interferes specifically in mitochondrial CII enzyme activity, increases intracellular oxidative stress, and induces apoptosis in breast cancer cells. DOX loaded nanocarrier (DTPP-TPGS) constructed using TPP-TPGS was positively charged, spherical in shape, sized below 100 nm, and had its drug content distributed evenly. DTPP-TPGS offers greater intracellular drug delivery due to its rapid endocytosis and subsequent endosomal escape. DTPP-TPGS also efficiently inhibits efflux transporter P glycoprotein (PgP), which, along with greater cell uptake and inherent cytotoxic activity of the construction material (TPP-TPGS), cumulatively results in 3-fold increment in anticancer activity of DOX in resistant breast cancer cells as well as greater induction of necroapoptosis and arrest in all phases of the cell cycle. DTPP-TPGS after intravenous administration in Balb/C mice with breast cancer accumulates preferentially in tumor tissue, which produces significantly greater antitumor activity when compared to DOX solution. [***Molecular Pharmaceutics, 2019, 16, 3744***]

5.1.7.3 Multifunctional hybrid nanoconstructs facilitate intracellular localization of doxorubicin and genistein to enhance apoptotic and antiangiogenic efficacy in breast adenocarcinoma

Herein, we have developed spermine (SPM) tethered lipo-polymeric hybrid nanoconstructs with two tier strategies, cell surface heparan sulfate proteoglycans (HSPG) specificity for higher intracellular localization and pH dependent charge reversal in the tumor microenvironment (below pH 5.8) to facilitate Doxorubicin (Dox) and Genistein (Gen) release in a synergistic combination. We have observed the specific uptake of SPM anchored hybrid nanoconstructs by receptor-mediated endocytosis in



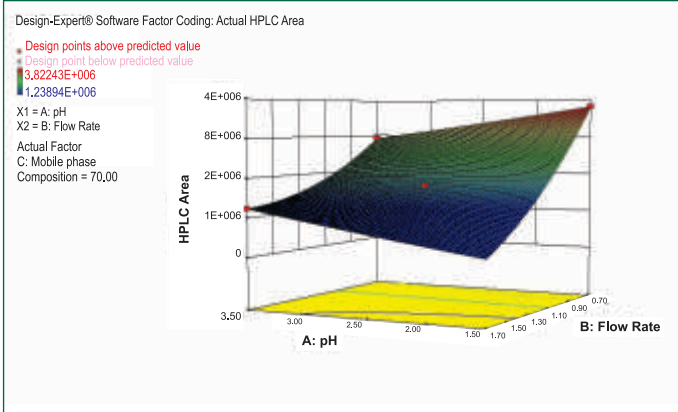
human breast cancer cells (MDA-MB-231) through the HSPG receptor. The SPM-D + G/NPs induced a higher rate of apoptosis in MDA-MB-231 cells via disruption of the mitochondrial membrane potential and also exhibited a stronger anti-angiogenic effect governing the inhibition of VEGF pathway modulation, proliferation, invasion and migration of HUVECs in in vitro and *in vivo* Balb/c mouse models. The involvement of Akt/Hif1α/VEGF dependent signal cascading and its down-regulation with a pro-apoptotic drug Dox and an anti-angiogenic agent Gen was evident as demonstrated by an in silico docking study and subsequently proven by RT-PCR and western blotting. Altogether this study highlights the potential role of SPM in targeting HSPG receptors and synergistic delivery of Dox and Gen as a promising strategy to effectively inhibit BAC progression and these findings could open a new window to deliver combinations of chemotherapeutic agents along with anti-angiogenic ligands using hybrid nanoparticles. ***Biomaterials Science, 2020, DOI: 10.1039/C9BM 01246J***

5.1.7.4 Analytical method development and validation utilizing QBD approach for oral sustained-release formulation of Fenofibrate intended to control alcohol –induced dose dumping

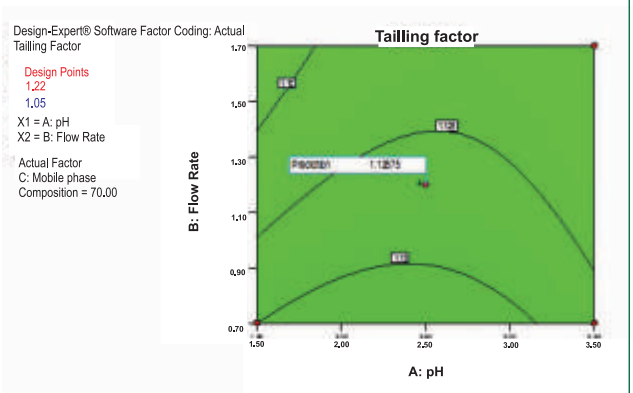
The preformulation and formulation development studies have been performed, to develop oral sustained-release tablet formulation of fenofibrate intended for controlling alcohol induced dose dumping. Further, a robust analytical method was developed for estimation of fenofibrate deliberated for content uniformity test, blend uniformity test, multimedia *in-vitro* studies, and dose dumping studies. The analytical method development has been done utilizing a novel and rational quality by design approach.

5.1.7.5 Development of self emulsifying delivery system bearing *Moringa oleifera* extract

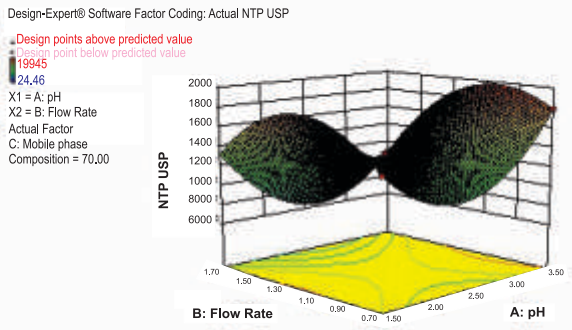
This particular work involves formulation of self emulsifying drug delivery system intended for oral delivery of extract of *Moringa oleifera*. The formulation involves selection of surfactant, co-surfactant and oil phase in accordance with solubility study of extract in different vehicles involving FDA approved oil, surfactant, and co-surfactant. The preformulation studies suggested compatible sets of excipients that can best accommodate the herbal extract providing a large window for dose adjustment. The compatibility study was conducted in 14 different ratio of oil and surfactant-cosurfactant mixture. The selected excipients were subjected for various formulation trials to get most favouring formulation on the basis of particle size, polydispersity index, emulsification volume & time in simulated gastric fluid, simulated intestinal fluid and water. The formulation was rationally optimised using quality by design approach i.e. involving response surface methodology using Box–Behnken design. After development, formulations were characterized for various physicochemical and pharmaceutical attributes.



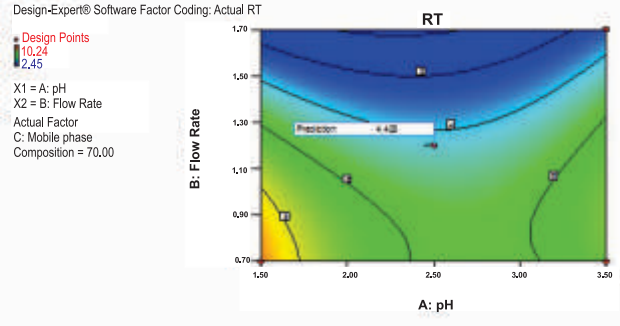
Representative graph of HPLC area optimization



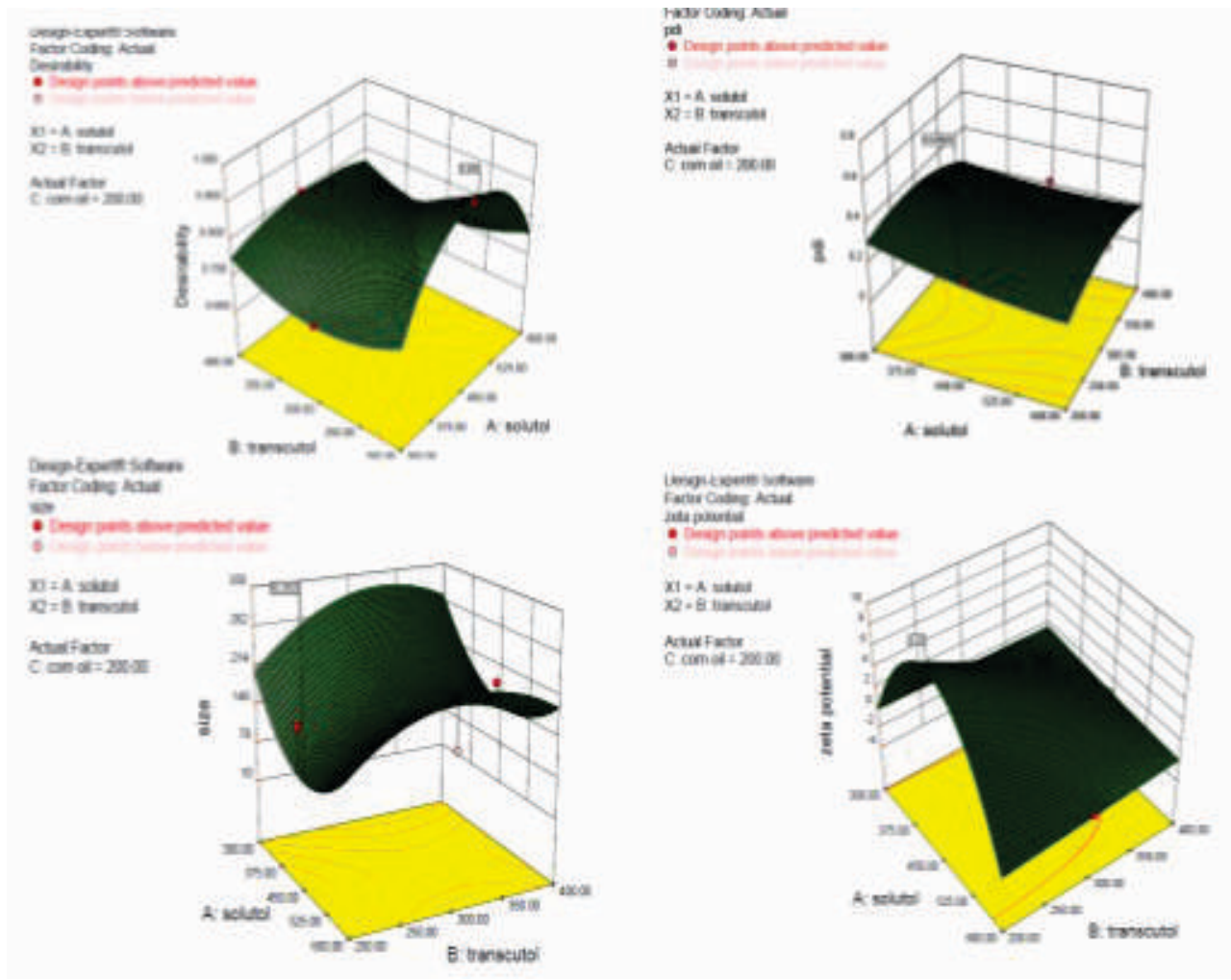
Representative graph of tailing factor optimization



Representative graph of number of theoretical plate Optimization



Representative graph of retention time optimization



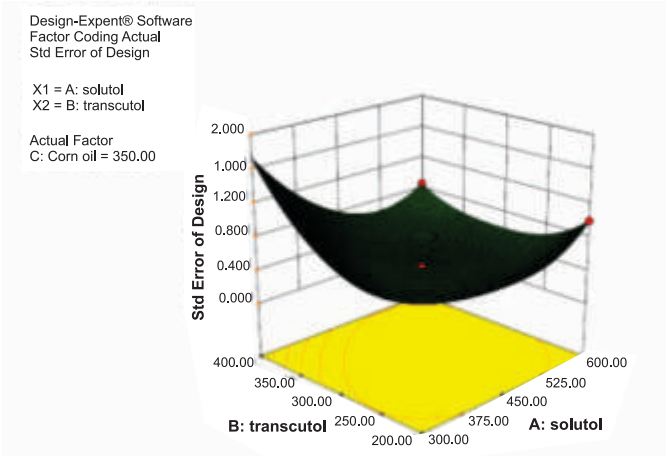


Figure: Optimization of formulations using quality by design approach

5.2 Pharmacokinetic studies

5.2.1 Oral Pharmacokinetic study of enrich fraction N-012-0001

Pharmacokinetic study of biomarker of *Terminalia Chebula* was carried out by estimation of chebulinic acid in systemic circulation following oral administration at 100 mg/kg. A selective and sensitive bioanalytical method was developed and validated for estimation of chebulinic acid in plasma using liquid chromatography-tandem mass spectrometry (LC-MS/MS) instrument. Healthy, male *SD* rats, weighing 220±20 g were obtained from National Laboratory Animal Facility, CSIR-CDRI and animal study was conducted as per the guidelines of Institutional Animal Ethical Committee. Animals were housed in hygienic conditions under controlled temperature (23-25 °C) and humidity (50-70%) conditions with 12/12 h light/dark cycles for one week prior to the start of experiments. A standard chow diet was given to animals with free access to water. Oral pharmacokinetic studies of enriched extract was carried out at dose of 100 mg/kg body weight. The chebulinic acid content in enriched fraction was 59% w/w. Oral formulation of enriched extract was prepared in 0.5% w/v methyl cellulose suspension. Following oral administration at 100 mg/kg, blood samples were collected at 0.25, 0.5, 1, 2, 3, 4, 6,8, 10, 12, 18 and 24 hr. Plasma was separated and chebulinic acid content was analysed using LC-MS/MS.

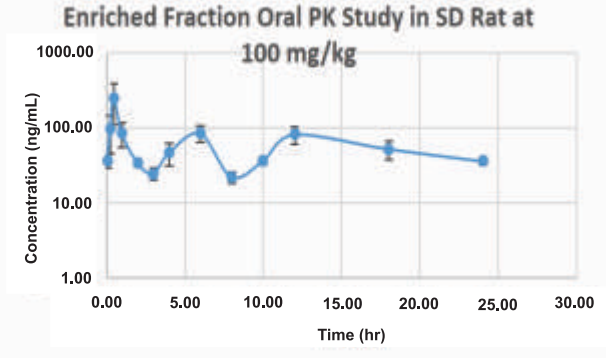


Figure: Plasma concentration profile of chebulinic acid upon oral administration of enrich fraction (N-012-0001) at 100 mg/kg in SD rats.

5.2.2 Bioanalytical method development and intravenous pharmacokinetic study of S016-1271 in *swiss albino* mice

S016-1271 (LR8P) is a broad spectrum novel cationic antimicrobial peptide. Bioanalytical method of S016-1271 in mice was developed, in order to uncover its pharmacokinetic aspects. The chromatographic separation of S016-1271 (FR8P as internal standard) was achieved on a Waters™ X select CSH-C18 column (75 x 3.0 mm, 2.5 µ) using mixture of acetonitrile and triple distilled water (TDW) both containing 0.05% formic acid as mobile phase. A seven-minute linear gradient method was designed to separate analytes from ion suppression at a flow rate

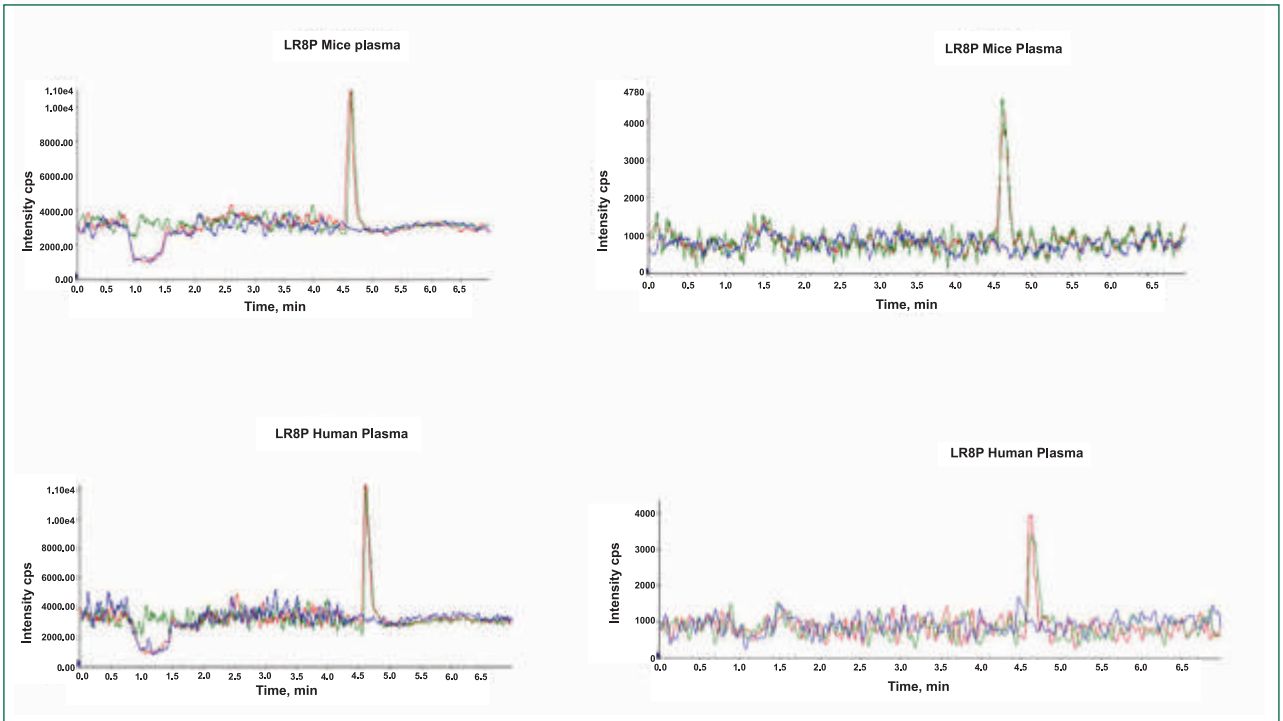


Figure: Overlay of MRM chromatograms of (---) neat analytical standard, (---) post extracted spiked sample and (---) plasma blank sample in optimized gradient method depicting qualitative matrix effect through post column infusion method.

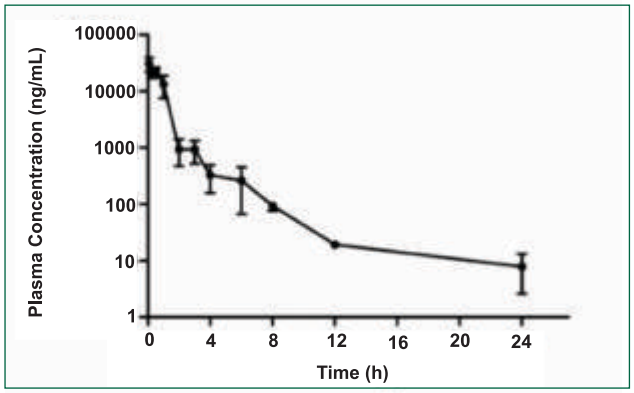


Figure: Plasma concentration time profile of S016-1271 (LR8P) following intravenous administration at 5 mg/kg in *swiss albino* mice

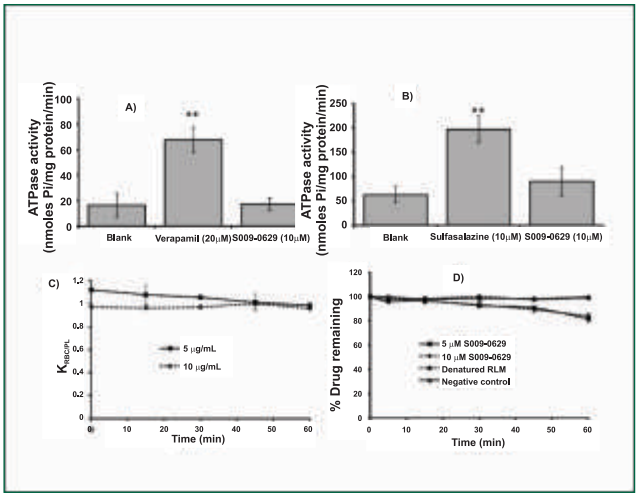
of 0.3 mL/min. The extraction of analytes from mice was performed through solid phase extraction technique using mixed mode weak cation exchange cartridge (Thermo SOLA WCX 10 mg 1CC) with an extraction recovery of analytes about 75%. Mass spectrometric detection of S016-1271 and FR8P was performed with optimized multiple reaction monitoring (MRM) transitions (Q1/Q3) at 658.8 $[M+3H]^{3+}$ / 653.2 $[M+3H\text{-}NH_3]^{3+}$ and 443.4 $[M+5H]^{5+}$ /434.7 $[y_{12}\text{-}NH_3]^{4+}$, respectively in positive electrospray ionization (ESI) mode. The linearity in mice plasma was established over a concentration range of 7.81 to 250 ng/mL with regression coefficient (r^2 > 0.99). The currently developed method was validated as per US-FDA guidelines and found to be within the acceptable limits. The method was successfully applied to intravenous (IV) pharmacokinetic study in mice wherein the levels were detected upto 24 hrs. The peptide demonstrated poor distribution characteristics as the volume of distribution at steady state was less than total body water of mice. The clearance of the peptide predominantly occurred through central compartment (central clearance is 25 fold greater than peripheral clearance). Also, the *in vitro* pharmacokinetic studies demonstrated the stability of S016-1271 in plasma and high plasma protein binding in mice and humans.

Table: Pharmacokinetic profile of chebulinic acid upon oral administration of enriched fraction N012-0001.

Pharmacokinetics parameter	N-012-0001 (Enrich fraction) *
Cmax (ng/mL)	275 ± 133.6
Tmax (hr)	0.4 ± 0.3
AUC 0-inf (ng.hr/ml)	1446.38 ± 273.81
T1/2(hr)	3.43 ± 1.45
Cl/F (L/hr/kg)	2035.00 ± 1679.31
Vd/F (L/kg)	911.27 ± 7094.743
MRT (hr)	30.24 ± 25.77

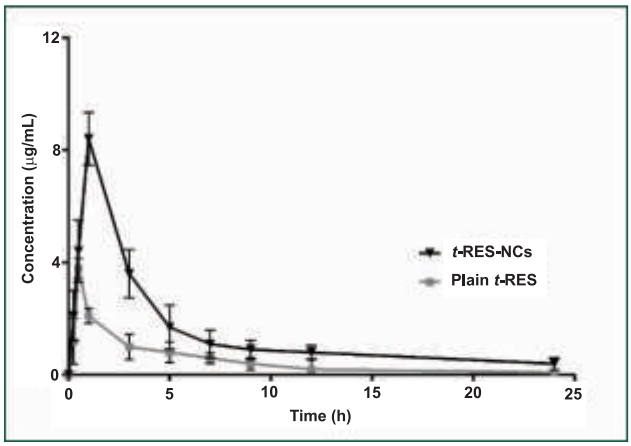
5.2.3 Pharmacokinetic studies of antidiabetic compound S009-0629

S009-0629 [methyl-8-(methylthio)-2-phenyl-6-p-tolyl-4,5-dihydro-2H-benzo[e]indazole-9-carboxylate] is a novel antidiabetic agent with PTP1B inhibitory activity. In this study, we have investigated the *in vitro* metabolic stability, plasma protein binding, blood partitioning and oral pharmacokinetic study of S009-0629 in rats. The plasma protein binding, blood partitioning and metabolic stability were determined by HPLC method. The oral pharmacokinetic study was analyzed by liquid chromatography coupled mass spectrometry (LC-MS/MS) method. The plasma protein binding of S009-0629 using modified charcoal adsorption method at 5 and 10 µg/mL was 80.58±1.04% and 81.95±1.15%, respectively. The KRBC/PL of S009-0629 was independent of concentration and time. The *in vitro* half-life of S009-0629 at 5 and 10 µM using rat liver microsomes was determined as 273±24.46 and 281.67±26.53 min, respectively. After oral administration, S009-0629 exhibited Cmax 55.51±1.18 ng/mL at 18 h (tmax). S009-0629 was found to have the large apparent volume of distribution (1894.93±363.67 L/kg). Oral *in vivo* $t_{1/2}$ of S009-0629 was found to be 41.23±5.96 h. A rapid and highly sensitive LC-MS/MS method was validated for S009-0629 in rat plasma. S009-0629 has high plasma protein binding and low hepatic extraction. S009-0629 has no affinity with human P-gp and BCRP in ATPase assay. After oral dosing, S009-0629 has slow absorption and elimination in rats.



5.2.4 *Trans*-Resveratrol formulation for Oral Administration

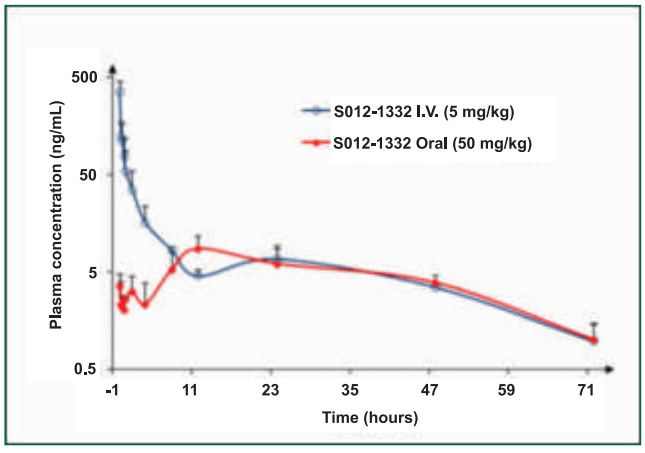
Trans-resveratrol (*t*-RES) a natural polyphenolic compound, with extensive therapeutic activities however its clinical application is circumscribed due to its poor solubility and low bioavailability. The purpose of this study was to prepare stable *t*-RES nanocrystals (*t*-RES-NCs) with different stabilizers to improve its oral bioavailability. *t*-RES-NCs were fabricated by probe sonication method and optimized by particles size, poly dispersive index and zeta potential. The pharmaceutical characterization of *t*-RES-NCs was further performed systematically. The i*n-vitro* cellular efficacy and *in-vivo* pharmacokinetics of *t*-RES-NCs were also evaluated. The optimized NCs were successfully accomplished a submicron particle size (110.28±12.55 nm) with high ζ-potential (-32.96±3.85 mV) value. Scanning electron microscopy (SEM) image indicated that morphology of *t*-RES-NCs was regular and rod like in shape. Meanwhile, the result of



in-vitro cellular efficacy against MDA-MB-231 cells revealed that developed *t*-RES-NCs were more efficacious and potent ($p<0.05$) than plain *t*-RES. Compared to plain *t*-RES, *t*-RES-NCs exhibited significant higher AUC_{0-t} (3.5 folds), and C_{max} (2.2 folds), demonstrating improved oral bioavailability of *t*-RES after grafting as NCs ($p<0.05$). The significantly increased oral bioavailability of developed *t*-RES-NCs represents an ideal vehicle for oral delivery of *t*-RES.

5.2.5 Pharmacokinetics of novel DNA ligase I inhibitor S012-1332

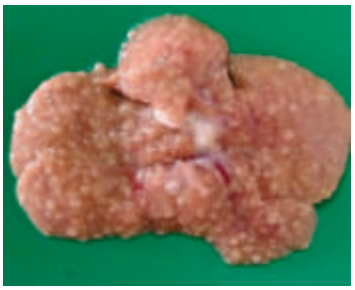
S012-1332 is the first DNA ligase I inhibitor that demonstrated *in vivo* anti-breast cancer activity. The present study aimed to assess the *in vivo* pharmacokinetics of S012-1332 in rats and correlated them with *in vitro* findings. A sensitive and selective liquid chromatography-tandem mass spectrometry bioanalytical method was developed and validated for quantitation of S012-1332. Following oral administration, the absolute bioavailability was 7.04%. The absorption was prolonged which can be explained by low solubility in simulated gastric fluid and several folds higher solubility in simulated intestinal fluid. The effective permeability across the intestinal membrane in *in-situ* single pass perfusion study for S012-1332 was $5.58 \pm 1.83 * 10^{-5}$ cm/sec compared to $5.99 \pm 0.65 * 10^{-5}$ cm/sec for carbamazepine, with no significant difference, indicating S012-1332 has high permeability. It was rapidly partitioning into plasma in blood, where it was stable. Plasma protein binding was moderate which may have attributed to the rapid distribution out of the vascular compartment. The pharmacokinetics of S012-1332 was characterized by extensive clearance as seen with rat liver and intestinal microsomes. *In vitro* results elucidate the *in vivo* pharmacokinetic data. These findings provide crucial information for further development of S012-1332 as anti-breast cancer agent.



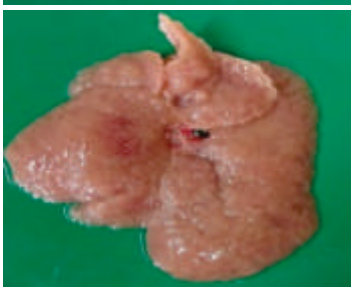
5.3 Toxicity studies

5.3.1 Attenuation of Diethylnitrosamine (DEN) induced hepatocarcinogesis by the enriched fraction of Kalmegh, Ratanjot and Parijat in experimental rat model

Hepatic cancer is well known, and leading cancer around the world and remain asymptomatic. The enriched fraction of Kalmegh, Ratanjot and Parijat possess the anti-proliferative, hepatoprotective property and used in the treatment of hepatic cancer. The current study deals to evaluate the chemoprotective and therapeutic property of the enriched fraction against diethylnitrosamine (DEN)-induced hepatic cancer. For the study, wistar rats were divided into four groups and hepatic cancer was induced with DEN. An oral dose of enriched fraction at a dose of 100 mg/kg body weight was given for 15 weeks. Histological evaluation, serum biochemistry, haematological



Rat liver: Cancer induced group: visceral surface showing nodularity at 60th day



Rat liver: Visceral surface – rough surface and no nodularity at 60th day tretment

profile and western blotting for VEGF were assessed to assess the therapeutic potential of the enriched fraction. Following are the results of the study: Nodules count-The gross examination of the liver showed 70% reduction of nodule count in the treated group as compared to the DEN group. VEGF Expression-The enriched fraction down-regulated the expression of VEGF (approximately 30%) in western blot analysis. Hepatic Serum enzymes - The level of hepatic serum enzymes were observed to be reduced in the treatment group. ALT (Alanine amino-transferase) was found to be reduced up to 35% while AST (Aspartate aminotransferase) was reduced up to 30% as compared to DEN group. Non-hepatic parameters- Parameters such as TLC, haemoglobin were elevated (76%), RBC (73%) in the enriched fraction group compared to DEN group. Masson's staining of liver showed that fibrosis level was reduced in the treatment group and lipids content was considerably low as indicated in oil red O staining with respect to the DEN group. Histopathological features also showed recovery of hepatic architecture in cancer-induced rats.

Toxicology & Experimental Medicine

(L to R) : Dr. Vivek Vidyadhar Bhosale, Dr. Aamir Nazir, Dr. Sarika Singh, Dr. Sharad Sharma, Dr. S.K. Rath, Dr. Rajkamal Tripathi, Dr. Madhav Nilakanth Mugale & Dr. Smrati Bhadauria

5.4 Regulatory pharmacology and toxicology GLP studies

5.4.1 All safety pharmacology and toxicology studies of CDRI compound S007-1500 is completed. The compound is found safe.

5.4.2 CNS safety studies on anti-leishmanial drug candidate 96/261:

The CNS safety of anti-leishmanial candidate drug 96/261 on was evaluated in Swiss albino mice as per "Schedule Y" guidelines. No adverse effect of this candidate drug on gross behavior and sensory systems at any tested doses (250, 500, 1000 and 2000 mg/kg) was observed. However, we observed that this compound induces hypothermia, decrease in locomotor response and attenuates neuromuscular coordination at highest dose 2000 gm/kg.

5.4.3 Single dose toxicity of 96/261 in Swiss mice and rat by oral route is completed. Based on acute studies ten day dose finding studies was done in rat. The data is being analysed.

5.4.4 90 day toxicity study of standardised fraction of *Cassia occidentalis* was conducted with 2.5 g, 1.25 g and 6.5 g/kg and the results are being analysed. No drug related adverse effects were seen in gross observation, biochemical parameters and haematology parameters. Histological data is being analysed.

5.4.5 Safety studies of compound S011-1793 has been completed.

5.4.6 Besides our own drug candidates, we also completed AMES assay of one candidate phytopharmaceutical from *Murraya koenigii* received from CSIR-IICB, Kolkata and a 28 days repeat dose toxicity study of a preparation from DIBER has also been conducted.

5.5 Clinical Trials

Phase 1 clinical trial permission by Drugs Controller General of India for antiplatelet molecule S007-867 has been granted.

Team GLP Test Facility for Pharmaceuticals

Notes

Section
II

Scientific & Technical Services

GLP Test Facility for Pharmaceuticals

The following studies are conducted under certificate of GLP compliance for various sponsors to meet the regulatory requirements:

- Acute toxicity study
- Oxygen Saturation study
- Respiratory Safety study
- CNS Safety Pharmacology
- CVS Safety Pharmacology

Types of Chemicals/Materials for Toxicity Studies:

- New chemical entities (NCE)
- Pharmaceuticals (Small molecules, Bio-similars, Bio-therapeutics, Vaccines, etc.)
- Veterinary drugs
- Nutraceuticals
- Phytopharmaceuticals
- Plant extracts in Ayush mode

Test Systems for the Studies:

- Rat (Wistar, SD, CF)
- Mouse (Swiss albino; C57Bl/6; Balb/C)
- Rabbit (New Zealand White, Belgium)

Studies under GLP Compliant Conditions:

- AMES assay
- *In vivo* micronucleus assay
- *In vitro* micronucleus assay
- *In vivo* chromosomal aberration assay
- *In vitro* chromosomal assay
- Repeat dose toxicity studies in rodents (28, 90 and 180 days)
- Repeat dose toxicity study in non-human primates
- Male fertility study
- Female fertility study
- Teratogenicity study
- One generation reproductive toxicity
- Two generation reproductive toxicity

Test Systems for the Studies:

- Rat (Wistar, SD, CF)
- Mouse (Swiss albino; C57Bl/6; Balb/c)
- Rabbit (New Zealand White, Belgium)
- Monkeys (*Macaca mulata*)
- Guinea Pig (Hartley)

Unique R&D Facilities and Services Group

1. GLP Test Facility for Pharmaceuticals

Good Laboratory Practice (GLP) is a quality system concerned with the organizational process and the conditions under which non-clinical health and environmental safety studies are Planned, Performed, Monitored, Recorded, Archived, and Reported.

The OECD Principles of Good Laboratory Practice (GLP) ensure the generation of high quality and reliable test data related to the safety of industrial chemical substances and preparations. The principles have been created in the context of harmonizing testing procedures for the Mutual Acceptance of Data (MAD).

The MAD system helps to avoid conflicting or duplicative national requirements, provides a common basis for co-operation among national authorities and avoids creating non-tariff barriers to trade. OECD countries and full adherents have agreed that a safety test carried out in accordance with the OECD Test Guidelines and Principles of Good Laboratory Practice in one OECD country must be accepted by other OECD countries for assessment purposes. This is the concept of "tested once, accepted for assessment everywhere*". This saves the chemicals industry the expense of duplicate testing for products which are marketed in more than one country. India is full-member for Mutual Acceptance of Data (MAD) in the OECD's Working Group on GLP w.e.f March 3, 2011. As a consequence, the non-clinical health and safety studies/ data of such studies generated by Indian GLP laboratories is acceptable in 36 OECD member countries and 6 non-member MAD adherent countries. National Good Laboratory Practice (GLP) Compliance Monitoring Authority {NGCMA}, DST is the nodal agency to run this program in India.

CSIR-CDRI is one of only 3 government funded institutes certified by NGCMA, India. At present CSIR-CDRI is certified to carry out Acute Toxicity and Safety Pharmacology GLP studies. We have applied for extension of scope of GLP certified studies to Geno-toxicity and repeat dose studies.

Team GLP

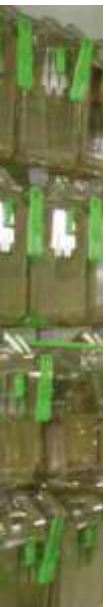
2. Sophisticated Analytical Instrument Facility (SAIF)

Sophisticated Analytical Instrument Facility (SAIF) has highly sophisticated and modern analytical equipment. The facility offers a wide range of analytical services viz. analytical testing/ method development / qualitative and quantitative analysis/ elemental analysis/ structure determination of small and large molecules/TEM/SEM specimen preparation and characterization of nanoparticles, APIs, nano-drug delivery systems, nanostructures like proteins, macromolecular assemblies and viruses / confocal microscopy for sub-cellular localization of macromolecules of biological interest. SAIF services are offered to both internal and external users. The services are availed by about 250 internal and 500 external users annually. More than 80% of the external users comprise researchers from universities and colleges. Researchers from national laboratories and industries constitute the rest.

Besides providing analytical service, the SAIF scientists contribute significantly to all disease areas of the institute and are involved in R&D activities of the institute with several ongoing institutional and extramural projects. Research fellows at SAIF are working for their Ph.D. degrees utilizing modern analytical equipments in line with the institute's mandate. In addition to the above, SAIF also offers contract/collaborative research options.

Facilities	External	Internal	Total
Mass Spectrometry	1609	20950	22559
NMR Spectroscopy	1764	17949	19713
Electron Microscopy	210	564	774
IR & UV-Vis Spectroscopy	463	869	1332
Flow Cytometry	71	12117	12188
HPLC & OR	27	2433	2460
Micro Analysis	221	234	455
Total	**4365**	**55116**	**59481**

(L to R) : Dr. Sanjeev Kanojiya, Dr. Ravi Sankar Ampapathi, Dr. Ravishankar Ramachandran (In-charge), Dr. Sanjeev Kumar Shukla & Dr. Kalyan Mitra



Workshops / Short term Trainings: SAIF offers training programs to motivate interested postgraduate students and research fellows with an opportunity to spend valuable time in gaining practical experience in the field chemical and biological sciences. Awareness programs on various techniques are held every year at SAIF-CDRI to keep the users informed about the scientific advancements in above areas. During the year, following workshops were organized:

(i) Certificate course in Skill Development Program in Electron microscopy; course code EMT, held during June 03 – July 12 2019

(ii) Organized 3 National Workshop on "Applications of Electron Microscopy in Life Sciences", 16-18 July 2019

(iii) Workshop on use of LC-MS/MS and HRMS in the analysis of secondary metabolites 14-16 October2019

(iv) National Workshop on Small Molecule Analysis by NMR Spectroscopy & Mass Spectrometry 11-13 December, 2019

(v) 75 research students of AcSIR visited lab and participated in the PhD course work-demo classes held in September 2019

3. Tissue & Cell Culture Facility

The Tissue & Cell Culture Laboratory is engaged in maintaining the various kinds of mammalian cell cultures and make provision to provide the cell lines to the user scientist within this institute. The laboratory at the present has 42 different types of mammalian cell lines in its repository out of which some of them are actively being maintained and propagated for the institute scientist required for their various research projects and rest of them are maintained in frozen state.


Dr. Neena Goyal, In-Charge

Task carried out/service rendered during reporting period:

- Provision of 218 cell culture flasks of various cell lines including MCF-7, MDA MB 231, Vero, J774 A.1, C6, SHSY 5Y, Hep G2, A 549, DLD 1, HT 29, Neuro-2A etc. to user scientist under different research projects of this institute.

4. National Laboratory Animal Facility

4.1. Objectives:

The Laboratory Animal Facility of CSIR-Central Drug Research Institute, Lucknow which is also recognized as the National Laboratory Animal Center (NLAC), is a CPCSEA-registered (Reg. no. **34/GO/ReBiBt-S/Re-L/ 99 CPCSEA**), Institutional Animal Ethics Committee (IAEC) monitored and GLP certified test facility (No.: GLP/C-108/2017, DOI: 18.10.2017) and R&D support facility of the institute engaged in breeding and production of small laboratory animal species like rodents (rat, mouse, hamster, gerbil, mastomys, guinea pigs) and rabbits required for use in biomedical research and experimentation programs. Facility also serves as national resource center for supply of healthy experimental animals for research purposes to more other CPCSEA registered research and academic institutions across the country. The facility possesses approximately twenty thousand animals of about 9 species with their more than 20 strains of inbred, out-bred, immunodeficient and transgenic models.

Major objectives of the center are as follows:

- Breeding, production and supply of standard quality laboratory animals for IAEC approved in-house biomedical studies and research programs.
- Supply of healthy animal models to other CPCSEA-approved private/government research and academic organizations.
- Monitoring and maintaining animal health and quality parameters through genetic, microbial, viral, pathological, and parasitological screening of

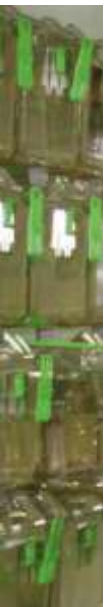
various animal colonies maintained in the facility.

- Acting as Referral Center for scientific and technical advisory/consultancy services for developing and establishing research animal facility in accordance with the guidelines of the CPCSEA
- Conducting human resource development programs including organizing symposium/ workshop/seminar on various aspects of laboratory animal science and hands-on fresher/advanced practical training in care, breeding and management of laboratory animals
- Publication and dissemination of scientific literature on contemporary issues of laboratory animal science and animal experimentation

4.2 Animal species and strains maintained in the facility

Sl. No	Species	Strains	Genotype	Opening stock (as on 01.01.19)	Closing stock (as on 31.12.19)
1	Mice	Out bred: Swiss, PS	Out bred	1949	1750
		Inbred: C57BL/6, CBA , AJ, BALB/c, DBA1J, DBA2J, db/db	In bred	7623	4661
		Transgenic: NOS1,NOS2,ApoE,	Inbred	1050	1290
2	Rat	Outbred: SD, CF, DR,	Out bred	2405	3868
		Inbred: Wister, Lew, SHR	Inbred	1797	1694
3	Hamster	Syrian golden	Out bred	1168	2035
		Syrian/golden	Inbred	456	222
4	Gerbil	Mangolian	Out bred	473	344
5	Mastomys	Coucha	Out bred	638	539
6	Guinea pig	Duncan Hartley	Out bred	544	510
7	Rabbit	NZW & Belgian	Out bred	551	536
8	Monkey	Rhesus	Out bred	44	44
9	Sheep	Marino	Out bred	1	1
			Total	**18699**	**17494**

(L to R) : Mr. S. Raja Kumar, Dr. Rajdeep Guha, Dr. Shishir Kumar Gupta, Dr. Dhananjoy Hansda & Dr. D.S. Upadhyay (In-charge)



4.3. New animal strains procured for in-house breeding:

During the year, C57BL/6; Balb /c; Nude; NOD SCID; & NIH III HE Mice strains and SD, SHR Rat strains were procured from Charles River Laboratory USA and Hylasco Biotech, Hyderabad. These strains are currently being deployed for ongoing R&D programs.

4.4. Supply of Experimental animals for researchers of CSIR-CDRI for IAEC approved projects and supplies to other IAEC approved CPCSEA Registered institutions:

Animal Species	In-house supply (CSIR-CDRI)Nos.	Out-side sale and supply Nos.	Total Animals Supplied
Mouse	13516	1655	15171
Rat	8550	1262	9812
Hamster	1502	243	1745
Mastomys	89	25	114
Gerbil	102	25	127
Guinea pig	122	19	141
Rabbit	87	124	211
Total	**23,968**	**3353**	**27321**

4.5. Experimentation on Non-Human Primates (NHPs):

The primate facility of the institute LAF is also approved by the CPCSEA for the purpose of research and experimentation on monkeys in the area of regulatory toxicology, pharmacology, anti-malarial and anti-leishmanial screening of novel compounds and vaccines. The eco-friendly NHP rehabilitation unit has been developed according to the norms of the CPCSEA to rehabilitate the monkeys surviving after termination of the experiments. Proper management and due veterinary care is extended to these animals round the clock by the expert veterinarians. Recently, the primate facility has been renovated and upgraded in view to comply with the GLP and other regulatory guidelines enabling the institute to perform experiments on NHPs as per global standards.

Status of Pimates in NHP facility:

Species maintained	Brought forward	Animals under experiment	Animals procured	Animals in rehabilitation unit	Animals euthanized as per protocol	Current stock position
Rhesus monkey	44	19	0	25	0	44

Nonhuman primates maintained in the units were periodically examined physically and clinically for their physical and physiological wellbeing. Tuberculin testing and chest radiography were done for screening of tuberculosis. Post mortem examinations were carried out for the animals sacrificed /died in during the course of experimentation as well as rehabilitation.

4.6. Parasitological monitoring of animals:

In rodents, for detection of ectoparasites, like mites, lice etc living in the skin, samples of the piece of the hair or deep skin scrapping were collected and examined microscopically. Faecal samples were collected for detection of endo-parasites or their eggs/ova by means of microscopic examination. Direct smear technique was performed to detect the infection. The detailed observations and findings is as follows:

Species	Total number of samples examined	Observation/Findings
Rat	420	*Hymenolepis nana* (37)
Mice	520	*Hymenolepis nana* (13) ,*Shypheshia* (02)
G.Hamster	60	*Hymenolapis nana* (10
Mastomys	60	Nil
Gerbil	80	Nil
Rabbit	140	Nil
G.Pig	60	Nil

4.7. Pathological monitoring of animals:

Diseased or moribund animals from the breeding colonies showing clinical symptoms were subjected to necropsy and their gross pathologies were recorded. Representative tissue samples were also collected and preserved for further confirmative histopathological diagnosis as per details given below.

Species	Number of Samples	Observation/Gross Pathology
Mice	51	Generalized vascular degenerative changes, emphysema of lungs and enteritis in 16 animals, others shows NAD*
Rat	38	Abscess in 5 rats, splenomegaly in 2 rats, others showed NAD*
G. Hamster	03	NAD*

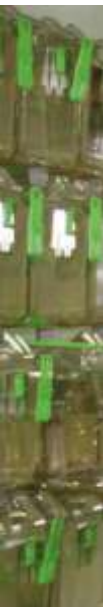
*NAD: No Abnormality Detected

4.8. Microbial monitoring of animals:

Rodent and non-rodent animal colonies were observed for potential infections that affect biomedical research outcome and can have adverse effects on health of the animals. Bacterial load was assessed in individual strains on periodic basis, floor swabs and air samples was assessed for bacterial load in GLP test facility as per the SOP.

The microbial screening was performed at regular intervals to determine the microbial presence in laboratory research animals. Animals were screened for the following microorganisms at regular intervals: *Helicobacter pylori; Corynebacterium sp.; Streptococcus pneumonia; Pasteurella multocida / P. pneumotropica; Pseudomonas aeruginosa; Salmonella sp.; Klebsiella pneumoniae' Group B-Streptococci; Staphylococcus aureus; Bordetella bronchiseptica*

The animal colonies of C57BL/6, BALB/c, Swiss mice, Wistar and SD rats and Golden Hamsters were screened for the potential infections that might have adverse effects on the health of the animals and affect biomedical research outcome. Most of the animal colonies were observed to be free from any disease symptoms. No outbreak of any disease was reported during the period. The screened laboratory rodents showed presence of opportunistic pathogens. Measures such pest control, proper cleaning and sterilization were taken up strictly as per SOP accordingly. Animals showing clinical signs of disease were immediately separated and euthanized.



4.9. Genetic monitoring of animals:

A panel of twenty SSLP markers was used as primary genetic screen to genetically monitor the common inbred mice strains and twenty markers were analyzed for Rats. Genetic profiling of the animals examined confirmed the homozygous state of the inbred strains of the animals being bred and heterozygosity of outbred strains maintained in the animal facility of the institute.

Animal Species	Sample No.	Marker Panel
Mice-Balb/C	12	D1Mit17, D1Mit77, D1Mit171, D2Mit75, D3Mit54, D3Mit200, D4Mit15, D4Mit53, D5Mit10, D6Mit39, D6Mit102, D7Mit25, D7Mit222, D9Mit172, D16Mit5, D17Mit24, D17Mit28, D18Mit14, D18Mit49, D18Mit87
Mice-C57Bl/6	12	
Rat-SD	5	D1Rat169, D2Rat255, D3Rat204, D4Rat107, D5Rat19, D5Ra34, D6Rat160, D7Rat10, D8Rat155, D9Rat33, D10Rat13, D11Rat52, D12Rat86, D13Rat129, D14Ra110, D15Rat6, D16Rat84, D17Rat75, D18Rat121, D20Rat37
Rat-Wistar	4	
Rat-SHR	4	

4.10. Human Resource Development Activities

- Certificate course under Skill India Initiative on “Care and management of laboratory animals and experimental techniques” conducted from 09 July to 14 August 2019.
- “Scientific and Technical Awareness Training Program in Animal Ethics & Experimentation”

for 53 research scholars under AcSIR PhD course was conducted in three batches, during 06 – 31 December 2019.

- Two M.Sc dissertation work conducted by scientists of LAF in 2019.

4.11. Ethics in Animal Experimentation Programs of the Institute:

- The IAEC meetings of the Institute was conducted depending upon the requirement. In the year 2019 more than 200 fresh and ongoing animal research proposals were reviewed and granted approvals. With recommendation of the IAEC, one proposal requiring rhesus monkeys has been approved by the CPCSEA, to use rhesus monkeys for studies on bone health.
- The students of the institute were regularly trained for justified use of animals in research in accordance with the principles of 3R.

5. Repository of Small Organic Compounds

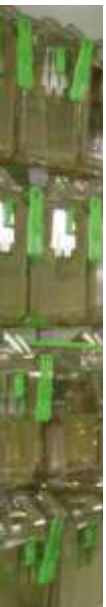
The new drug design and discovery is highly challenging, cost intensive and time-consuming research effort. Still the problem of resistance to the present treatments or improvement of the present treatments to alleviate human sufferings from different diseases and provide affordable healthcare underscores the need to continually discover new drugs. With better understanding of molecular biology, genetic layouts, biochemical pathways and protein science, the new drug discovery and development now follows the paradigm of target driven approach rather than hypothesis driven. The success of the target driven drug discovery relies on bioinformatics approaches which allow drug designers to visualize ligands bound to different targets providing a wealth of details concerning the non-bonded interactions that control the binding process and their implications. Various computational techniques including molecular docking, virtual screening, molecular simulations, and machine learning methods are employed to study the ligand-protein interactions and discover novel molecular entities with selective pharmacological activity. Such target-oriented approaches are commonly followed for discovering bioactive compounds for different life style disorders and age-related diseases. Although, the discovery process for parasitic diseases and microbial infections still relies on hypothesis driven phenotypic screening or random approach, target-driven route in selected disease areas exists. Notably, the two distinct discovery approaches viz. hypothesis and target driven require a large pool of diverse chemical prototypes for in silico, biochemical or cell-based screening to identify hits. On the other hand, the paradigm of drug discovery via repurposing of bioactive which is being pursued globally too requires a large collection of compounds. In this context, this institute realized the importance of archiving the compounds which are produced in the medicinal and process chemistry division in the state of the art conditions. Thus this institute purchased and installed the Automated Chemical Stores in 2012 which was commissioned in October, 2013. Since commissioning all the compounds available with the institute were transferred and archived in the repository. Simultaneously all the new compounds produced over the period are added to this archival facility and therefore the chemical library is progressive. In addition to the compounds being produced within the institute, the institute also acquired commercial chemical libraries of organic compounds and pure natural compounds to boost the efforts for identifying the leads. Presently the CDRI

Dr. Sanjay Batra, In-charge

Repository comprises of approximately 87,000 small organic compounds and 215 natural compounds. The Repository at this institute is equipped with state of the art Liquid handling Platform that is effectively utilized for preparing stock solutions of compounds and their distribution for bioassays towards identifying bioactives under different diseases areas being pursued at the institute. There is a battery of more than 20 primary screens which is often employed for identification of hits. Needless to mention that SOPs and cut offs for all bioassays as per the global standards are maintained. In order to maintain the proper record of all compounds being distributed and archived in the Repository, an Online Chemical and Biological Assay Reporting System popularly acronymed as CBRS was developed inhouse by the Computer division. This not only assist in archiving the spectral records and purity parameters of all compounds present in the repository but also allow to keep record of all assays together with results of biological investigations any compound has undergone. In order to enhance the diversity of the chemical library, the institute welcome recruiting compounds from all academic and research institutes and universities.

All the work related to Repository is handled by the team of Dr. Anil K. S and Dr. Bhawana Sharma. From receiving the sample in the Repository, assessing its purity, preparing the stock solutions and distribution of the solutions to biologists for bioassay and archiving is done by this team. It is imperative to mention that all biologists in the institute can request any compound from the collection for their bioassay.

- Small Organic compounds (Inhouse) ~37300
- Small Organic Compounds (Commercial) ~50000
- Pure Natural Compounds (Commercial) 215
- Total Number of Primary Screens 23



Knowledge Management Group

1. Business Development & Intellectual Property

Business Development & Intellectual Property Group aims to establish a stronger link between the Institute and Industry, Stakeholders and Society. The overall objectives of the group:

- To promote the technologies developed at CSIR-CDRI and facilitate the R&D divisions of CSIR-CDRI to have a better interaction with industries to develop novel technologies.
- Management of Intellectual Property Rights of the Institute.
- Coordination of the technical services based on immense expertise available with CSIR-CDRI to various users.
- Representing CSIR-CDRI in the exhibitions and expo to exhibit accomplishments of the Institute and opportunities available for industry, academia and society to collaborate with CSIR-CDRI.
- Coordination of the International S&T Affairs activities at CSIR-CDRI.

During the reporting period, The Business Development group continued to explore the business development opportunities by establishing liaison with national and international organizations and industries in order to have more public–private partnership at early stage of the development and to have collaborations for new leads. Several new contracts / assignments were signed / undertaken by the Institute during reporting period.

Dr. Sripathi Rao Kulkarni, IP Coordinator
Mr. Naseem Ahmed Siddiqui, Head, BD

(A) Number of Agreements Signed

- Demonstration of Technology 1
- Licensing Agreements 1
- Sponsored Agreements 1
- MoU for joint R&D 13
- Collaborative Research Agreements 4
- Testing Services 8
- Secrecy Agreements 10
- Memorandum of Agreements 4
- Material Transfer Agreements 14

Details given in the Research Output Section

(B) Number of Patents Processed:

- Patents Filed in India 2
- Patents Filed Abroad 3
- Patents Granted in India 5
- Patents Granted Abroad 8

Details given in the Research Output Section

(C) Participation in the Exhibitions & Expo

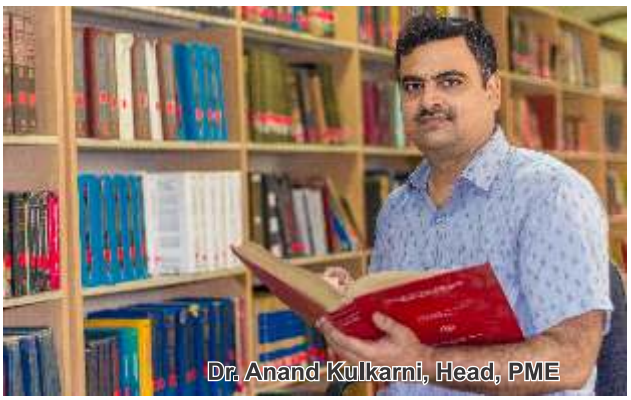
- Flower Exhibition, Drawing Competition & Dog Show of Lucknow Nagar Nigam Lucknow on 23-24 Feb. 2019. CSIR-CDRI received best exhibitors award.
- 7th International Symposium on Current Trends in Drug Discovery Research (CTDDR-2019) at CSIR-CDRI, Lucknow on 20-23 Feb. 2019
- IISF-2019 Outreach Program on October 31, 2019 at CSIR-CDRI.
- Generics and Healthcare Pavilion of CSIR at Science City, Kolkata during India International Science Festival (IISF-2019) during Nov. 5-8, 2019.
- "Pride of India Expo" under Genomics & Healthcare Pavilion of CSIR in 107th Indian Science Congress, University of Agricultural Sciences, GKVK Campus, Bangalore, Karnataka from 3-7 January, 2020.
- Kisan Mela, CSIR-CIMAP, Lucknow 29–31 January 2020

2. Scientific Directorate

The Scientific Directorate is looking after three major portfolios viz. Director Secretariat, PME, and Technical Information, apart from Coordination with agencies, and other crucial management activities. Significant work carried out during the year are as follows:

2.1 PME

- Revised budget estimates 2019-20 and Budget estimates 2020-21
- Vetting of project proposals and processing for approval of the competent authorities Monitoring of funds and day to day clearance of indent through the Real Time
- Processing of indents through Budget Monitoring Tool raised by the scientists & other staff members in various projects.
- Incorporation of newly joined staff and new sanctioned projects in S&P software
- Co-ordination with Finance & Accounts and Stores & Purchase
- Maintenance of all kind of project folders and record keeping at central place
- Vetting of expenditure statements, utilization certificates and processing for approval of the competent authorities.
- Digitized information management
- Coordination with Audit
- Management of R&D Portal of the ERPS
- Research Council Meeting coordination, preparation of Executive Summary and Presentation.

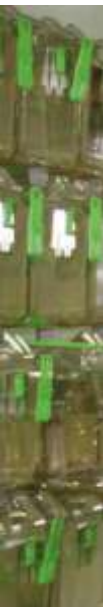

Dr. Anand Kulkarni, Head, PME

2.2 Director Secretariat

- Support in overall R&D planning activity with inputs from concerned stake holders
- Implementation & follow up reports on policy decisions taken by the Director from time to time
- Preparation of background papers/ documents and policy drafts
- Collation and analysis of information pool for informed decisions
- Preparation of reports/documents sought by the CSIR from time to time
- Periodic performance mapping and reports to the Director
- Monthly/ Quarterly Reports
- Processing of scientific matters & budgetary requests for Director approval
- Any other activity as assigned by the Director from time to time
- Background work for recruitment of Technical & Scientific Staff
- Nominations for training programs
- Processing of staff nominations for honours & awards and fellowships
- Instrumental support in organizing visits of important delegations, VIPs, Industry personnel, etc
- Popular Health Talk and Nobel Symposium organization
- Coordinating organization Faculty Colloquium
- Coordination of CDRI Awards for Excellence in Drug Research

2.3 Dissemination of Technical Information

- Response to queries from various corners (Govt./ non-Govt. agencies)
- Replies to Parliament Queries
- Communication within and outside the institute
- Management of database on projects, staff, budget, ECF, Awards, etc.



2.4 Institutional Publications

- CSIR-CDRI Annual Report 2018-19 (Hindi)
- CSIR-CDRI Annual Report 2018-19 (English)
- CDRI Newsletters (Bi-annual)
- Banners, Brochures and publicity material
- CSIR-CDRI Advertisements

2.5 Institutional Photography and Design Work

Scientific Directorate is the core of institutional photography and all designing work. It undertakes given activities under its domain

- Scientific Digital Photography for all publications, Scientific Journals and Research papers
- CSIR-CDRI Advertisements
- Photography coverage of all institutional events namely, seminars, symposiums, agreements, conferences, lectures, farewells, colloquiums, and many such events
- Designing of Institute publications including Invitation Cards, Posters, banners, certificate, Brochures, Mementos.
- Allied services under photography and designing like Poster designing for conferences, computerized graphic diagrams, drawings and charts, editing and processing of digital images for publications, etc.
- Maintenance and update of central Institutional Digital Photo repository.

3 Academic Affairs Unit

3.1 Academic Activities

Coordination of the academic activities related to PhD Programs of Jawaharlal Nehru University (JNU) New Delhi and Academy of Scientific and Innovative Research (AcSIR), Ghaziabad starting from admission, organization of course works, seminars, comprehensive, Research/Doctoral Advisory Committee (RAC/DAC) Meetings to Thesis submission, Viva-voce examination and finally award of Doctoral Degree. In the reporting period nearly 451 (240 from AcSIR and 211 from JNU) research scholars are registered for PhD.

3.1.1 Coordination of admission process of ~182 (74+108) PhD positions in reporting period under CSIR-CDRI PhD Program (JNU & AcSIR):

- Drafting and designing and processing for publication of advertisement for CSIR-CDRI PhD Programs
- Collection, compilation and approval of JRF requirement from scientists as per norms Constitution and getting approval of screening committee and coordination with screening committee for screening of more than 500-600 admission forms in each session and selection committee for Interview.
- Compilation, preparation of result proceedings, declaration & communication of results.
- Facilitated the interaction with scientists and completion of documental requirements for admission
- Orientation program for newly admitted research fellows (Number of Research Students registered in AcSIR in January 2019 batch: **33**, and in JNU in August 2019 batch: **71** and in AcSIR in August 2019: **09**)

3.1.2 Coordination of Pre-PhD Course work of CSIR-CDRI PhD Programs:

- Preparation, display & distribution of academic calendar for Pre-PhD course work including notification of Examination Schedule for each Semester (Four exams per semester i.e., Ist sessional, Mid Term, IInd Sessional & End Term Examinations)

Dr. Sanjeev Yadav, Dr. Saman Habib & Dr. S.K. Rath
Coordinator Co-coordinator

- Organization and coordination of meeting of course coordinators to discuss syllabus for smooth conductance of pre Ph.D. course work
- Compilation of Optional subjects collected from students and coordination with course coordinator and HRMS for proper attendance
- Coordination with faculty and course coordinators for smooth conduction of classes, seminars and other activities related with Pre PhD course work, exams and evaluation of answer sheets, question paper formatting & printing
- Compiling results, result sheet with SGPA and display of results.

3.1.3 Coordination with Doctoral/Research Advisory Committee (DAC/RAC) for CSIR-CDRI PhD Programs:

- Coordination with supervisors for constitution of Doctoral/Research Advisory Committee (DAC/RAC) for each student
- Coordination for Comprehensive for candidates registered with AcSIR
- Formalities regarding issue of Enrolment number and confirmation and registration process of students for PhD Program
- Collection of RAC/DAC reports periodically
- Collection of synopsis for the approval of Academic committee
- Coordination with supervisors for Panel of examiners for thesis evaluation
- Thesis submission along with all the documents related to thesis & viva voce, scanned & send to JNU and AcSIR

3.1.4 Coordination for conducting Viva-voce Examination:

- Formalities related to Ph.D. thesis submission (**49** Thesis submitted in the reporting period)
- Organizing viva-voce examinations of JNU/AcSIR students of previous batches (**75** viva-voce examinations were conducted during reporting period)

- To promote Digital India, many viva-voce examinations were done through SKYPE (**48** viva-voce examinations were conducted during reporting period)
- Follow up of thesis in case of delay in viva-voce
- Coordination with AcSIR/JNU for awards of provisional degree and degree and related issues.

3.1.5 Issue of Transcripts and certificates and verifications thereof:

- Issue of certificate of completion of PhD Course work as per the UGC norm
- Issue of Transcripts, verification of Degree, current and previous students as and when required by the employer or by third party academic record verifying agencies.
- Maintaining record of Ph.D. certificates received from JNU and issued to students.

3.1.6 Formalities regarding other financial remittance to JNU/AcSIR according to commitments

- Coordination with JNU and CDRI administration for submission of affiliation fee to JNU as per the MoU for continuation and smooth running of CSIR-CDRI-JNU PhD Program.
- Process the payments of TA/DA and Honorarium for the evaluator of thesis and examiners of viva-voce.
- Handling of AcSIR budget (P-92-205) for AcSIR related activities.

3.1.7 Coordination and organization of Academic Council (Institutional, JNU & AcSIR)/ JNU Scrutiny committee meetings

- Coordination for JNU-CDRI Academic Council meeting (twice in a year) from constitution of committee to preparation of minutes of meeting
- Coordination for Scrutiny Committee Meeting for scrutiny of the results of course work of CSIR-CDRI-JNU PhD Program (This year we did it first time)
- Coordination for CDRI Academic Committee meeting (twice in a year) for formulating the guidelines to implementing the existing guidelines.

3.2 Administrative Activities

Beside academic activities, Unit is also involved on other activities to support the science and technology management and administrative work.

3.2.1 Financial approval of Monthly Fellowship, HRA and Contingency of UGC Fellows

In the reporting period, for regular disbursement of Monthly Fellowship, HRA and Contingency of UGC JRF & SRF of CSIR-CDRI; Unit perform the following activities for more than **126** UGC JRF & SRF as a "Maker" on UGC-portal as financial administrator on the basis of records available in Establishment-I section.

3.2.2 Processing of applications for attending the conference/ seminar/ workshop/symposium

In the reporting period, Total **285** application were processed for the research scholars (JRF, SRF, RA, N-PDF and Women Scientists) who have attended various national and international conference/ seminar/ symposium/workshops.

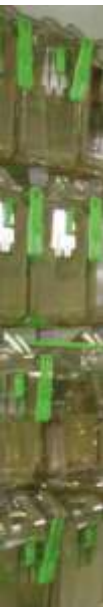
3.2.3 Processing of application of SRFs and RAs for various funding agencies

In the reporting period total **46** applications including, 04 applications for ICMR-Research Associate (RA), 01 for DBT-RA, 01 for DST-TARE, 02 for DBT India Alliance Early Career Fellowship, 04 N-PDF, 06 CSIR-RA and 13 ICMR-Senior Research Fellow (SRF), 14 CSIR-SRF, 01 DST-Woman Scientists Fellow and 01 applications for AYUSH JRF were processed.

3.3 Print, Electronic and Social Media (Twitter & Facebook) Management Activities

3.3.1 Print and Electronic Media

Organization's brand image can be as important as the goods or services it produces. A strong brand image is a powerful asset. A recognized and trusted brand identity makes people confident that the organization is dependable. Hence, the image building of Institute is very crucial part for any organization it



showcases the achievements and relevance of organization to society nationally and internationally and attracts the other stakeholders. During the reporting period Institute comes in limelight for **45** days with **173** news articles in local and national print and electronic media.

3.3.2 Social Media (Twitter & Facebook)

During the reporting period on twitter handle of CSIR-CDRI, followers increased from **4095** to **6330** with the help of more than **2000** tweets from our handle. The average tweet impression increased from **7680** per day to **13400** per day during reporting period. During the reporting period, on Facebook account of CSIR-CDRI, number of followers increased from **2440** to **4017** with more than **4950** friend followers during the reporting period.

3.4 Activities under the aegis of Scientific Social Responsibility (SSR) of Institute

Scientific Social Responsibility (SSR) is the confluence of scientific knowledge with visionary leadership and social conscience. SSR is about building synergies among all stakeholders in our scientific knowledge community and also about developing linkages between science and society.

3.4.1 CSIR-800 Program (Health Awareness and Outreach Projects by PhD Students)

The major objective of the CSIR-800 project is to create and nurture a sense of social consciousness and responsibility by participation in Science & Technology activities relevant to the nation. CSIR 800 focus areas: The two major focus areas of CSIR-800 are to enhance income and to improve the quality of life of the 800 million people of India. Some typical examples are as the following:

To Enhance Income of the downtrodden:

- Value added Agriculture
- Waste to Wealth
- Energy efficiency

To Improve Quality of Life:

- Affordable health care
- Low cost housing
- Potable Water supply
- Sustainable energy
- Means of protecting environment

In the reporting period, Unit coordinated total **11** projects which were undertaken in the focus area for improve the quality of life through enhancing the awareness related to affordable healthcare.

3.4.2 Students Motivation Programs for various Schools & Colleges

To initiate and promote experimentation and innovativeness in education and bringing confidence to society about relevance of Institute in terms of Social Impact, various student motivation programs were organized to inculcate the scientific temperament. During the reporting period, Total 22 Student Motivation Programs (SMP) for 69 Schools and Colleges other than Kendriya Vidyalaya were organized in which total 226 faculties and 2486 students get benefitted with these program. This program is being carried out in coordination with Human Resource Development Group.

4. Human Resource Development & Knowledge Resource Centre

4.1 Skill Development Program (Healthcare & Life Science)

Skill India is an initiative launched to empower the youth of our country with skill sets which make them more employable and more productive in their work environment. We offer six certificate courses of level IV to VII under the CSIR-CDRI, Skill Development Program. Skill shortage remains one of the major constraints to continued growth of the Indian

Mr. Prem Prakash & Mr. Vinay Tripathi, In-charge

economy. We wish to address this knowledge-gap by professionally trained youth of India. The courses have been designed to meet the aspirations of students, young researchers and industry sponsored personnel looking for training. These courses provide an opportunity for skill development and hands-on experience in the area of healthcare and life science.

4.2 Skill Development Program for Postgraduate Students

The course meets the aspirations of students/young researchers looking for training and hands-on experience in the chosen area. Students pursuing their Post-graduation course from Universities/ Colleges in any of the relevant areas can improve skills through these this course. During the period 122 candidates have taken training for a duration of minimum 4 months upto 1 year depending upon the recommendation of his/her HOD.

4.3 Advance Training Courses for the employees of R & D Institutions/ Pharmaceutical Industry/ Government Laboratories etc.

Institute conducts different kinds of training of short duration in various disciplines against payment. The courses comprise both lectures and practicals by our experienced scientists with emphasis on practical R & D aspects in a particular discipline. During the year 12 candidates from Indian Academy of Science, 1 from JNCR, 1 from academia/organizations and 3 research student took training.

4.4 Biological Activity Screening:

Over the years CSIR-CDRI has developed a large number of Biological Assays and Screening Protocols to carry out biological activity studies of compounds against various diseases. Disease areas for which the assays are available on payment basis are CNS-CVS, Reproductive Health, Malaria and other Parasitic Diseases, Cancer, Tuberculosis and Microbial Infections and Regulatory/ Experimental Toxicity Studies.

We have received 90 samples through Biological Activity Screening during the year from 21 beneficiaries. External Cash Flow (ECF) generated Rs. 4,07,310/-.

4.5 International Science & Technology Affairs:

Over the years the institute has invited several foreign researchers visiting under fellowships such as TWAS, RTF-DCS etc. Research scholars are eligible for assistance from the Human Resource Development Unit towards conducting their research under international fellowships/scholarships.

During the period Mr. Adam Olaitan Abdulkareem, from Department of Zoology, University of Ilorin, Nigeria has been awarded CSIR TWAS Postgraduate Fellowship for a period of 1 year starting from 15th October, 2019 under the supervision of Dr. Kashif Hanif.

Some other activities include :

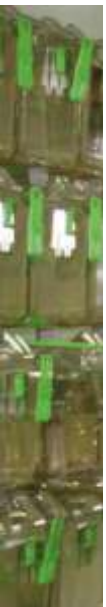
- Providing foreign deputation reports to the Head, ISTAD, CSIR regarding scientists visited abroad
- Arranging training programs for foreign candidates, coordination of distinguished foreign visitors/ delegation at CSIR-CDRI
- International collaborative projects, bilateral International cooperation programs

4.6 RTI

Implementation of Right to Information Act-2005 in the institute to promote transparency and accountability in the working of every public authority in India.

4.7 JIGYASA – Quest for Curiosity

JIGYASA, a student-scientist connect programme, initiated by Council of Scientific and Industrial Research (CSIR) and Kendriya Vidyalaya Sangathan (KVS) in year 2017, however now Navoday Vidyalaya and other Government Schools have also been added in it. The objective of the programme is to expose students with practical activities to get a flavor of research in CSIR-CDRI by extending classroom learning to research and laboratory-based learning at early age. In the reporting period, 30 Kendriya Vidyalaya were visited under the aegis of JIGYASA



Program out of that 104 faculty and 1121 students get benefitted with these program. This program is being carried out in collaboration with Academic Affairs Unit of CSIR-CDRI.

4.8 Knowledge Resource Centre

During the year, the KRC has served the purpose and mission of the institute by subscribing and making available the scientific resources to the researchers including students of CSIR- CDRI. Knowledge Resource Centre of CSIR- CDRI also provides information on Biomedical Research in general and drugs and pharmaceutical in particular, to users all across India in academia, drug industry and research institutions. Apart from that large number of students and faculty visited the library during 2018-2019 as well as about 1397 walk-in users from universities and other academic institutions. Present collection of books and bound volumes of journals has reached to 23000 and 73969 respectively including Hindi books.

Apart from regular journals subscription, Institute continued to avail services of SciFinder, Web of Science, Grammarly iThenticate and other databases along with resources like Current Protocols in Molecular Biology, Current Protocols in Pharmacology, Annual Reviews, and Methods in Enzymology. The centre also manages, maintains and updates the institute's web OPAC based on KOHA and institutional repository which is available online.

Infrastructure Management Group

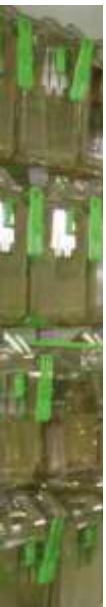
1 Information Technology and Networking

1.1 Software Development/Maintenance: Computer Center has developed, implemented and maintained the following software systems during the reporting period:

- Software enhancement, maintenance and support for old and new SnP Software and migration of Stores module to .NET platform
- Compound Submission and Bio-Assay Reporting (CBRS) System and its enhancement for natural compounds.
- CDRI internet and intranet website.
- Requisition for Bio-evaluation of compounds from CDRI Repository
- Online Request / Reporting for Small Molecule X-ray Diffraction Facility
- Online Sample Submission/Analysis and Equipment Booking software for SAIF
- Biometric based attendance system for contractual staff of old campus, new campus (Engineering Section, Animal house)
- Biometric based attendance system for students/Project staff/Trainee
- Enhancement of AEBAS Record Management System(AEBAS+) for regular staff
- MIS application for AEBAS Record Management System for regular employees
- Maintenance of MoES database Application
- Operation and maintenance of HRMS system for students
- Enhancement of Software for online Digital Herbarium
- Online Electrical/Civil/Refrigeration/Other Lab Services Job cards
- Software for dispensary automation (under-implementation)
- Instrument online pre-booking system
- Subject expert database, Alumni database, online registration for seminars etc.


Er. Santhosh Shukla & Er. Kural, In-charge

- Android mobile application for IT helpdesk
- Implementation of latest DSPACE software
- SMS (Through GSM Modem) and Landline/Mobile Call based monitoring/alert system for Server room temperature monitoring.
- Customization of Desktop Biometric devices for attendance of regular staff.
- Animal Issue Software
- Co-operative Society Database
- Database for GPF Statement
- Online Budget Monitoring System
- Online Guest House Booking System (under-implementation)
- Visitor Management System
- Vendor Registration Software for CSIR-HQ, its security audit and hosting
- Online Skill Development Program (SDP) registration for CSIR-CDRI Courses
- Online Gate Pass application for visitors
- Management & hosting of plantmetabolome.cdri.res.in Plant Metabolites database and Tendem Mass Spectrum Database
- Vehicle Booking System
- Software for automating Foreign deputation processes
- Website for CTDDR-2019 registration
- Student ID card data collection
- Software for Wireless Controller log
- Security audit of public hosted websites and web applications
- Web application for seeking nominations for awards for Annual day etc.
- Design and development of new institutional website
- Development of website for Survey on Mental health awareness
- Enhancements and hosting of web application for Scientist recruitment 2019
- Development of website for Canteen requisitions



1.2 ICT Infrastructure Management and Services

- Operation and Management of LAN/WAN System comprising of 1500 wired nodes and campus-wide Wireless network and NKN link of 1 Gbps bandwidth.
- Operation and Management of servers and SAN systems
- Comprehensive IT support to institute wide users comprising of approximately 1000 clients.
- Web hosting services for several publicly accessible websites including institute's internet website (www.cdri.res.in)
- Support provided for implementation of e-procurement System
- Provisioning for NIC e-mail services
- Maintenance of PCs as per Standard Operation Procedure(SOP) for Protection and validation of Hardware and Software under GLP
- Routine backup for GLP related data
- Hosting of CDRI tenders on website Portal
- Helpdesk for ERP & AEBAS user support
- Skype & Videoconferencing facility
- Operation and Management of CCTV and access control systems
- ICT support to administration for conducting CBT test for recruitment
- ICT support for Audiovisual arrangements
- Bulk procurement of ICT items (Desktop, Laptops, Printers etc.) for institute wide users
- ICT support for implementation of Account-manager
- ICT support for adoption of GeM software
- Procurement and Support for setting up of ICT infrastructure for AMRIT Incubation Center
- Procurement and Installation of Large Sized Digital Signage
- Trial run of SnP module of ONECSIR ERP.

2 Division of Institute Core Facilities

Environmental health & safety carries utmost importance in research laboratory; Compliances of various statuary and government agencies i.e. Ministry of Environment & Forest, UP Pollution control board, Good Laboratory practice for rigorous monitoring the experimental and environmental parameters has been followed by the CSIR-CDRI. Our lab core facilities at CSIR-CDRI provide very important services in terms of operation and maintaining various centralized gas supply i.e. LPG, Nitrogen, Compressed air, vacuum and pharmaceutical buffer grade water to the work bench in chemical and biological research labs. The centralized services optimize the recurring expenditure and maintenance cost of the institute where the quality at centralized point can be assessed /analysed. Presently following services are effectively functional and maintained under Division of Institute Core Facilities Management at the CSIR-CDRI, Lucknow.

2.1 Operation and maintenance of GLP Test Facility

ICF Division maintaining the Institutional GLP Facility as per the OECD Guidelines to comply the statutory requirements of NGCMA, New Delhi.

- Preparation and revision of 7 nos. of Standard operating procedure (SOP).
- Preparation and revision of following controlled documents
- Mater equipment List (107 Nos. of GLP equipment)
- Calibration/Validation record (94 Nos. of GLP equipment)

Mr. N.K. Agarwal, Mr. Ranvir Singh, Er. Manoj Kumar Rawat & Dr. Atul Goel, In-Charge

- Minor equipment List (7 Nos. of GLP equipment)
- Withdrawn/Replaced equipment list (16 Nos. of GLP equipment)
- Unique Identity Tag (107 Nos. of GLP equipment)
- Technical specification verification, procurement, installation and commissioning of GLP equipment.
- Calibration/validation of 85 nos. of GLP equipment as per OECD guidelines.
- Troubleshooting/repair of sophisticated GLP equipment.
- Quarterly Performance check/preventive maintenance and report preparation of 83 nos. of GLP equipment.·
- Monthly Monitoring, controlling and report preparation for the standard environmental conditions in experimental rooms and other GLP labs (TICO, CADC, Toxicology & Histopathology).

2.2 Operation and management Auditorium and Audio-Visual systems

Audio Visual Unit under ICF division looks after the audio visual and related facility of auditorium and meeting rooms/ halls for institutional scientific lectures, conferences, seminars, workshops, project meetings, selection committee meetings, RC meetings and other general events. The major activities of this unit are:

- Operation & maintenance of high end audio and visual systems to ensure smooth functioning during events.
- Co-ordination with other facility section for smooth organizing of events.
- Preventive maintenance of amplifiers, switchers, feedback suppresser, microphones, portable sound systems, speakers and projection systems.
- Up-gradation of audio and visual system to make it compatible with available latest technology.

- Operation & maintenance of Information display system in Auditorium Complex for event information.
- Operation and management of Live broadcast systems.
- Operation & management of information kiosk installed at auditorium complex.
- Co-ordination with other section to maintain and renovate the related facilities of auditorium.

2.3 Management of Instruments

Instrumentation section provides efficient and economical repair, maintenance and upkeep of different sophisticated analytical, biomedical, electronics and laboratory equipments in the CSIR-CDRI. Due to non-availability of imported components/spares, indigenous substitute was used to ensure the smooth functioning of equipments. Tracing of part of circuit were carried out whenever circuit diagram/service manual was not available. Technical specification verification was carried out for the procurement of state of the art new equipment. This unit helped the user scientists to prepare broad based technical specification and to choose right equipments to suit their applications. Laboratory equipments of different divisions of institute are calibrated as per GLP guidelines as per user requirement. Training provided on instrumentation technique and hardware to students from different academic institute under Skill development program.

2.4 Centralized Gas Supply & Utility Generation services

Centralized Gas supply and utility services under other lab services at CSIR-CDRI provide crucial technical services in terms of operation and maintaining various centralized Services. Presently following services are effectively functional and maintained under ICF Division at CSIR-CDRI, Lucknow

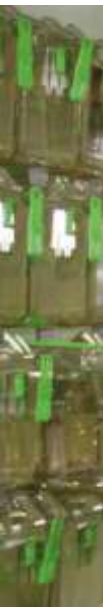
- Onsite generation of Liquid Nitrogen (LN_2).
- Operation & maintenance of nitrogen gas generation and onsite supply in approx. 500 distribution points in 120 labs.
- Onsite supply and maintenance of LPG gas at work bench.
- Operation & maintenance of vacuum generation services, air compressor and onsite supply at work bench at approx. 500 distribution points.
- In House operation and maintenance of Glass Blowing Unit to manufacture glass capillaries repair of glassware equipment's etc.
- Operation & Maintenance of pharmaceutical grade (ASTM D1193 Grade-III) specification De-ionized water supply at work bench.
- In House Operation & maintenance of Sewage Treatment Plant (STP) & Effluent Treatment Plant (ETP), Biomedical waste disposal through Incineration unit and statuary compliances of UPPCB and Ministry of Environment & Forest.
- Operation, up keeping of fire alarm, fire-fighting, fire hydrant system, public announcement (PA) system, fire pumps and Safety stations as per statuary guidelines of Department of Fire services, Uttar Pradesh Government.
- Maintaining of various housekeeping services i.e. Pest & rodent control, termite control, fogging, specialized cleaning in Animal care lab, Horticulture services etc. Environmental & Waste management as per statuary /Good Laboratory Practices (GLP) guidelines.

2.5 Management of Guest House

The division is maintaining Guesthouse facility of the CSIR-CDRI to cater our guest from different government organizations, institutions, universities, colleges, industries coming for official meetings, workshops, conferences, seminars etc.

2.6 Horticulture Services:

Institute has 62 acre residential lush green campus; its flora and fauna related activities get maintained by Horticulture unit. In this year during rainy session approx. 500 sapling plants purchased from Forest Department Government of Uttar Pradesh was planted in open area for more green belt development.



Presently, CDRI has approx. 10,000 big plants/trees of various medicinal values, scientific importance. Botanical name and medicinal value of plant / uses for particular disease has been displayed in front of particular tree/plant; initiative of owning of plant was also taken where the individual has to take care of plant owned by him.

There was lot of seasonal plants, flowers; bushy flora/fauna were developed. CDRI campus earns very good applause for horticulture/ housekeeping maintenance as spoken by number of Indian & foreign delegates on dais while making his speech. The bouquets presented to the guests are prepared from seasonal flowers collected from CDRI garden. Further, Mr Kalim-Ullah, Padma Sri Awardee from Government of India did tree plantation and gifted special breed of plant developed in his nursery at Malihabad, Lucknow.

2.7 Disaster Management: Fire Fighting Unit

CDRI laboratory fulfil compliances of "National Building Code-2005"; there is dedicated team for operation and up keeping of fire alarm system which has main control unit along with the modular control and repeater panel system. The fire detection devices i.e. Refractive indication, Optical detector, Manual calls point and speaker system and fire fighting devices i.e. Fire Extinguishers, Fire Hydrants, hose reels, hose pipes etc. installed as per approved design from Fire Department. Demonstration of fire fighting system and safety management done to all the scientific and administrative staff at every month. The building is inspected by Fire & safety officers of UP Government and consent/ no objection issued by them time to time. Further, in case of fire in nearby areas of CDRI, Fire tender on emergency basis also filled by CDRI time to time.

2.8 Environmental, Health & Safety Services:

The division coordinates and maintain Housekeeping services, specialized cleaning in Animal care labs, environmental & Waste management as per statuary /Good Laboratory Practices (GLP) guidelines. The divisional activity includes:

- Operation and maintenance of Effluent Treatment Plant (ETP), Sewage Treatment Plant (STP) and Biomedical waste Incinerator etc.
- Pest & rodent control, fogging for mosquito removal, termite control etc.
- Operation and up keeping of fire alarm, fire-fighting, fire hydrant system and public announcement (PA) system and Safety stations.
- Cleaning & maintenance of drinking water purification system & maintenance of common facilities.
- Miscellaneous work on waste solvent /chemical recycle; horticulture & preparation of sports ground, play grounds in campus.

Photo: Effluent treatment plant

Photo: Sewage Treatment plant

3 Engineering Services

Laboratory Engineering Services Division, comprising of Civil, Electrical, & HVAC sections continued to provide Engineering Services to the Institute to maintain the existing infrastructure & services for R & D works and create new infrastructure. The major works carried out during reporting period are as follows:

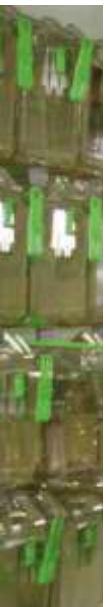
Completed Works:

- Repair and painting of Director's Bungalow at CDRI New campus at Sitapur Road, Lucknow.
- Providing temporary shed for existing walk-way from PCS Block up to Main canteen at CDRI New Campus, Sitapur Road Lucknow.
- Miscellaneous maintenance, Painting and structural steel works at CDRI New Campus Lucknow.
- Miscellaneous door/window repairs/ replacement at CSIR Scientist Apartment, Sector K, Aliganj, Lucknow.
- Rectification replacement of existing polycarbonate roofing sheet at One R and D Block and allied works at CDRI New Campus, Sitapur Road, Lucknow.
- Repairing of stone cladding along with other miscellaneous repairs at New CDRI Campus, Lucknow.
- Providing temporary shed for sitting space in refreshment counter in Lawn of R & D Blocks at CDRI New Campus, Sitapur Road Lucknow.

Er. Parvez Mahmood, In-Charge, Er. Kamal Jain

Ongoing Works:

- Strengthening of (i) separation fencing wall between CDRI Chattar Manzil premises and ASI and (ii) provision of concertina wire fencing at river side up to Incinerator in Old Campus of CDRI, Lucknow.
- Renovation and upgradation of Guest House Canteen at CDRI New Campus, Sitapur Road, Lucknow.
- Repairing and painting work of existing boundary wall at CDRI, New Campus, Sitapur Road, Lucknow.
- Construction of Radio Isotope Laboratory at CDRI New Campus, at Sitapur Road, Lucknow.
- Repair, Painting, and Fencing of boundary wall of CFTRI resource centre, Deva Road, Lucknow.
- Proposal for creation of BSL-3 Facility at CDRI, Lucknow.
- Proposal for International Guest House at CSIR Scientist Apartment, Sector K, Aliganj, Lucknow.
- Upkeep of GLP Facility.
- Upkeep of water supply to the Institute.



Section
III

Research Output

दैनिक जागरण की वरिष्ठ पत्रकार सम्मानित

विज्ञान पत्रकारिता के लिए दैनिक जागरण की वरिष्ठ पत्रकार रूमा सिन्हा को गुरुवार को सम्मानित किया गया। इस दौरान विभिन्न क्षेत्रों के लोगों को भी सम्मानित किया गया। सीडीआरआइ में आयोजित इंडिया-इंटरनेशनल साइंस फेस्टिवल-2019 के तहत आउटरीच प्रोग्राम का आयोजन किया गया। इस दौरान विज्ञान भारती के प्रो. सोमदेव भारद्वाज, सीडीआरआइ के पूर्व निदेशक डॉ. वीपी कंबोज, चीफ साइंटिस्ट डॉ. ऐके सिन्हा ने विज्ञान पत्रकारिता के लिए दैनिक जागरण की वरिष्ठ पत्रकार रूमा सिन्हा को सम्मानित किया। इसके अलाव केंद्रीय विद्यालय के शिक्षक सुशील द्विवेदी केजीएमयू की डॉ. तूलिका चंद्रा समेत विभिन्न क्षेत्रों के लोगों को सम्मानित किया गया। पत्रकार रूमा सिन्हा को 15 अक्टूबर को भी विज्ञान रिपोर्टाज के क्षेत्र में आइआइटीआर में सम्मानित किया गया था।

https://epaper.jagran.com/epaper/02-sep-2019-262-national-edition-national-page-12.html

वैक्सीन के जरिये मलेरिया पर लगेगा अंकुश

CDRI scientists to get NASI awards

PIONEER NEWS SERVICE ■ LUCKNOW

Two CDRI scientists have been nominated for the prestigious awards by National Academy of Sciences (NASI). Atul Goel will receive the NASI-RELIANCE Industries Platinum Jubilee Award-2019. Senior principal scientist of CDRI, Goel has been recognised for his significant contributions to application-oriented innovations in the area of developing new drugs and diagnostics. He will be honoured with a plaque and Rs 3 lakh in cash at the 89th Annual Session of NASI to be held at Hyderabad in December later this year.

Besides, principal scientist Ritu Trivedi has been chosen for Dr P Sheel Memorial Lecture Award-2019 (Young Women Award) from NASI. She was selected for this award for her research in the area of metabolic bone disorders, specifically on osteoporosis and osteoarthritis. She has worked on several molecules derived from either natural resources or chemically synthesised for improvement of bone health. Out of these, a pure small molecule has shown promise as an anti-resorptive agent and is being prepared for clinical trials.

Leprosy drug to treat cancer? Docs hunt for new uses of old meds

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New Delhi: Can a leprosy tablet priced at Rs 2 be the miracle cure to treat blood-cell cancer? Or can expensive injections given to treat osteoporosis in post-menopausal women be replaced with a pill that costs as little as Rs 100 for a month's supply? These are questions Indian doctors have set out to answer as they look towards repurposing old drugs as affordable treatments for new diseases.

At the Central Drug Research Institute, Lucknow, scientists recently found certain leprosy drugs might help treat myeloma, a type of blood cancer.

Sabyasachi Sanyal, a researcher at CDRI, in collaboration with clinical haematology department of King George's Medical University, Lucknow, screened FDA-approved drugs in chronic myeloid leukaemia (CML) cells and found that a leprosy drug — clofazimine, priced at Rs 2 per tablet — was a potent inhibitor of these cells.

▶Cost to launch, P 8

CLINICAL TRIALS ON

- Drug trials are on to see if itraconazole, an anti-fungal medicine, can be used to fight prostate cancer
- Dextromethrophan, a cure for dry cough, could come in handy to treat Type 2 diabetes
- Mifepristone, used to induce a miscarriage, is now being tested as a remedy for bipolar disorder

Cost to launch repurposed drugs 85% less

▶Continued from P 1

...search's colleagues and chief scientist at CDRI Lucknow, Dr Nishtha Chatopadhyay, screened a library of over 1,000 drugs with the aim to discover several substitutes for teriparatide — an injectable given to women suffering from post-menopausal osteoporosis. "Our pre-clinical studies found that Pioxsulfrine, a drug prescribed for treatment of a disease of peripheral artery when given to osteoporotic female rabbits mimicked effects of teriparatide including restoration of bone mass, strength, microarchitecture and quality," Chatopadhyay told TOI. The cost of launching a repurposed drug is approximately 85% less than that incurred on launching a new drug, said Chatopadhyay. "Strategic repurposing of old drugs for new uses can save time as their pharmacokinetics, safety for formulation and potential toxicity are already available," Chatopadhyay said.

Doctors at AIIMS are conducting clinical trials on repurposed drugs. Dr Kameshwar Prasad, professor of neurology at AIIMS, recently wrote to ICMR to set up a task force to identify and validate low-cost alternatives to expensive drugs. He said doctors were already prescribing cheaper therapies.

https://timesofindia.indiatimes.com/india/leprosy-drug-to-treat-cancer-doctors-hunt-for-new-uses-of-old-medicines/articleshow/70929944.cms

Dr Purkait CSIR-Your Scientist A

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Central Drug Research Institute scientist Bidyut Purkait has received this year's CSIR-Young Scientist Award (Biological Sciences). Purkait is currently working in Molecular Parasitology and Immunology Division of CDRI. He has made significant contributions in the field of Drug Resistance in Visceral Leishmaniasis (VL) or Kala-azar caused by Leishmania donovani.

"He reported first time the amphotericin B clinical isolates and decoded the mechanism of amphotericin B resistance in his clinical isolates of Leishmania donovani. He demonstrated the synergistic involvement of membrane composition, ABC transporter and thiol metabolic pathway in conferring AmB resistance," media incharge CDRI Sanjeev Yadav said. In connection with his resistance mechanism, he has explored the functioning of molecular-level histone acetylase enzyme. This work has been published in a high-impact international journal. "His contribution, commitment and achievement in the field of visceral Leishmaniasis (drug resistance) is praiseworthy. In search for the new drug targets, Dr Purkait is currently working on both the Visceral

He has significant contribution in field of Drug Resistance in Visceral Leishmaniasis or Kala-azar caused by Leishmania donovani

Leishmaniasis (VL) a... Lymphatic Filariasis (LF)... started characterising RI... editing pathway, a unique p... transcriptional modificati... process," said Yadav.

Purkait has 19 publicati... in major international jo... nals proving the scientific ... nificance of his work. T... award is given annually in th... fields of Biological Science... Chemical Sciences; Earth ... Atmosphere, Ocean an... Planetary Sciences; Engineerin... Sciences; and Physical Sciences... Each award consists of a citation... (signed by the CSIR DG an... vice-president), a cash prize o... Rs 50,000 and a plaque... Awardees are entitled to a spe... cial honorarium of Rs 7,500 pe... month till the age of 45 years... Research grant of Rs 25 lak... over a period of five years is als... given to awardees.

औषधीय ज्ञान को मिलेगी वैज्ञानिक मान्यता

लखनऊ | निज संवाददाता

सीडीआरआई और मणिपुर के ईएमआरसी-फोड्स के बीच पूर्वोत्तर भारत के पारंपरिक ज्ञान को वैज्ञानिक मान्यता दिलाने के लिए गुरुवार को समझौता ज्ञापन पर हस्ताक्षर हुए। सीडीआरआई के निदेशक प्रो. तपस कुमार कुंडू व ईएमआरसी-फोड्स के निदेशक डॉ. ऐके रावत ने एमओयू पर हस्ताक्षर किए। समझौते के अनुसार, ईएमआरसी-फोड्स एथ्नो मेडिसिनल रिसर्च सेंटर दवाईयां बनाने में काम आने वाले चिन्हित औषधीय पौधों को बड़े पैमाने पर खेती करेगा। साथ ही पादप सामग्री की आपूर्ति और जैव सक्रियता के मूल्यांकन को भी सुनिश्चित करेगा।

वहीं, सीडीआरआई फोड्स सेंटर द्वारा भेजी गई पादप सामग्री और उनके सक्रिय घटकों के फाइटोकेमिकल डेटा के संग्रह के साथ उनके लोक पारंपरिक ज्ञान की डॉक्यूमेंटेशन की प्रमाणिकता का मूल्यांकन करेगा।

http://epaper.livehindustan.com/imageview_381766_864776196_4_54_15-11-2019_8_i_1_sf.html

युवा वैज्ञानिकों को मिलेगा सम्मान

परजीवी से मिला प्रोटीन दिलाएगा जोड़ों के दर्द से छुटकारा

जागरण विशेष ▸ रिह्यूमेटाइड आर्थराइटिस के इलाज में मील का पत्थर साबित हो सकती है सीडीआरआइ की खोज

1 Publications

2018

(Not included in the previous year Annual Report due to late reporting)

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2 Patents

2.1 Patents Filed in India

Patent Application No.: 201911001367 **Date of Filing :** 11-01-2019
Title: Synergistic formulation for the prevention or treatment of osteoarthritis/ joint related disorders
Inventors: Ritu Trivedi, Rabi Shankar Bhatta, Priyanka Kothari, Ashish K Tripathi, V Teja Banala, Sudhir Kumar, Divya Rai, Shradha Sinha, Rakesh Maurya, Prabhat Ranjan Mishra & Lal Hingorani

Patent Application No.: 201911025087 **Date of Filing :** 24-06-2019
Title: Potency of a Platinum-NHC (N-heterocyclic carbene) compound as antibacterial agent targeting drug resistant *Staphylococcus aureus*
Inventors: Jitendra Kumar Bera, Sidharth Chopra, Saravanan Matheshwaran, Mandeep Kaur, Ritesh Thakare, Arindom Bhattacherya & Prem Anand Murugan

2.2 Patents Granted in India

Patent No.: 321531 **Date of Grant :** 26-09-2019
Title: Preparation and antimalarial activity of novel quinoline derivatives
Inventors: Seturam Bandhacharya Katti, Wahajul Haq, Kumkum Srivastava, Sunil Kumar Puri, Manish Sinha, Awakash Soni & Rajeev Kumar Srivastava
Support staff : Kamlesh Kumar Singh

Patent No.: 321486 **Date of Grant :** 26-09-2019
Title: Chiral 3-aminomethylpiperidine derivatives as inhibitors of collagen induced platelet activation and adhesion
Inventors: Dinesh Kumar Dikshit, Madhu Dikshit, Tanveer Irshad Siddiqi, Anil Kumar, Rabi Shankar Bhatta, Girish Kumar Jain, Manoj Kumar Barthwal, Ankita Mishra, Vivek Khanna, Prem Prakash, Manish Jain, Vishal Singh, Varsha Gupta & A K Dwivedi
Support staff : Surendra Singh, C P Pande, Kanta Bhutani, M.S. Ansari & Devendra Singh

Patent No.: 318030 **Date of Grant :** 09-08-2019
Title: 4-Amino quinolines and process of preparation thereof
Inventors: Seturam Bandhacharya Katti, Wahajul Haq, Kumkum Srivastava, Sunil Kumar Puri, Vasantha Rao Dola, Awakash Soni & Rajeev Kumar Srivastava

Patent No.: 315581 **Date of Grant :** 05-07-2019
Title: Substituted fluoranthene-7-carbonitriles/esters as fluorescent dyes for cell imaging applications
Inventors: Atul Goel, Ashutosh Sharma, Kalyan Mitra, Arindam Bhattacharjee & Manoj Kathuria

Patent No.: 309213 **Date of Grant :** 14-03-2019
Title: Antidiabetic and antidyslipidemic activities of pregnane-oximino-aminoalkylethers
Inventors: Prem Chandra Verma, Jyoti Gupta, Dharmendra Pratap Singh, Varsha Gupta, Hari Narayan Kushwaha, Anamika Misra, Neha Rahuja, Rohit Srivastava, Natasha Jaiswal, Ashok Kumar Khanna, Akhilesh Kumar Tamrakar, Shio Kumar Singh, Anil Kumar Dwivedi, Arvind Kumar Srivastava, & Ram Pratap

2.3 Patents Filed Abroad

Europe Patent Application No. : 18728989.7 **Date of Filing :** 20-11-2019
Title: Substituted methanopyrido [2, 1-a] isoindolones as mAchR modulators for treating various associated pathophysiological conditions and process for preparation thereof
Inventors: Ganesh Pandey, Rajesh Varkhedkar, Divya Tiwari, Prem Narayan Yadav, Shalini Dogra & Yusuf Hussain

United States Patent Application No.: 16/614482 **Date of Filing:** 18-11-2019
Title: Substituted methanopyrido [2, 1-a] isoindolones as mAchR modulators for treating various associated pathophysiological conditions and process for preparation thereof
Inventors: Ganesh Pandey, Rajesh Varkhedkar, Divya Tiwari, Prem Narayan Yadav, Shalini Dogra & Yusuf Hussain

United States Patent Application No. : 16/434323 **Date of Filing :** 07-06-2019
Title: Bioactive extract, fraction of *Cassia occidentalis* and formulation thereof for bone regeneration
Inventors: Naibedya Chattopadhyay, Subhashis Pal, Sudhir Kumar, Ramakrishna Eppalapally, Padam Kumar, Sapana, Jiaur Rahaman Gayen, Mohammed Riyazuddin, Sabyasachi Sanyal, Anagha Gurjar, Prabhat Ranjan Mishra, Naresh Mittapelly, Kamal Ram Arya, Brijesh Kumar, Srikanta Rath, Arun Kumar Trivedi, & Rakesh Maurya
Support staff: Satish Chandra Tiwari, Athar Husain

2.4 Patents Granted Abroad

Great Britain Patent No.: 2527958 **Date of Grant** : 04-09-2019
Title: Antidiabetic and antidyslipidemic activities of pregnane-oximino-aminoalkylethers
Inventors: Verma Prem Chandra, Gupta Jyoti, Singh Dharmendra Pratap, Gupta Varsha, Kushwaha Hari Narayan, Misra Anamika, Rahuja Neha, Srivastava Rohit, Jaiswal Natasha, Khanna Ashok Kumar, Tamrakar Akhilesh Kumar, Singh Shio Kumar, Dwivedi Anil Kumar, Arvind Kumar Srivastava, & Ram Pratap

Indonesia Patent No. : IDP000062010 **Date of Grant** : 29-08-2019
Title: Carbodithioates and process for preparation thereof
Inventors: Sharma Vishnu Lal, Lal Nand, Sarswat Amit, Jangir Santosh, Bala Veenu, Kumar Lalit, Rawat Tara, Jain Ashish, Kumar Lokesh, Maikhuri Jagdamba Prasad & Gupta Gopal

United States Patent No. : 10292994 **Date of Grant** : 21-05-2019
Title: *Dalbergia sisso* derived extract and compounds employed in prevention or treatment of osteo-health related disorders designated as osteoNATURAL care
Inventors: Rakesh Maurya, Preety Dixit, Ritu Trivedi, Vikram Khedgikar, Jyoti Gautam, Avinash Kumar, Divya Singh, Shelendra Pratap Singh, Wahajuddin, Girish Kumar Jain & Naibedya Chattopadhyay
Support staff: Satish Chandra Tiwari, Bendangla Chagkija, Priyanka Kushwaha

United States Patent No. : 10265297 **Date of Grant** : 23-04-2019
Title: Formulation for the prevention and treatment of bone related disorders
Inventors: Ritu Trivedi, Prabhat Ranjan Mishra, Sulekha Adhikary, Naseer Ahmad, Dharmendra Chaudhary, Naresh Mittapelly, Sudhir Kumar, Kapil Dev & Rakesh Maurya
Support staff: Satish Chandra Tiwari

United States Patent No. : 10266564 **Date of Grant** : 23-04-2019
Title: Cationic lipid cordiarimide hybrid compounds and a process for preparation thereof
Inventors: Bathula Surendar Reddy, VKK Durga Rao, Komal Sharma, M Prathap Reddy, Dibyendu Banerjee & Deependra Kumar Singh

Great Britain Patent No. : 3154943 **Date of Grant** : 19-12-2018
Title: Cationic lipid cordiarimide hybrid compounds and a process for preparation thereof
Inventors: Bathula Surendar Reddy, VKK Durga Rao, Komal Sharma, M Prathap Reddy, Dibyendu Banerjee & Deependra Kumar Singh

France Patent No.: 3154943 **Date of Grant** : 19-12-2018
Title: Cationic lipid cordiarimide hybrid compounds and a process for preparation thereof
Inventors: Bathula Surendar Reddy, VKK Durga Rao, Komal Sharma, M Prathap Reddy, Dibyendu Banerjee & Deependra Kumar Singh

Germany Patent No.: 3154943 **Date of Grant** : 19-12-2018
Title: Cationic lipid cordiarimide hybrid compounds and a process for preparation thereof
Inventors: Bathula Surendar Reddy, VKK Durga Rao, Komal Sharma, M Prathap Reddy, Dibyendu Banerjee & Deependra Kumar Singh

3 Papers Presented in Scientific Conventions

25th ISCB International Conference (ISCBC-2019), Lucknow, 12-14 January, 2019

- Copper-catalyzed decarboxylative regioselective synthesis of 1,5-disubstituted 1,2,3-Triazoles. *Navaneet Kumar and Atul Kumar.*
- Copper-mediated aerobic oxidative synthesis of benzimidazo fused quinazolines via a multicomponent approach, *Mohd Yeshab Ansari and Atul Kumar.*
- Regioselective synthesis of fused imidazo[1,2-a] pyrimidines via intramolecular C−N Bond formation/6-Endo-Dig cyclo-isomerization, *Sumedha Swarnkar, Mukesh Kumar, Shivam Maurya and Atul Kumar.*
- Zinc oxide-NP catalyzed direct indolation of *in situ*, generated bioactive tryptanthrin. *Ratnakar Dutt Shukla, Byanju Rai, and Atul Kumar.*

International Conference on Translational Research in Cardiovascular Science, Bengaluru, 15-17 February, 2019

- Inflammation in pulmonary hypertension: A study on the involvement of p-38kinase/map kinase activated protein kinase 2 pathway. *Mohammad Shafiq and Kashif Hanif.*

7th International Symposium on Current Trends in Drug Discovery Research, Lucknow, 20-23 February, 2019

- A novel glideosome-associated protein coordinates motility and invasion of Plasmodium sporozoites. *Ghosh A, Narwal SK, Gupta R, Gaurav S, Choudhary HH, Ahmed S, Mishra S.*
- A standardized *Xylocarpus moluccensis* fruit fraction ameliorates collagen-induced arthritis in mice. *Priya Gupta, Amit Kumar, Subhashis Pal, Sachin Kumar, Amit Lahiri, Naibedya Chattopadhyay, Madhu Dikshit, Manoj Kumar Barthwal.*
- Aminopropanol derivatives-based treatment of malaria against laboratory strains of *Plasmodium falciparum. Kanchan Yadav, Shint U Methew, Kishore Mohanan and Renu Tripathi.*
- Angiotensin-II Mitigates OVA-induced allergic airway inflammation in mice via Let-7c/miR-99a/TNFα Axis. *Mohita Maurya, Anant Jaiswal & Manoj Kumar Barthwal.*
- Anticyto-adhesion potential of artemisinin derivatives in human brain endothelial cell line to prevent cerebral malaria pathology. *Salique Hassan Shaham, Prince Joshi, Hemlata Dwivedi and Renu Tripathi.*
- Astrocytes exhibit protective mechanism on neurons upon 6OHDA induced neurotoxicity. *Jitendra Singh and Shubha Shukla.*
- Biased KOR agonist alleviates the pain without causing aversive effects. *Veena Yadav, Shalini Dogra, Poonam Kumari and Prem N. Yadav*
- Brain targeting of trans-resveratrol using mixed micelle carrier system. *Roshan A. Katekar, Ganesh S. Thombre, Mohammed Riyazuddin, Athar Husain, Saurabh Verma and Jiaur R. Gayen*
- cAMP-dependent protein kinase catalytic subunit mediated signaling is essential for erythrocytic stages but not required for pre-erythrocytic stages of *Plasmodium berghei*. *Choudhary HH, Gupta R, and Mishra S.*
- Chronic unpredictable mild stress effects hippocampal neurogenesis by glial cell activation in Rat model of stress. *Parul, Seema Singh, Sonu Singh, Akanksha Mishra and Shubha Shukla*
- Combination therapy of pancreastatin inhibitor PSTi8 with metformin in Type 2 Diabetes. *Pragati Singh, Anand P. Gupta, Richa Garg, Umesh K. Goand, Anees A. Syed and Jiaur R. Gayen.*
- Design and synthesis of Donor-Acceptor based fluorescent molecules and their mechanochromic and bio-medical applications. *Deepak Purohit, Ashutosh Raghuvanshi, Shahida Umar, Kalyan Mitra, Monika Sachdev and Atul Goel.*
- Design of potent antimicrobial, anti-mycobacterial and anti-endotoxin peptides from human protein chemerin. *Devesh P. Verma, Tripti Kumari, Neeraj K. Verma, Mohd M. Ansari, Bhupendra N. Singh and Jimut K. Ghosh.*
- Development of a dual colorimetric-ratiometric fluorescent probe NAP-3 for imaging endogenous

labile Iron(III) pools in *C. elegans*. *Neeraj M. Gupta, Shahida Umar, Lalit Kumar, Aamir Nazir and Atul Goel.*

- Development of fluoranthene based fluorescent probes for the detection of excess lipid droplets for diagnosis of human cervical cancer. *Chandra P. Sharma, Ashutosh Sharma, Ankita Jain, Bhavana S. Chauhan, Manoj Kathuria, Renu Tripathi, Kalyan Mitra, Monika Sachdev and Atul Goel.*
- Digital library of indian medicine plants and their metabolites: MS-based bioinformatics tool. *Yatendra Singh, Sumit K. Singh, Nisha, Priyanka Rawat, D. K. Mishra, Santosh Shukla and Sanjeev kanojiya.*
- Distinct role of anaphylatoxins C3a and C5a in immunomodulating the effector cells during tropical pulmonary eosinophilia. *Laxmi Ganga, Neha Satoeya, Ruchi Jha, Mrigank Srivastava.*
- Dopamine D1 receptor activation improves adult hippocampal neurogenesis and exerts anxiolytic and antidepressant-like effect via activation of Wnt/β-catenin pathways in rat model of Parkinson's disease. *Akanksha Mishra, Sonu Singh, Virendra Tiwari, Parul and Shubha Shukla.*
- Elucidating the role of aurora-related kinases 3 in malaria parasite. *Nayak B, Gupta R, Choudhary HH, Narwal SK, Srivastava PN and Mishra S.*
- Elucidating the role of regulatory dendritic cell subsets following infection with infective larvae of *Brugia malayi* . *Neha Satoeya, Laxmi Ganga, Ruchi Jha and Mrigank Srivastava.*
- Flavonoid rich extract and fraction from *Ulmus wallichiana* Planch(Plant). mitigates isoprenaline induced cardiac hypertrophy in rats. *Anees A. Syed, Divya Mohan, Anand P. Gupta, Sudhir Kumar, Rakesh Maurya, Kashif Hanif and Jiaur R. Gayen.*
- Glycine dehydrogenase of *Mycobacterium tuberculosis* and its evaluation as a drug target. *Anu Chauhan, Ram Kumar, Nirbhay Singh, Sudheer Kumar Singh.*
- Glycoconjugate hybrids of phenylhydrazono-indolinones as potent antiplasmodial agents. *Prince Joshi, Ravi Kumar Thakur, Rama Pati Tripathi and Renu Tripathi.*
- Immunogenicity and protective efficacy of calreticulin protein of human filarial nematode *Brugia malayi* (Bm-CRT). *Ruchi Jha, Sunita Yadav, Pankaj Sharma, Laxmi Ganga, Neha Satoeya, Mrigank Srivastava.*
- *In vitro* and *in vivo* preclinical pharmacokinetic studies of novel anti-tubercular CDRI candidate drug. *Athar Husain, Mohammed Riyazuddin, Guru R. Valicherla, Syed Anees Ahmed, Pragati Singh, Arun K Sinha, and Jiaur R. Gayen.*
- Investigating extra-ribosomal functions of ribosomal proteins in *Mycobacteria. Chetan Prakash, ManitoshPande, Amit Pandey and Niti Kumar.*
- Investigating the functional diversity of HSP40 family of human malaria parasite. *Mohammad Anas, Aradhya Tripathi, Priyobarta Nag, Varsha Kumari, L. Sathish, Ashan Manhas, Chetan Prakash, Niti Kumar.*
- IRAK1/4 deficiency promotes Angiotensin II induced left ventricular hypertrophy in Apoe-/- mice. *S S Reddy, Preeti Maurya, H Agarwal, S Banerjee, K Jagavelu and MK Barthwal.*
- miR-99a Induced M2 Polarization Reduces Adipose Tissue Inflammation & Type-II Diabetes. *Anant Jaiswal, Sukka Santosh Reddy, Mohita Maurya, Preeti Maurya and Manoj Barthwal.*
- Nod1-mediated lipolysis promotes diacylglycerol accumulation and successive inflammation via PKCδ-IRAK axis in adipocytes. *Sharma A, Maurya CK, Rai AK, Singh S, Tamrakar AK.*
- NOS isoforms; iNOS and nNOS mediates ROS stimulated induction of apoptotic signaling in human leukaemic K562 cells. *Samreen Sadaf, Deepika Awasthi, Sachin Kumar, Manoj Kumar Barthwal and Madhu Dikshit*.
- Oxidized-LDL regulates PKM2 nuclear translocation and mediates Hif-1α and SREBP-1a induced inflammation and foam cell formation in macrophages. *Amit Kumar and Manoj Kumar Barthwal.*
- Palladium-catalyzed intermolecular dehydrogenative carboamination of alkenes with amines and N-substituted isatin. *Kemant Pratap and Atul Kumar.*
- Parasite mediated desaturation of fatty acid is essential for completion of liver stage schizogony. *Narwal SK, Choudhary HH, Ghosh A, Mishra S.*
- Phosphatidylserine decarboxylase of *Mycobacterium tuberculosis* and its evaluation as a drug target.

Ram Kumar, Nirbhay Singh, Anu Chauhan, Sudheer Kumar Singh.

- Phytochemical investigation of *Pterocarpus marsupium* by LC–MS techniques. *Pratibha Singh, Vikas Bajpai and Brijesh Kumar*
- Phytochemical investigations of Ayurvedic osteoporotic active crude drug *Cissus quadrangularis* Linn using LC-ESI-QqTOF MS/MS technique. *Vikas kumar Gond, Vikas Bajpai, Brijesh Kumar.*
- *Plasmodium berghei* Phospholipase DDHD1 plays a key role in egress of merozoites from liver-stage. *Srivastava PN, Narwal SK, Mishra S.*
- Positive allosteric modulator of 5-HT2C and negative allosteric modulator of 5-HT2B receptors role in food intake and anti-obesity. *Kartikey Singh, Chandan Sona, Ankita Mishra, Rama P. Tripathi and Prem N. Yadav.*
- Protriptyline exert neuroprotective effect by inhibition of oxidative stress via up-regulation BDNF/CREB mediated signalling in Alzheimer's pathology in rat model of dementia. *Virendra Tiwari, Shameema Bano, Akanksha Mishra and Shubha Shukla*
- PST inhibitor ameliorates PST-dependent dexamethasone induced gluconeogenesis in C57BL/6 mice. *Anand P. Gupta, Umesh K. Goand, Pragati Singh, Richa Garg, Anees A. Syed, Jiaur R. Gayen.*
- Qualitative analysis of ethanolic extract & bioactive fractions of *Artemisia nilagirica* using HPLC-ESI-QTOF-MS/MS. *Vijaya Shukla and Brijesh Kumar*
- Role of negative regulatory protein of Toll-like receptor signaling pathway during *Plasmodium* Infection in Balb/c Mouse Model. *Rahul Shivahare, Kanchan Yadav, Anamika Sharma, Salique Hassan Shaham and Renu Tripathi*
- Secreted protein with altered thrombospondin repeat (SPATR)is essential for asexual blood stages but not required for hepatocyte invasion by the malaria parasite *Plasmodium berghei*. *Mishra A, Gupta R, Choudhary HH, Narwal SK, Nayak B, Srivastava PN, Mishra S.*
- Study of MRA_3031 role in *Mycobacterium tuberculosis* growth and survival. *Nirbhay Singh, Ram Kumar, Anu Chauhan, Sudheer Kumar Singh.*
- Synthesis of biocompatible fluorescent carbon quantum dots from beetroot and watermelon Extract for *in vivo* Live Imaging in *C. elegans* and BALB/c mice. *Kundan S. Rawat, Vikram Singh, Shachi Mishra, Tanvi Baghel, Navodayam Kalleti, Aamir Nazir, Srikanta K. Rath, Monika Sachdev and Atul Goel.*
- Synthesis of diphenylamine-tethered fluorescent stilbene derivatives and their E/Z-Photoisomerization. *Jagriti Singh, Shachi Mishra, Pallavi Awasthi, Ram Jeet and Atul Goel.*
- Synthesis of nature-inspired osteoinductive agents for bone health. *Pallavi Awasthi, Divya Singh and Atul Goel.*
- Targeting mycobacterial antibiosis regulon: A potential strategy to reduced drug resistance. *Bijina J. Mathew, Dhananjay Singh, Kripa Lata, Shivendra K. Chourasiya, Bhupendra N. Singh, Debasis Biswas, Sarman Singh and Anirudh K. Singh.*
- The malnutrition-inflammation complex syndrome leads to erythropoietin resistant anemia in patients of chronic kidney disease. *Vivek V Bhosale, Anil Gangwar, Shail Singh, Mukesh Srivastava and Styendra Kumar Sonkar*
- Understanding protein quality control machinery in mesenchymal stem cells and exploring its pharmacological modulation. *Bhagyashri Gupta, Richa Sharma and Niti Kumar.*
- White Light Induced E/Z-photoisomerization of diphenylamine-tethered fluorescent stilbene derivatives (DPAS). *Shachi Mishra, Pallavi Awasthi, Jagriti Sing and Atul Goel.*

23rd National Convention of Society of Pharmacognosy and International Conference on New Opportunities and Challenges for Quality, Safety and GMPs in Herbal Drug Development, Lucknow, 22-23 February 2019

- Determination of bioactive compounds of Fenugreek (*Trigonella foenum-graecum*) using LC-MS techniques. *Pratibha Singh and Brijesh Kumar.*
- Gedunin a bioactive limonoid from *Xylocarpus granatum* fruits, prevents adipogenesis and ameliorates dyslipidemia. *Salil Varshney, Durgesh kumar, Abhishek Gupta, Shreesha Nambiar,*

Sanchita Gupta, Vinita kushbaha, Rakhi Choudhary, Muheeb Beg, Kripa Shankar, Sujith Rajan, Ankita Srivastava, Vishal M. Balaramnavar, T. Narendra and Anil N. Gaikwad.

- Identification and quantitation of phytochemicals in *Cannabis sativa* leave using UPLC-ESI-QTRAP-MS/MS Techniques. *Vikas Bajpai and Brijesh Kumar*
- Phytochemical analysis of *Coelogyne cristata* lindl. (Orchidaceae) using HPLC-ESI- QTOF MS. *Surabhi Tiwari, Brijesh Kumar, Kalidas Upadhyay and Bhim Pratap Singh.*
- Qualitative analysis and identification of *Centella asiatica* L. (Apiaceae) phytoconstituents using HPLC-ESI-QTOF-MS/MS. *Surabhi Tiwari and Brijesh Kumar.*
- Qualitative analysis of extract & isolated compound of *Sarcococca saligna* using HPLC-ESI-QTOF-MS/MS. *Vijaya Shukla and Brijesh Kumar.*

The Global Conference on Reproductive Health with Focus on Occupational, Environmental and Lifestyle Factors and the 29th Annual Meeting of the Indian Society for the Study of Reproduction and Fertility (ISSRF), New Delhi, 22-24 February, 2019

- Covert persistence of *Trichomonas vaginalis* in rat prostate promotes inflammation driven premalignant condition. *Bhavana Kushwaha, Rajender Singh and Gopal Gupta.*
- Glycogen Synthase Kinase-3β (GSK-3β): Role in motility regulation of rat epididymal sperm. *Bineta Singh, Archana Devi, Rajender and Gopal Gupta.*
- Stress MAPK-p38 is deactivated during sperm motility initiation. *Archana Devi, Bineta Singh, Rajender Singh and Gopal Gupta.*
- Redox potential of sperm thiols governs motility initiation and fertility. *Lokesh Kumar, J.P. Maikhuri and Gopal Gupta.*
- Alterations in miRNA profile in sperm correlate with male infertility. *Meghali Joshi, Waseem Andrabi, Sandeep Kumar Bansal, and Singh Rajender.*

International Symposium on Advances in Functional & Biological Materials (ISAFBM-2019), Lucknow, 28 February, 2019

- Fluorescent donor-acceptor Pyranone based dyads for blue, yellow and white organic light emitting devices. *Chandra Prakash Sharma, Ashutosh Sharma, Jagriti Singh, Neeraj Mohan Gupta and Atul Goel*.
- Green and cost effective synthesis of biocompatible fluorescent carbon quantum dots from beetroot and watermelon extract for non-invasive live animal imaging. *Kundan S. Rawat, Vikram Singh, Shachi Mishra, and AtulGoel.* **Best Poster Award**

9th World Congress of Diabetes DIABETESINDIA 2019, Jaipur, 28 February - 3 March, 2019

- Pancreastatin inhibitor attenuates pancreastatin mediated chronic hyperinsulinemia induced obesity associated insulin resistance in adipose via NOX3-JNK pathway. *Anand P. Gupta, Anees A. Syed, Richa Garg, Pragati Singh, Umesh Kumar Goand, Mohammed Riyazuddin, Guru R. Valicherla, Athar Husain and Jiaur R. Gayen.*

International conference on molecular basis of disease and therapeutics (ICMBDT) 2019, Ajmer, 8-10 March, 2019

- Non-invasive early detection of cervical cancer through a novel cancer biomarker (NCB). *Agnihotri S K, Jain A, Agrawal A K, Hakim B A, Vyas A, Singh D, Sachan R, Srivastava K, Gupta R, Bhatt M L B and Sachdev M.*
- Therapeutic effect of novel nutraceutical product for benign prostrate hyperplasia in rat model. *Singh D, Agnihotri S K, Hakim B A, Agrawal A K, Tyagi V, Singh R, Firdausi N, Jain A, Vyas A, Mishra T, Tadigopulla N, and Sachdev M.*
- Finding of oocyte maturation markers through chemo-ablated Infertile mouse model. *Tyagi V, Hakim B A, Singh D, Firdausi N, Singh R, Agnihotri S K, Vyas A, and Sachdev M.*

National level seminar on "Local Biodiversity: Documentation and Conservation, Depal, West Bengal, 16 March, 2019

- Role of plant tissue culture in conservation of medicinally important plants. *Renu Nimoriya and D.K. Mishra.*
- Identification and characterization of bioactive pyrano carbazoles in *Murraya koenigii* plant. *Sumit K. Singh and D.K. Mishra.*

Endocrine Society's Annual Meeting 'ENDO-2019', New Orleans, Louisiana (LA), USA, 23-26 March, 2019

- Functional cross-talk between MCP-1 and integrin

linked kinase is required for endometriosis disease progression. *Upendra Kumar Soni and Rajesh Jha*.

2nd International Conference on Energy, Functional Materials and Nanotechnology & Sustainable Environment Management, Nainital, 24-26 May, 2019

- Fluorescent donor-acceptor pyranones and their derived conjugated scaffolds for organic light emitting devices, *Chandra Prakash Sharma, Ashutosh Sharma, Jagriti Singh, Neeraj Mohan Gupta and Atul Goel.* **Young Scientist Award**
- Biocompatible fluorescent carbon quantum dots synthesized from beetroot and watermelon extract for *in vivo* Live Animal Imaging. *Kundan S. Rawat, Vikram Singh, Shachi Mishra, and AtulGoel*.

52nd Annual Meeting of Society for the Study of Reproduction, San Jose, California, USA, 18-21 July, 2019

- RHOA is associated with ovarian follicular dynamics and regulated by activation of PKC-β1. *Vaibhave Ubba and Rajesh Kumar Jha.*

CSIR- Inter Institutional Students Conference on Sustainable Chemistry for Health, Environment and Materials (Su-CHEM Yuva), CSIR-Indian Institute of Chemical Technology, Hyderabad, 24-26 July, 2019

- Multicomponent reaction of isatin with alkynes and amines for the synthesis of pyrido[2,3-*b*]indoles and of 5,6-dihydropyrrolo[2,1-*a*]isoquinolines. *A. Ghosh, S. Kolle, Dinesh S. Barak, R. Kant, V. Jaiswal S. Batra*
- Development of nature –inspired novel osteoinductive agents for bone fracture repair. *Kundan S. Rawat, Vikram Singh, Shachi Mishra, and Atul Goel* .
- Donor-acceptor pyranone based fluorescent materials for multi colour organic light emitting devices. *Chandra Prakash Sharma, Ashutosh Sharma, Jagriti Singh, Neeraj Mohan Gupta, Jwo-HueiJou and Atul Goel.*
- Environmentally benign fluorescent carbon quantum dots from beetroot and watermelon extract for biomedical imaging. *Kundan S. Rawat, Vikram Singh, Shachi Mishra, and Atul Goel.* **Best Poster Award**

5th Inhaled Therapies for Tuberculosis and Other Infectious Diseases Conference 2019, Groningen, 25-27 August, 2019

- A phase-1 clinical trial design for inhalable particles containing isoniazid and rifabutin. *Rajiv Garg, Amita Jain and Amit Misra.*
- Transient transfection of lung and airway epithelium with gamma interferon. *Reena Bharti, Rajeev Ranjan, Ashish Srivastava, Trisha Roy and Amit Misra.*

4th Annual Conference of Indian Society for the Study of Xenobiotics, Bengaluru, 18-21 September, 2019

- Demonstrating an easy and rapid liquid chromatographic tandem mass spectrometric(LC-MS/MS) method development for simultaneous determination of total homocyctein and methylmalonic acid and its clinical application. *Anjali Misra, Sarvesh K. Verma, Amol Bisen, Mukesh Kumar, Sachin Sanap and Rabi Sankar Bhatta.*
- Rapid and simultaneous analysis of multiple class of antimicrobial drugs by solid phase extraction coupled with liquid chromatography- tandem mass spectrometery. *Anjali Misra, Sarvesh K. Verma, Sachin Sanap, Mukesh Kumar, Amol Bisen, Yashpal Chhonker, Tulsankar Sachin Laxman, Hardik Chandasana Rabi Sankar Bhatta.*
- Liquid chromatography-tandem mass spectrometry based method development and validation of S016-1271, a novel cationic antimicrobial peptide for its application to pharmacokinetic studies. *Santosh K. Puttrevu, Tulsankar Sachin, Anjali Misra, Sarvrsh K. Verma, Anand Yadhav, Rajesh Pradhan.*
- Estimation of novel potent anti-cancer CDRI molecule by development and validated LC-MS/MS method upon oral administration of drug in female *Sprague Dawley* rat. *Sarvesh K. Verma, Tulsankar Sachin, Santosh K. Putrevu, Anjali Misra, Shivani Saxena, Mukesh Kumar, Amol Bisen, Sachin Sanap, Sristi Agarwal, Rabi Sankar Bhatta.*

30th National Congress of Parasitology & Global Summit on Malaria Elimination (NCP-GSME 2019), New Delhi, 26-28 September, 2019

- Chaperone-assisted protein is cytoplasmic resident protein in rodent malaria parasite. *Anamika Sharma, Kanchan Yadav, Renu Tripathi.*
- Anti-malarial potential of glycoconjugated-oxopropylideneoxindoles against chloroquine-resistant strain. *Prince Joshi, Ravi Kumar Thakur,*

Rama Pati Tripathi, Renu Tripathi.

- Repurposing of Lentinan as a partner drug with a sub-optimal dose of Miltefosine to cure experimental visceral *Leishmaniasis. Rahul Shivahare, Wahid Ali, U.S. Singh, Sunil K. Puri and Suman Gupta.*
- The malarial stearoyl-CoA desaturase is essential only for parasite late liver stage development. *Narwal SK, Choudhary HH and Mishra S.*
- Secreted protein with altered thrombospondin repeat (SPATR) is essential for asexual blood stages but not required for hepatocyte invasion by the malaria parasite *Plasmodium berghei*. *Mishra A, Gupta R, Choudhary HH, Narwal SK, Nayak B, Srivastava PN and Mishra S.*
- Reverse genetic and biochemical approaches to elucidate protein kinase 9 function in *Plasmodium berghei. Narwal SK and Mishra S.*

European Respiratory Society International Congress, Madrid, Spain, 28 September-2 October 2019

- A study to perceive the role and function of proteasome accessory factor-C (PafC) in *Mycobacterium tuberculosis. Apoorva Narain, Ekta Dhamija, Kanchan Srivastava, Kishore K Srivastava and Surya Kant.*
- A mycobacterial encoded hypothetical protein is localized in mitochondria and regulates oxidative phosphorylation of infected macrophage. *Rikesh Kumar Dubey, Ekta Dhamija, Alok K Mishra, Dheeraj Soam, Shivraj M Yabaji, Kanchan Srivastava and Kishore K Srivastava.*

2nd Annual Meeting of Animal Physiologists Association cum National Conference, Tirupati, 14-15 October, 2019.

- Poly (ADP-ribose) polymerase-2 is crucial for endometrial receptivity and is regulated by caspase-8. *Upendra Soni, Chadchan Sangappa Basanna, Anubha Joshi and Rajesh Kumar Jha*

XV J-NOST 2019, New Delhi 18-21 October, 2019

- Amino acid-catalyzed direct synthesis of β-Keto Sulfones via aerobic difunctionalization of Terminal Alkynes in an aqueous medium. *Navaneet Kumar and Atul Kumar.*
- Copper-catalyzed decarboxylative regioselective synthesis of 1,5-disubstituted 1,2,3-triazoles. *Sumedha Swarnkar, Navaneet Kumar, Mohd Yeshab Ansari and Atul Kumar.*
- Regioselective intermolecular sulfur–oxygen difunctionalization (Phenoxysulfonylation) of alkynes: one-pot construction of (Z)-β-phenoxy vinyl sulfones. *Mohd Yeshab Ansari, Navaneet Kumar and Atul Kumar.*
- Metal-free decarboxylative reactions of isoxazoles. *Dinesh S. Barak, D. J. Dahatonde, S. U. Dighe and Sanjay Batra*

88th Annual Meeting of the Society of Biological Chemists, India (SBCI-2019) and Conference on Advances at the Interface of Biology & Chemistry, Mumbai, 01-03 November, 2019

- Construction of a respiratory mutant of *Mycobacterium tuberculosis* and its validation as a phenotypic screening model for discovering specific respiratory inhibitors. *Neetu Kumari, Umamageswaran Venugopal, Asha Ganeshar, Gautam Panda and Manju Krishnan.*
- Effect of a *Mycobacterium tuberculosis* PE protein in biofilm formation of Mycobacteria. *Romil Sharma and Manju Y Krishnan.*
- *A* sigF mutant in *Mycobacterium bovis is* deficient in biofilm maturation and showed reduced adherence to lung epithelial cells. *Debashis Dutta, Md. Mustkim Ansari and Bhupendra N Singh*.
- Diminazeneaceturate (DIZE) modulates glial activation and neuroinflammation in 6OHDA induced neurotoxicity via NFkB/pERKsignalling pathway. *Shivangi Gupta, Akanksha Mishra, Virendra Tiwari, Kashif Hanif and Shubha Shukla.*

8th Annual Conference of International Chemical Biology Society (ICBS 2019), Hyderabad, 2-4 November 2019

- Phenanthrenoid Coelogin Exerts Bone Forming Activity by Differential Mitogen Activated Protein Kinase Signalling. *Ravi Prakash*
- Identification of a novel osteogenic agent with therapeutic potential in post-menopausal osteoporosis. *Alok Tripathi*
- Identification of Novel agents for osteoporosis treatment using Monotherapy and Combination Therapy. Kriti Sharma, **Best Poster Award**

3rd Asian Conference on CHEMOSENSORS AND IMAGING PROBES, Amritsar, 6-9 November, 2019

- Pyranone derived donar-acceptor based fluorescent molecules for bio imaging Lipid droplets and vacuoles. *Sajiya Parveen, Ashutosh Sharma, Ashutosh Raghuvanshi and Atul Goel.*
- Fluorescent donor-acceptor pyranone based dyads for multicolour organic light emitting devices. *Ravi Prakash Vats, Chandra Prakash Sharma, Ashutosh Sharma, Jagriti Singh, Neeraj Mohan Gupta, and Atul Goel.*

International Conference on New Horizons in Biotechnology (NHBT 2019), Thiruvananthapuram, 20-24 November, 2019

- PhosphatidylserineIserine decarboxylase down-regulation leads to reduced *Mycobacterium tuberculosis* survival under stress. *Ram Kumar, Nirbhay Singh, Anu Chauhan, Sudheer Kumar Singh.*
- Role of a putative glycine dehydrogenase in survival and persistence of *Mycobacterium tuberculosis. Anu Chauhan, Ram Kumar, Nirbhay Singh and Sudheer Kumar Singh*
- Characterization of ketol-acid reductoisomerase, a putative gene of branched chain amino acid biosynthetic pathway and study of its role in *Mycobacterium tuberculosis* survival. *Nirbhay Singh, Ram Kumar, Anu Chauhan, Sudheer Kumar Singh.*

Clinical and Molecular Portrayals under Hypoxia - 10th Leh Symposium 2019, Delhi, 15 November, 2019

- Inhibition of MAP kinase-activated protein kinase 2 (MK2) in pulmonary hypertension is protective. *Mohammad Shafiq and Kashif Hanif.*

2nd National Biomedical Research competition, (NBRCom-2019), Chandigarh, 17 November 2019

- Impact of chronic unpredictable mild stress and chronic restraint stress on bone health in rat model. *Parul, Priyanka Kothari, Virendra Tiwari, Swati Chaturvedi, Shradha Sinha, M. Wahajuddin, Ritu Trivedi and Shubha Shukla.*

XX NOST-Organic Chemistry Conference, Udaipur, 4-7 December, 2019

- Organic molecules as photocatalysts under visible light irradiation. *Namrata Rastogi*.

2nd National conference on "Alternatives to Animal Experiments 2019" (NCAAE-2019), Mumbai, 13-14 December, 2019

- Employing genetic model system *Caenorhabditis elegans* towards understanding the role of glial cells in neurogenesis, neural reprogramming and neuro-repair. *Rohil Hameed and Aamir Nazir.*
- Impediment of reproductive senescence leads to attenuation of effects associated with neurodegenerative Disease via Mimicking calorie restriction in *Caenorhabditis elegans* Model. *Shikha Shukla, Lalit Kumar and Aamir Nazir.*
- The regulation of protein quality control machinery by microRNA molecules for clearance of aggregated proteins in *C. elegans* expressing alpha-synuclein. *Arunabh Sarkar, Rohil Hameed, Shikha Shukla, Shamsuzzma Ansari, Lalit Kumar, Aamir Nazir.*

10th Annual Conference of Indian Society of lung cancer (NALCCON) - 2019, Lucknow, 14 -15 December, 2019

- Ameliorative effect of NAA novel molecule in epithelial (A549 and NCI-H358) cancer cell line and development of non-small cell lung cancer (NSCLCs) in A/J mice model. Foziya Khan, Anupama Viswas, Sharmeen Ishteyaque,, Abhishek Soni, T. Narender and Madhav Nilakanth Mugale

4 Invited Lectures Delivered by Institute Scientists

Prof. Tapas K. Kundu

- Chemical Biology Approach to Understand Differentiation and Disease: Implication in Therapeutics, in 25th ISCB International Conference, Lucknow, 12-14 January 2019
- Role of Chromatin Dynamics Regulator: From Cell Survival to Memory Retention, in a symposium on MCB75: From Molecules to Organisms, IISc, Bengaluru. 17 – 21 January, 2019
- Epigenetic Regulation of Gene Expression: Implication in Disease Therapeutics, 19th Indian Veterinary Congress, West Bengal University, Kolkata, 1-2 February, 2019.
- Inaugural address of 34th Annual National Conference of Indian Society for Study of Pain, NIMHANS, Bengaluru. 1-3 February, 2019
- Life Beyond Your Genes: Implications in Disease and Therapeutics, in Transdisciplinary University, Bangalore, 12-14 February, 2019
- Epigenetic Regulations of Oral cancer: Implications in Therapeutics, in International Symposium on Current Trends in Drug Discovery Research 2019, CSIR-CDRI, Lucknow, 20-23 February, 2019
- Epigenomics and Human Health, in Genomics Endowment Lecture, International conference on Genome Biology, Madurai Kamaraj University, Madurai 27 February, 2019
- Epigenetic Modulation of Gene Expression in Brain: Implications in Memory and Neurodegenerative Diseases, in International Conference on Advances in Chemical Biology & Biologics (ICACB-2019), CSIR-IICT, Hyderabad, 28 February – 02 March, 2019
- Master Epigenetic Enzyme p300 in Life & Death, in the Kick-off Symposium of Advanced Graduate Program for Future Medicine and Health Care, Tohoku University, Sendai Japan, 5 -7 March, 2019
- Life Beyond Your Genes: Implications in Disease and Therapeutics, in World DNA Day, Kalinga Institute of Industrial Technology, Bhubaneswar 24-29 April 2019
- Epigenetics-Life Beyond Your Genes: Implications in Behaviour and Health, in Innovators cum Entrepreneurs Meet, CSIR-North East Institute of Science and Technology, Jorhat, 9-14 May, 2019
- Advances in Molecular Oncology, in National Institute of Biomedical Genomics, Kalyani (WB), 06 July 2019
- The Phenomenon of Ageing, Related Disorders and Smart Ageing, in Paschim Banga Vigyan Mancha, Malda, 05-14 July 2019
- Cancer-Still a Challenge in 21st Century-Novel Approaches to Combat the Disease, in Saha Institute of Nuclear Physics, Kolkata, 18-21 July, 2019
- Nanobiotechnology: Prospect in Drug Development, in Professional Development Programme on Regulatory Compliance in Research, Amity Institute of Biotechnology, AMITY University, Lucknow, 22-23 August, 2019
- "Epigenetics: Life beyond our Genes, in Center for Research in Infectious Diseases (CRID) 3rd Annual Meet, SASTRA Deemed to be University Thanjavur, 11 September 2019
- Epigenetic Regulation on Oral Cancer: Implications in Therapeutics, in conference on Carcinogenesis, Gujarat University, Ahmedabad 27-29 September, 2019
- A Natural Compound Derived Small Molecule Activator of Master Epigenetic Enzyme, p300/CPB: Implications in Neural Disorders and Therapeutics, in International Conference on Applied Sciences, REVA University, Bengaluru, 15 -18 October 2019
- Epigenetics, Life beyond your Genes: Implications in Diseases and Therapeutics, in Young Scientists Meet, India International Science Festival-2019, Kolkata, 7 November, 2019
- Epigenetics, Life Beyond Your Genes: Implications in Disease and Therapeutics, Dr. Nuggehalli Narayana Memorial Lecture, Indian Institute of Science, Bengaluru, 11 November, 2019
- Epigenetic Regulation of Oral Cancer: Implications in Therapeutics, in National Conference on Cancer Biology and Therapeutics, Institute of Life Sciences, Bhubaneshwar 28 November – 2 December, 2019
- Rare Genetic Disorders and Epigenetic Influence: Implications in Therapy, in INSA Anniversary Meeting, NIO, Goa, 16-18 December, 2019
- A Natural Compound Derived Small Molecule

Activator of Master Epigenetic Enzyme, p300/CBP: Implications in Neural Disorder and Therapeutics, in International Chemical Biology Society Meeting, CSIR-IICT, Hyderabad, 2-4 November, 2019

Dr. A.K. Sinha

- Innovation Toward Green Future: Natural-product-inspired synthesis of small molecules of biological and industrial relevance, International Conference on Recent Advances in Fundamental School & Applied Sciences (RAFAS-2019), School of Chemical Engineering & Physical Sciences, Lovely Professional University, Phagwara, Jalandhar, 5-6 November 2019.
- (1) Chemistry of polyphenolic compounds: Natural resources, importance & application (2) Natural product-inspired green approaches for economical synthesis of polyphenolic compounds of biological and industrial importance, Science Academies' Lecture Workshop on Medicinal Chemistry & Natural Products: Approaches towards new drugs discovery, Department of Chemistry, Rajiv Gandhi University (A Central University), Arunachal Pradesh (sponsored by INSA, NASI and IASc), 25-27 September, 2019.
- Natural product-inspired green chemistry approach for the synthesis of polyphenolic compounds of biological and industrial relevance, 25th ISCB International Conference (ISCBC-2019)Trends in Chemical and Biological Sciences, Lucknow, 12- 14 January, 2019.
- Natural product-inspired green chemistry approach for step-economical synthesis of polyphenolic compounds of biological and industrial relevance, 6th World Congress on Nanomedical Sciences SNSCON-2018 & Chemistry Biology Interface Synergistic in New Frontiers (CBISNF-2019), Vigyan Bhawan, New Delhi, 7-9 January, 2019.

Dr. Brijesh Kumar

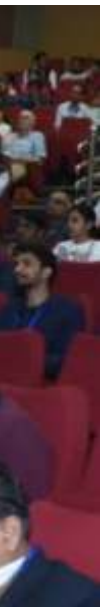
- Basics and applications of MS and LC-MS/MS Instruments, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, 31 January, 2019.
- Cultivation of Scientific Attitude in Eastern Zone, Golden Jubilee Year MGPG College, Gorakhpur, 30 January, 2019.
- Phytochemical Investigations using MS and LC-MS/MS tools, National Workshop on Opportunity and Challenges in Ayurveda and Medical Sciences: Global Perspective, Department of Dravyaguna, Ayurved Faculty, Banaras Hindu University, Varanasi ,15 January, 2019.
- Applications of LCMS tools in natural products, Indian Society of Chemist and Biologists, Lucknow 12 January, 2019.
- Phytochemistry using mass spectrometry, Seminar in HPTLC Technique and its Applications, Shimadzu lab, Mumbai, 5 December, 2019.

Dr. Renu Tripathi

- Discovery of α/β Arteether (EMAL) and its role in malaria control, 30th National Congress of Parasitology & Global Summit on Malaria Elimination, JNU, New Delhi, 26-28 September, 2019.

Dr. Sharad Sharma

- Role of QA in review of SOP's, Training course for QA Personnel of GLP test facility organized by National GLP Compliance Authority NGCMA, New Delhi, 21-23 September, 2019.
- Role of QA auditing Test & reference Items, Training course for QA Personnel of GLP test facility organized by National GLP Compliance Authority NGCMA, New Delhi, 21-23, September, 2019.
- OECD Principles of GLP, Train the Trainer Program at Amity University, Noida, organized by NGCMA India, 16-17 May, 2019.
- Standard Operating Procedures, Train the Trainer Program at Amity University, Noida, organized by NGCMA India, 16-17 May, 2019.
- Animal house requirements & conduct of toxicity studies in a GLP test Facility, Training course for Study Directors of GLP Test facility, New Delhi, 29-31 May, 2019.
- Conduct of toxicity study: Gross pathology & histopathology, Training course for Study Directors of GLP Test facility, New Delhi, 29-31 May, 2019.
- Resources & Documentation in GLP Environment, National Workshop series on GLP for Faculty & Scientists of Public Funded Institutions, NIPER, Guwahati, 20 May, 2019.
- OECD principles of GLP professional development program on regulatory compliance in research, AMITY, Lucknow, 22-23 August 2019.
- Resources & animal house requirements, National workshop on Good Laboratory Practices for Sensitization of Faculty & Scientists, NIPER,



Hyderabad, 29 March, 2019.

- Resources and documentation, One-day training program for GLP personnel, CSIR-IITR, 17 September, 2019.

Dr. S.K. Rath

- Safety concerns of nanomedicines, RMIT, Lucknow,25 Sept.2019.
- Safety issues of nanomedicines, ISPR, Unnao,12 October 2019.
- Good laboratory practice, NIPER, Kolkata, 25 October 2019.
- How the drug pass from laboratory to bedside, Netaji Subhash Memorial CITY College, Cuttack,18 January, 2020
- Natural bioactive compounds on the therapeutic efficacy of celecoxib in colon cancer, Utkal University, Vanivihar, Bhubaneswar, 20 January, 2020.

Dr. Sanjay Batra

- Strategic advances in medicinal chemistry, Sourav Pal Endowment Lecture-Celebrating Science at LPU (Mini-symposium), Lovely University, Punjab, 17 May, 2019.
- Chemistry: Innovation and advances, analytical tools and laboratory technique (workshop), IT College Lucknow, 20th August, 2019.

Dr. Amit Misra

- Inhaled therapies for pulmonary tuberculosis, Sumandeep Vidyapeeth / Pharmarendzvous 2019 - National Seminar on "Health Care Management of Respiratory Diseases by Physician and Pharmacist," Vadodara, 07 December, 2019.
- Pharmacokinetics-inspired drug delivery systems and devices, IIT-Guwahati/ CDRI-IIT-G Conclave, 12 November, 2019

Dr. Gautam Panda

- Amino acids towards anticancer alkaloids and steroidomimetics: Rays of Hope, IIEST, Shibpur, 31 August, 2019.

Dr. Atul Goel

- Pyranone-derived fluorescent molecules for biomedical and optoelectronic material applications, International Symposium on Advances in Functional and Biological Materials, Lucknow, 28 February, 2019.

Dr. Prabhat Ranjan Mishra

- Nanotechnology for Healthcare and Environment, RITM (AKTU)-Lucknow 24 September, 2019.
- Nanomedicine - An emerging tool to overcome conventional challenges, Institute of Chemical Technology, Mumbai 09 December, 2019.

Dr. T. Narender

- Aegeline inspired synthesis of novel β3-AR agonists for insulin resistance and Amino alcohol and thiazolidinedione hybrids for antiadipogenic activity, 25th ISCB International Conference (ISCBC-2019), Lucknow, 13 January 2019.
- Chemical and biological exploration of Indian medicinal plants for human health, National Symposium on Natural Products for Human Health, Loyola College, Chennai. 7 February 2019.
- Drug discovery program at CSIR-CDRI, National Institute of Technology, Warangal, Telangana, 18 April 2019.
- Exploration of therapeutic potential of Indian spices, International Conference on Nutraceuticals and Chronic Diseases, IIT, Guwahati, 24 September, 2019.
- Therapeutic potential of Indian spices for the management of metabolic diseases, 5th IUPHAR WCP-NP-2019, NIN, Hyderabad, 7 December, 2019.

Dr. Manoj Barthwal

- Targeting inflammation and angiogenesis in abdominal aortic aneurysm, KGMU Lucknow 2-3 February, 2019.

Dr. Prem N. Yadav

- The two facets kappa opioid receptor in neuropathic pain & major depression, IBRO-APRC-MLSU School of Neuroscience, Udaipur, 7-9 August 2019.

Dr. Rabi Sankar Bhatta

- Pharmacokinetic guided drug discovery and development, SSX-2019, JN Tata Auditorium, IISc Bengaluru, 20 September 2019.

Dr. Kashif Hanif

- Inhibition of MAP Kinase-Activated protein kinase 2 (MK2) in pulmonary hypertension is protective, CSIR-Institute of Genomics and Integrative Biology, 15 November, 2019.

Dr. Kumaravelu J

- Mitochondria mediates endothelial microparticles (EMPs) mediated inflammation inducing endothelial dysfunction, Niper-Kolkata, 22 October, 2019.
- Endothelial microparticles: The transducer of inflammation, ISARCON-2019, Lady Hardinge Medical College- Delhi, 08-10 November, 2019.

Dr. Satish Mishra

- The malarial stearoyl-CoA desaturase is essential only for parasite late liver stage development, 30th National Congress of Parasitology & Global Summit on Malaria Elimination. JNU, New Delhi, India 26-28 September, 2019.

Dr. D.K. Mishra

- Red list status of medicinal and aromatic plants of undivided Midnapore District, West Bengal: Current scenario and future scope, In the National Level Seminar on "Local Biodiversity: Documentation and Conservation" at

Dr. Prem Prakash Yadav

- The role of chemistry in discovery of new drugs, National Seminar on "Recent Advances in Chemistry and its impact on Society", S.S. Khanna Girls Degree, 26-27 November, 2019.

Dr. Susanta Kar

- *Leishmania donovani* exploits tollip, a multitasking protein, to impair TLR/IL-1R signaling for its persistence in the host, Molecular Immunology Forum – 2019, CDFD, Hyderabad, 07-09 February, 2019.
- *Leishmania donovani* subverts host immune response by epigenetic reprogramming of macrophage M1/M2 polarization, 7th International Symposium on Current Trends in Drug Discovery Research-2019, CSIR-CDRI, Lucknow, 20-23 February, 2019.

Dr. Ravindra Kumar

- Enantioselective unified oxidative cyclization strategy to diverse carbocyclic scaffolds, Indian Society of Chemists and Biologist (ISCB), Lucknow, 12-14 January, 2019.

Dr. Mrigank Srivastava

- The tussle for survival: An immunological perspective of lymphatic filariasis, 12th Annual Conference and Workshop of the Cytometry Society of India, SGPGI, Lucknow, 10 October, 2019.

Dr. Niti Kumar

- Understanding the functional diversity of protein folding machinery in human malaria parasite, IIT-Kanpur, 26 July, 2019.

Dr. Sachin Kumar

- Regulation of neutrophil infiltration: implication in meta-inflammation and metabolic syndrome, Young Investigators' Meeting, Guwahati, 6-8 March, 2019.

Dr. Madhav Nilkanth Mugale

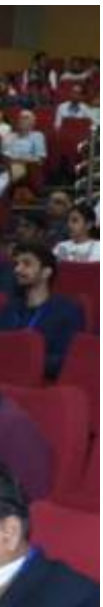
- Novel synthesis & biofunctionalisation of nano particles for anti-cancer activity, Gramin Mahila PG College Sikar, Rajasthan, 27 November, 2019.
- Novel synthesis & biofunctionalisation of nano particles for anti-cancer activity, President science college, Ramnagar College, Depal, West Bengal, 16 March, 2019.

Dr. Nayan Ghosh

- Recent advances of ynamide chemistry: Application in total synthesis of natural products, natural product likes structures and *N*-heterocycles, NIT Meghalaya, shilong,14-15 October, 2019.

Dr. Mukesh Srivastava

- Principal component analysis based pattern recognition of early renal failure and discrimination of plant species for health, Patanjali Research Foundation, Haridwar, 30 March, 2019.



5 Networks & Inter Agency Linkages

1. CSIR Mission / Thematic / In-house Projects (Duration up to 31 March 2020)

Nature	Project Title	PI
CSIR Mission	CSIR Phytopharmaceuticals Mission	Dr. Naibedya Chattopadhyay
CSIR Mission	Mission Nutraceuticals and Nutritionals	Dr. Naibedya Chattopadhyay
CSIR - FTT	Validation of potential biomolecules against Parkinson's disease: A Preclinical study	Dr. Aamir Nazir
CSIR - FTT	Development of male infertility diagnostic kits (DeMID)'	Dr. Rajender Singh
CSIR - FTT	Development of a small molecule inhibitor of PCSK9	Dr. Manoj Kumar Barthwal
CSIR - FTT	Clinical development of antiplatelet compound S007-867 for treatment of cardiovascular diseases	Dr. Vivek Vidyadhar Bhosale
CSIR - NCP	Non- alcoholic steatohepatitis (NASH)	Dr. Durga Prasad Mishra
CSIR - NCP	Chronic respiratory disease innovation and solution program (CRISP)"	Dr. Kashif Hanif
CSIR - NCP	Development of therapeutics against skeletal targets to improve bone health : Therapeutic repurposing of Pentoxyfylline	Dr. Naibedya Chattopadhyay
CSIR - NCP	Regulatory development of CSIR-CDRI prioritized lead compounds	Dr. Sharad Sharma
CSIR - NCP	Therapeutics for lifestyle disorders [TheraLSD]	Dr. Prem Narayan Yadav
CSIR - NCP	Cell penetrating peptide, IMT-P8 as a drug delivery vehicle in management of MRSA infections (PEPTIDOCURE)	Dr. Mukesh Pashupulati
CSIR - FBR	Investigating chemical therapeutic space and determinates of survival and virulence in malaria [ParaDIgM]	Dr. Saman Habib
CSIR - FBR	Development of identified lead molecule as novel anti-leishmanial therapeutic agent	Dr. Neena Goya
ICSIR - FBR	Development of therapeutic against skeletal targets to improve bone health	Dr. Naibedya Chattopadhyay
CSIR - FBR	Dissecting the architecture and molecular mechanism of multi protein complexes (BERosomes) involved in DNA Base Excision Repair (BER) and Transcription coupled DNA repair (TCR) pathways from *M. tuberculosis*	Dr. Ravishankar R
Facility Creation	Up-gradation of existing non-human primate experimentation facility	Dr. DS Upadhyay
Facility Creation	Clinical Pharmacology and Pharmacokinetics Facility at CSIR-CDRI	Dr. Amit Misra
Major Lab Project	Addressing biological processes for designing new strategies of intervention in parasitic diseases and anti-parasitic drug discovery	Dr. Saman Habib
Major Lab Project	AMR: Drug resistant-mycobacterial infections & ESKAPE pathogens	Dr. R. Ravishankar
Major Lab Project	Research on anabolic skeletal targets in health and illness: Bone health and metabolic bone diseases	Dr. Naibedya Chattopadhyay
Major Lab Project	Pre-clinical studies in drug development and translation: Development of new drug entities, phytopharmaceuticals and standardized extracts in AYUSH mode	Dr. Srikanta Kumar Rath
Other Lab Project	Advancing knowledge frontiers in the area of Life style diseases and reproductive health	Dr. Prem Narayan Yadav
Network	CSIR Integrated Skill Initiative programme	Mr. Vinay Tripathi
Network	Jigyasa: Scientist-Student connect" programme	Mr. Vinay Tripathi

2. Grant in Aid Projects

Title of the Project	PI	Project Start	Completion Date
CSIR - New Millennium Indian Technology Leadership Initiative Project			
Novel DPP IV Inhibitor - phase I/II Study: A safety, pharmacokinetic and pharmacodynamic study of CPL - 2009-0031 in healthy volunteers and patients with type 2 *Diabetes mellitus*(T2DM)	Dr. Srikanta Kumar Rath	01-04-2016	31-03-2019
CSIR Young Scientist Award			
Elucidation of functional inactivation of cdx2 expression in colon cancer cells: possible role of E3 ubiquitin ligases in regulating steady state levels of cdx2 protein expression via ubiquitination.	Dr. Arun Kumar Trivedi	01-04-2014	31-03-2019
CSIR-Emeritus Scientist			
Standardized phytopharmaceuticals for the prevention and treatment of bone related disorders and cardiovascular health: End to end pre-clinical development	Dr. Rakesh Maurya	06-01-2017	30-06-2019
Department of Scientific & Industrial Research and Council of Scientific & Industrial Research			
Creation of DSIR – Common Research and Technology Development Hub (CRTDH) in the area of Affordable Health under DSIR-CRTDH Programme	Dr. Amit Misra	01-01-2019	13-12-2023
Department of Biotechnology, Ministry of Science & Technology, India			
Biotechnology Information System Network Distributed Information sub-centre (BTIS-DIC)	Dr. Anand P Kulkarni	01-01-1989	31-03-2020
Assembly of Iron-Sulphur [Fe-S] cluster on critical proteins of the Plasmodium apicoplast	Dr. Saman Habib	11-10-2013	10-10-2019
Mechanistic studies on napthaquinone based anticancer agents in cancer	Dr. Durga Prasad Mishra	29-07-2015	27-07-2019
Design, development and performance evaluation of hybrid systems comprising novel cationic lipids intended to deliver therapeutic siRNA to solid tumors	Dr. Manish Kumar Chourasia	15-02-2016	30-06-2019
Induction of autophagy as a strategy for treatment of tuberculosis	Dr. Amit Misra	01-06-2016	31-05-2019
Deciphering the roles of secreted proteases in host-*Mycobacterium tuberculosis* interaction: Implications for novel drug discovery and vaccine development	Dr. Arunava Dasgupta	13-07-2016	12-07-2020
Understanding the role of RBR-E3 Ubiquitin ligase in *P. falciparum* and exploring its potential for pharmacological intervention	Dr. Niti Kumar	08-11-2016	07-11-2019
Evaluation of TGF-β mediated signaling mechanism in the endometriosis using mouse model	Dr. Rajesh Kumar Jha	08-11-2016	26-01-2020
Synthesis and anti-parasitic activities of quinoline-tetrahy dropyrimidine hybrids with special reference to anti-malarial, anti-leishmanial and anti-filarial activities	Dr. Renu Tripathi	13-10-2016	12-10-2019
Study to establish infection of *L. donovani* through intradermal route in hamsters and its pathological validation	Dr. Amogh Anant Sahasrabuddhe	31-03-2017	30-03-2019
Characterization of *L. donovani* S-Adenosyl methionine decarboxylase: Spermidine synthase interactions	Dr. J. Venkatesh Pratap	25-06-2017	24-06-2020
Small molecule inducers of Redox stress targeting antibiotic resistance	Dr. Sidharth Chopra	05-07-2017	04-07-2020

Functional characterization and validation of drug target potential of a unique triacyl glycerol synthase of *Mycobacterium tuberculosis*	Dr. Manju Y Krishnan	17-07-2017	16-07-2020
Exploring the role of Nucleotide binding Oligomerization Domain proteins (NODs)-mediated inflammation in diet-induced insulin resistance	Dr. Akhilesh Kumar Tamrakar	25-07-2017	24-07-2020
Deciphering organellar genome maintenance in the Malaria parasite	Dr. Saman Habib	25-09-2017	24-09-2020
Regulation of pancreastatin to control the energy homeostasis in diabetes	Dr. Jiaur Rahaman	30-12-2017	29-12-2020
Development of small molecule inhibitor of PCSK-9, a new target for LDL receptor and atherosclerotic cardiovascular disease	Dr. Manoj Kumar Barthwal	26-02-2018	25-08-2019
Identification of the role of Serine 7 phosphorylation of RNA polymerase II CTD in the mRNA transcription	Dr. Sohail Akhtar	26-03-2018	25-03-2021
Design and synthesis of hybrid molecules for multi-drug resistant Tuberculosis	Dr. Arunava Das Gupta	02-08-2018	01-08-2021
Novel rationally designed DNA gyrase inhibitors as antibacterials	Dr. Sidharth Chopra	31-07-2018	30-07-2021
Determination and structural elucidation of bioactive compounds from the selected traditional medicinal plants of Mizoram with a focus on anticancer compounds	Dr. Brijesh Kumar	29-09-2018	28-09-2021
In silico design, synthesis, bioassay and elucidation of novel analogues of Vasicine and other quinazolinone compounds as potent antimycobacterial agents	Dr. Vinita Chaturvedi	13-09-2018	12-09-2021
Screen for identification of small molecule orally active glucagon-like peptide-1 receptor agonist	Dr. Sabyasachi Sanyal	02-07-2018	01-07-2019
Repurposing Oxconazole: Alone and in combination with PUFA's as a broad spectrum antibacterial	Dr. Sidharth Chopra	02-01-2019	01-01-2022
Screening of phytochemical and Bioactive compounds against human pathogenic bacteria from some selected indigenous medicinal plants of Arunachal pradesh, India	Dr. Sidharth Chopra	11-01-2019	10-01-2022
Antileishmanial properties of some selected medicinal plants of North East India: Screening Isolation and identification of active phytoconstituents India: Screening, Isolation and identification of active phytoconstituents	Dr. Narender Tadigoppula	23-01-2019	22-01-2022
Role of the RIPK3-MLKL necrosome in the regulation of TGFβ-signaling mediated renal fibrosis during the development and progression of chronic kidney diseases	Dr. Shrikant Ramesh Mulay	01-02-2019	31-01-2024
Exploration of role of ACE -2/Ang-(1-7) Mas receptor (ACE2/ Ang-(1-7)/MasR) axis in neuroinflammation activation in hypertension and neurodegeneration	Dr. Kashif Hanif	04-02-2019	03-02-2022
Repurposing of anticancer drugs for the treatment of malaria	Dr. Renu Tripathi	12-06-2019	11-06-2022
Structure-activity validation of inhibitors of bacterial peptidyl-tRNA hydrolase for tackling AMR	Dr. Ashish Arora	22-07-2019	21-07-2022
To investigate the 4-hydroxyisolucine signaling mechanism in the ovarian follicular development for the management of polycystic ovarian syndrome	Dr. Rajesh Kumar Jha	02-09-2019	01-09-2022
Development of candidate RL348 for methicillin- and vancomycin-resistant *Staphylococcus aureus*	Dr. Sidharth Chopra	21-09-2019	20-09-2020
A cocktail of phages effective against urinary tract infections caused by biofilm forming MDR uropathogenic *E.coli*	Dr. Sidharth Chopra	27-09-2019	26-09-2021

Bio prospecting of medicinal plants of Sikkim Himalaya against breast cancer angiogenesis	Dr. Durga Prasad Mishra	30-09-2019	29-09-2022
To investigate the role of HOXB1 in spermatogenesis and male infertility	Dr. Rajender Singh	02-09-2019	01-09-2022
Ramalingaswami Fellowship, Department of Biotechnology, Ministry of Science & Technology, India			
Discovery of novel cell-autonomous host pathways and the counteracting immune evasion strategies employed by vacuolar pathogens-an approach to identify new antimicrobial host-factors and novel microbial targets	Dr. Arun Kumar Haldar	09-08-2017	08-08-2022
RhoA GTPase in neutrophil chemotaxis and functions during inflammation	Dr. Sachin Kumar	31-05-2016	30-05-2021
Tata Innovation award, Department of Biotechnology, India			
Novel oral combination formulation for the treatment of resistant malaria (*Plasmodium falciparum*) comprising α/β Arteether and Lumifantrine	Dr. Prabhat Ranjan Mishra	01-03-2019	31-03-2022
Science & Engineering Research Board, Department of Science and Technology, India			
Sophisticated Analytical Instrument Facility	Dr. Brijesh Kumar	01-04-1975	Long Term
Long termOriginal biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis	Dr. Kishore Kumar Srivastava	16-09-2015	15.09.2019
Design and synthesis of natural, un-natural analogues of Calothrixins A, B and evaluation of antimalarial and anticancer activity	Dr. Niti Kumar	12-01-2016	31-01-2020
Do transmembrane protein kinase PERK, IRE1 and activation transcription factor 4 and 6 (ATF4 & 6) are involved in neuronal death?	Dr. Sarika Singh	07-04-2016	06-04-2019
Enantioselective organocatalysis: A novel approach to use acetal as pro-nucleophile and hydroxylactam as pro-electrophile via co-operative catalysis	Dr. Dipankar Koley	27-09-2016	26-09-2019
Targeting the DnaG-DnaB interaction in *Mycobacterium tuberculosis* to identify and validate suitable small molecule inhibitors	Dr. Manju Y Krishnan	28-09-2016	27-09-2019
Dissecting the role of Drp1, a Rint1 family protein during DNA damage response and its implication on cell cycle checkpoint pathway in fission yeast *S. pombe*	Dr. Shakil Ahmed	30-09-2016	29-09-2019
Adipocyte biology and insulin resistance: Metabolic homeostasis using naturally occurring bio -active/dietary lipids Quest for druggable targets against Filarial manifestation of	Dr. Anil Nilkanth Gaikwad	27-09-2016	26-09-2019
Tropical Pulmonary Eosinophilia (TPE): A mass spectrometry based global proteome analysis of Eosinophilis	Dr. Mrigank Srivastava	30-12-2016	29-12-2019
Decarboxylative cross couplings en route to the synthesis of heterocycles	Dr. Sanjay Batra	04-01-2017	15-08-2020
NMR based metabolic profiling of osteogenic phytoconstituents in *Dalbergia sissoo*	Dr. Sanjeev Kumar Shukla	21-02-2017	20-02-2020
Understanding the role of CTD phosphorylation of RNA polymerase II for the transcription during mitosis	Dr. Sohail Akhtar	22-03-2017	21-03-2020
Novel small molecules as selective and Positive Allosteric Modulators (PAM) of 5 HT2c receptor: Discovery and development of potential anti-obesity agents	Dr. Prem Narayan Yadav	27-06-2017	26-06-2020
Synthesis and therapeutic evaluation of new LpxC inhibitors as potent anti-bacterial agents	Dr. Sidharth Chopra	19-07-2017	18-07-2020
Applications of experimental charge density and crystal structure prediction approaches in multi- component crystal development and for studying intermolecular interactions in protein-ligand complexes	Dr. Tajender Singh Thakur	17-08-2017	16-08-2020

Synthesis of privileged heterocycles via visible light photoredox catalyzed cascade reactions	Dr. Namrata Rastogi	04-09-2017	03-09-2020
In vitro biosynthesis and enrichment of indole alkaloids from *Alstonia scholaris* and elucidation of their metabolic pathway	Dr. Dipak Kumar Mishra	28-09-2017	27-09-2020
Role of autophagy in vascular smooth muscle cell remodelling and phenotype	Dr. Manoj Kumar Barthwal	28-09-2017	27-09-2020
Development of small molecular inhibitor specifically targeting mTORC2 for cancer therapeutics: Development of targeted anti-cancer strategy	Dr. Smrati Bhadauria	17-03-2018	16-03-2021
Plasmodium SCOT1 mutant as experimental malaria vaccine: Implications for inducing pre-erythrocytic and cross-stage immunity	Dr. Satish Mishra	17-03-2018	16-03-2021
Genetic validation of actin as a drug target in Leishmania and development of drug screening assay system	Dr. Amogh Anant Sahasrabuddhe	22-03-2018	21-03-2021
Biochemical, biophysical and structural analysis of NhaA antiporter: A structure based study	Dr. Manish Dwivedi	05-12-2017	17-07-2018
Structural and functional characterization of PadR-like transcriptional regulatory proteins from *Mycobacterium tuberculosis* H37Rv	Dr. Ashish Arora	09-07-2018	08-07-2021
A systematic screen of functional genomics and epigenetic interventions towards identification of novel genetic modulators of Amyloid Beta effects in a transgenic *C. elegans* models of Alzheimer's disease	Dr. Aamir Nazir	10-07-2018	09-07-2021
Modulation of host endocytosis during Plasmodium liver stage development	Dr. Satish Mishra	17-07-2018	16-07-2021
Redox regulation of immune cells, neutrophils in insulin resistance and type 2 diabetes	Dr. Sachin Kumar	27-07-2018	26-07-2021
Targeting Triple Negative Breast Cancer (TNBC) by a plant derived small molecule: An *in vitro* and *in vivo* approach	Dr. Dipak Datta	30-07-2018	29-07-2021
To decipher the role of RHOG in the endometrial receptivity for blastocyst adhesion and invasion process	Dr. Rajesh Kumar Jha	10-06-2018	10-05-2021
Therapeutic evaluation of organometallic compounds as potent antibacterial agents	Dr. Sidharth Chopra	12-10-2018	11-10-2021
Identifying critical hotspots in macromolecular complexes involved in bacterial BER	Dr. Ravishankar Ramachandran	26-10-2018	25-10-2021
Studies to delineate the immunoregulatory role of PD -L 1 /PD-1 pathway and exploring it as a potential tool for vaccination strategies against Visceral Leishmaniasis	Dr. Amogh Anant Sahasrabuddhe	09-05-2018	09-04-2021
Branch chain amino acid biosynthesis in *Mycobacterium tuberculosis* and relevance of ketol– acid reducto-isomerase for antimycobacterial drug discovery	Dr. Sudheer Kumar Singh	02-11-2018	01-11-2021
Trifluorodiazoethane as a precursor for the rapid synthesis of Trifluoromethylated building blocks	Dr. Kishor Mohanan	12-10-2018	11-10-2021
Neuroprotective and neuritogenic effects of a cell-permeable bacterial histone-mimic protein: Therapeutic implications for neurodegenerative pathologies	Dr. Shubha Shukla	15-11-2018	14-11-2021
Targeting DNA repair proteins to overcome topoisomerase drug resistance	Dr. Dibyendu Banarjee	05-11-2018	04-11-2021
Investigating the role of the NLRP3 inflammasome in fractose-included peripheral Insulin resistance	Dr. Akhilesh Kumar Tamrakar	06-11-2018	05-11-2021
To elucidate the role of MAPKAPK2 (MK2) in inflammation mediated lymphangiogenesis during myocardial infarction	Dr. Kumaravelu Jagavelu	06-11-2018	05-11-2021
Identification and characterization of microRNAs controlled by mutations in Phex gene, a regulator of X-linked hypophosphatemic rickets, an intrinsic bone mineralization defect	Dr. Divya Singh	06-11-2018	05-11-2021

Cooperative catalysis through dual activation for stereoselective synthesis of glycosides	Dr. Pintu Kumar Mandal	28-11-2018	27-11-2021
Investigation of the role of small RNAs in genomic imprinting	Dr. Rajender Singh	04-12-2018	03-12-2021
Role of p21Waf1Cip1 in regulation of autophagy: its implication in tumorigenesis and cancer therapy	Dr. Jayanta Sarkar	25-02-2019	24-02-2022
Chalcogenide catalysis for enantioselective olefin functionalization and synthesis of biologically relevant compounds	Dr. Chandra Bhushan Tripathi	04-03-2019	03-03-2022
Synthesis of biologically relevant privileged heterocycles by metal-catalyzed C-H bond functionalization with diazo compounds	Dr. Malleswara Rao Kuram	06-03-2019	05-03-2022
Catalytic asymmetric dearomatization of (Het) Arenes via Decarboxylative cycloaddition: Synthesis of natural product-inspired novel scaffolds for drug discovery	Dr. Nilanjana Majumdar	04-03-2019	03-03-2022
Investigating auxiliary functions of HSP110 in malaria causing parasite *Plasmodium falciparum*	Dr. Niti Kumar	11-03-2019	10-03-2022
Probing sp^3-rich spirocyclic scaffolds in drug discovery: Syntheses of Cyanogramide, FR901483 and their diversified analogues towards leads against Mtb and ESKAPE pathogen	Dr. Ajay Kumar Srivastava	12-03-2019	11-03-2022
Rational design and syntheses of non-natural, silicon and boron based antibiotics: Sila-and boro-b-lactams and beyond	Dr. Ravindra Kumar	12-03-2019	11-03-2022
Cloning and characterisation of PSPG mitif containing glycosyltrasferases genes involved in secondary metabolism from *Calotropis procera*	Dr. Vineeta Tripathi	30-03-2019	29-03-2022
Understanding CTD- Chromatin crosstalk during transcription through nucleosome	Dr. Sohail Akhtar	20-08-2019	19-08-2022
Development of the SPLUNC1 protein loaded composite nanoparticles based targeted therapy for the treatments of lung inflammation	Dr. Sohail Akhtar	28-10-2019	29-10-2022
Endoplasmic Reticulum stress response in orchestrating mucosal immune response: exploring novel therapeutic intervention for Inflammatory Bowel Disease	Dr. Amit Lahiri	19-11-2019	18-11-2021
Unraveling the role of RNA- binding protein Quaking in cardiac remodeling with emphasis on Titin alternative splicing	Dr. Shashi Kumar Gupta	20-11-2019	19-11-2021
National Post-Doctoral Fellowship, SERB, DST, India			
Role of antidepressants in the regulation of bone morphogenesis	Dr. Shailendra Kumar Maurya	31-03-2017	07-02-2019
Evaluation of stress dependent functional responses and gene expression in ras1Δ and allied mutants of *Schizosaccharomyces pombe* cells as a functional study for targeting Ras-Redox pathway in cancer therapy	Dr. Noosrat Masood	07-04-2017	06-04-2019
RGB emitting Carbon quantum dots from vegetables/ fruits extract and their applications	Dr. Vikram Singh	06-07-2017	05-07-2019
Deciphering the role of negative regulators of TLR-mediated signaling in parasite survival during experimental malaria Targeting epigenetic alterations in regulating Aldehyde	Dr. Rahul Shivahare	10-04-2017	09-04-2019
Dehydrogenase (ALDH) expression in Triple Negative Breast Cancer (TNBC) *in vitro* and *in vivo*	Dr. Akhilesh Singh	07-04-2017	06-04-2019
Understanding protein quality control system and exploring its pharmacological potential in mesenchymal stem cells	Dr. Bhagyashri Gupta	01-05-2017	30-04-2019
Exploring the role of Notch/Nrf-2 signalling in amelioration by flavonoids in endometriosis	Dr. Radhika Kapoor	03-04-2017	02-04-2019
Targeted co-delivery of gemcitabine and betulinic acid using hyaluronic acid functionalized amphiphilic PLGA-PEG copolymer nanoparticles for the treatment of pancreatic cancer	Dr. Md. Noor Alam	08-06-2017	07-06-2019
Structural and functional characterization of oxidative stress proteins from *Mycobacterium tuberculosis* as potential drug	Dr. Radhey Shyam Kaushal	12-06-2017	11-06-2019

target against tuberculosis: A cross-talk with Fenton reaction			
Investigation of effect of CDRI08 (keenmind) on Parkinson's disease pathology	Dr. Arun Kumar Yadawa	02-04-2018	01-04-2020
Elucidating the effect of resveratrol on Nrf2 Mediated signalling and unfolded protein responses during Parkinson's disease pathology	Dr. Ashish Singh	02-04-2018	01-04-2020
Investigating the role of high risk human papilloma virus E5 protein in regulation of crosstalk of apoptosis signals between mitochondria and endoplasmic reticulum	Dr. Deepa Gandhi	02-04-2018	01-04-2020
Deciphering the effect of quercetin on the mitochondrial dysfunction endoplasmic reticulum stress and oxidative stress in rotenone induced Parkinsonism	Dr. Pratibha Tripathi	07-05-2019	06-05-2021
JC Bose National Fellowship, SERB, DST, India			
Vaccine development against Visceral leishmaniasis	Dr. Anuradha Dube	09-08-2016	14-07-2021
Woman Scientist Scheme-A, SERB DST, India			
Protective effect of topical application of Celecoxib and/or N-Acetylcysteine on Deoxynivalenol: A mycotoxin induced skin	Dr. Sakshi Mishra	01-07-2016	30-06-2019
Inflammation, genotoxicity and tumorigenecity in mice Identification of shikimate kinase as a drug target against *Mycobacterium tuberculosis*	Dr. Sapna Pandey	16-01-2017	15-01-2020
Unveiling the role of host BTF3 protein in immune regulation against intracellular bacterial infections: A CRISPR/Cas 9 system directed study	Ms. Kavita Rawat	23-10-2017	23-07-2019
Profiling nanoprarticle-protein corona and investigation the role of specific proteins in NP uptake	Dr. Vani Mishra	12-01-2018	17-05-2019
Role of estrogen subtype estrone and estriol on hematopoietic stem cells (HSCs) and bone marrow regeneration	Dr. Rupali Saini Kumar	02-04-2018	01-04-2021
Deciphering the roles of *Mycobacterium tuberculosis* proteases in host-pathogen interaction: Implications for novel drug discovery and vaccine development	Ms. Tanu Garg	12-07-2019	11-07-2022
Inspire Fellowship, DST, India			
New approaches to the fluorinated N-heterocycles via A+C109 mine radical cation pathway	Dr. Sushobhan Chowdhury	08-09-2017	07-09-2022
TARE, DST, India			
Mechanistic studies of bacteriophage-derived Lysins to combat multidrug resistant bacterial pathogens	Dr. Aditi Singh	05-11-2019	04-11-2022
Indian Council of Medical Research (ICMR), India			
Drug targeting for improved treatment of multi-drug resistant tuberculosis (MDR TB)	Dr. Amit Misra	01-08-2018	31-07-2021
Do Endoplasmic Reticulum stress mediated death signalling pathways involved in Alzheimer's pathology?: Role of transmembrane protein kinase PERK,IRE1 and activation transcription factor 4 and 6 (ATF 4 & 6)	Dr. Sarika Singh	15-10-2018	14-10-2019
Role of Pancreastatin towards amyloid formulation in Diabetes	Dr. Jiaur R Gayen	01-09-2019	31-08-2022
Harnessing therapeutic potential of novel spisulosine derivative as robust autophagy inducer against triple negative breast cancer {TNBC) *in vitro* and *in vivo*	Dr. Dipak Datta	22-08-2019	21-08-2022
Indian Council of Medical Research (ICMR) Emeritus Scientist Scheme			
Design, synthesis and biological evaluation of ATP synthase inhibitors as potential antitubercular agents	Dr. Anil Kumar Saxena	17-07-2017	16-07-2019
DRDO - Institute of Nuclear Medicine & Allied Sciences			
Development of preclinical formulation of radioprotective RK-IP-006 and its pharmacokinetic evaluation as per regulatory guidelines	Dr. Rabi Sankar Bhatta	28-09-2018	27-12-2019

Indian National Science Academy			
Deciphering the role of SOCS proteins in regulating pro/ anti-inflammatory response during experimental visceral leishmaniasis	Dr. Susanta Kar	01-03-2016	28-02-2019
Ministry of Earth Science (MoES)			
Synthesis and bioevaluation of chemical libraries of B- Carboline based mimics of marine natural products	Dr. Sanjay Batra	20-04-2015	
Ligand and structure based screening of designed and synthesized chemical library around Psammaplin A against DNA methyltransferase I (DNMTI) and diversity oriented synthesis of Pachastrissamine as anticancer agents	Dr. Gautam Panda	01-02-2016	
Biological evaluations, discovery of novel bioactive compounds & coordination of the program "Drug From Sea"	Dr. Manoj Kumar Barthwal	06-03-2018	31-03-2020
A high-throughput screening for modulators/inhibitors of quorum sensing, class b-β-Lactamase inhibitor, biofilm and efflux pump	Dr. Mukesh Pasupuleti	21-05-2018	20-05-2021
Third party verification and outsourcing of activities Related to Lead compound GS/IICT5/6 showing anti-angiogenic activity	Director	27-11-2018	31-03-2020
AYUSH			
Exploration, identification and isolation of bone fracture healing agents from Indian folk traditional plants *Pholidota articulate* and *Coelogyn cristata* (Orchidaceae)	Dr. Brijesh Kumar	09-01-2018	08-01-2021
BIRAC, SRISTI Ahmedabad NPDF			
RGB emitting Carbon quantum dots from vegetables/ fruits extract and their applications	Dr. Vikram Singh	06-07-2017	05-07-2019
Department of Atomic Energy (DAE)			
Design and synthesis of donor-acceptor based new organic fluorescent dyes and their applications	Dr. Atul Goel	06-01-2016	05-01-2021
Amino acids derived steroidal and non-steroidal ligands as inhibitors of steroid 5-α-reductase in cancer	Dr. Gautam Panda	18-06-2018	17-06-2021
Indian Council of Agricultural Research (ICAR-NASF)			
Study the effect of mesenchymal stem cell transplantation on ovarian function and fecundity in Goats	Dr. Monika Sachdev	01-02-2017	31-12-2019
Lady Tata Memorial Trust, Mumbai			
Elucidating mechanisms underlying breast cancer invasion and metastasis: Role of E3 ubiquitin ligase Fbw7 in suppressing breast tumorigenesis	Dr. Arun Kumar Trivedi	06-07-2017	05-07-2020
Council of Science & Technology, Uttar Pradesh			
To evaluate anti-metastatic potential of diminished cardiotoxic tumor targeted liposomal formulation of Etoricoxib	Dr. Smrati Bhadauria	01-06-2018	31-05-2021
Global Challenges Research Fund - Network for Neglected Tropical Diseases			
Structural studies of the GTP binding proteins Rab7 from *Leishmania donovani*	Dr. Ashish Arora	01-10-2018	30-09-2019
Structural and functional characterization of early endocytosis related Rab proteins of *Leishmania donovni*	Dr. Ashish Arora	19-08-2019	18-08-2021
Sponsored Projects			
Anti-malarial activity of one of Evolva ingredients Nootkatone	Dr. Renu Tripathi	17-07-2017	16-07-2019
Assessment of a TCL product on systemic calcium and skeletal parameters in estrogen deficient(OVX) rats	Dr. Naibedya Chattopadhyay	14-11-2018	13-11-2019
Sub-acute toxicity testing of sample	Dr. Srikanta Kumar Rath	16-09-2019	15-09-2020
Pore size from XRD diffraction using Rietveld refinement	Dr. Tejender Singh Thakur	28-11-2019	27-11-2020

6 Memorandum of Understandings, Agreements & Services

Sl. No.	Title of Contract / Agreement	Client / Collaborator	Signing Date
Demonstration of Technology (Know-how)			
1.	Demonstration of Know-How process technology for the preparation of the CSIR-CDRI plant product N-012-0001 for the early management of Benign Prostatic Hyperplasia (BPH)	Lumen Marketing Company, Chennai	27-09-2019
Licensing Agreements			
1.	CSIR-CDRI plant product N-012-0001 for the early management of Benign Prostatic Hyperplasia (BPH)	Lumen Marketing Company, Chennai	17-02-2019
Sponsored Agreements			
1.	Pore size from XRD diffraction using refinement	Sun Pharmaceutical Industries Ltd., Mumbai	16-10-2019
Memorandum of Understanding for joint R&D			
1.	To promote institutional linkage between CSIR-CDRI and Indrashil University, Mehsana to explore for possible collaborative research programs in specific fields of interest	Indrashil University, Mehsana, Gujarat	09-12-2019
2.	To work jointly in the area of bioprospection of NE plant diversity for development of new drugs	Foundation for Environment & Economic Development Services, Manipur	28-10-2019
3.	To promote institutional linkage between CSIR-CDRI and BBAU, Lucknow to explore for possible collaborative research programs in specific fields of interest	Babasaheb Bhimrao Ambedkar University (BBAU), Lucknow	18-10-2019
4.	To promote institutional linkage between CSIR-CDRI and THSTI, Faridabad to explore for possible collaborative research programs in specific fields of interest	Translational Health Science and Technology Institute (THSTI), Faridabad	02-09-2019
5.	To promote institutional linkage between CSIR-CDRI and MAHE, Manipal and to explore other avenues for possible collaborative research programs in specific fields of interest	Manipal Academy of Higher Education (MAHE), Manipal, Karnataka	30-05-2019
6.	To promote institutional linkage between CSIR-CDRI and Era University, Lucknow and to explore other avenues for possible collaborative research programs in specific fields of interest	Era University, Lucknow	09-08-2019
7.	To promote institutional linkage between CSIR-CDRI and RCB, Faridabad and to explore other avenues for possible collaborative research programs in specific fields of interest	Regional Centre for Biotechnology, NCR Biotech Science Cluster, Faridabad	15-07-2019
8.	To promote institutional linkage between CSIR-CDRI and HBTU, Kanpur and to explore other avenues for possible collaborative research programs in specific fields of interest	Harcourt Butler Technical University (HBTU), Kanpur	09-05-2019
9.	To promote institutional linkage between CSIR-CDRI and NIPER, Kolkata and to explore other avenues for possible collaborative research programs in specific fields of interest	National Institute of Pharmaceutical Education and Research (NIPER), Kolkata	18-04-2019
10.	Formulation and development of a dry powder inhalation for pulmonary hypertension	Shobhaben Pratapbhai Patel School of Pharmacy & Technology Management, Mumbai	25-03-2019
11.	To establish collaborative cooperation through research programs in specific fields of interest	Saraswati Dental College & Hospital, Lucknow	30-03-2019
12.	Drugs from Sea – Marine Natural Product inspired Drugs Leads (DFS-MNPIDL)	Ministry of Earth Science, Government of India, New Delhi	22-02-2019
13.	Neuroprotective and neuritogenic effect of a cell-permeable bacterial histone-mimic protein: Therapeutic implications for neurodegenerative pathologies	Jamia Hamdard, New Delhi	03-01-2019

Sl. No.	Title of Contract / Agreement	Client / Collaborator	Signing Date
Collaborative Research Agreements			
1.	Development of Levo form of Ormeloxifene for indication including but not limited to contraceptive, osteoporosis, morning after, endometriosis and other indications in antineoplastic and anticancer treatment types	CIPLA Limited, Mumbai	15-11-2019
2.	To understand the molecular mechanism of Nef-mediated alteration in host vesicular trafficking regulating cellular functions which may lead to enhance viral replication	University of Nebraska, USA	23-07-2019
3.	Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis" in the research field of "Dendrimers against tuberculosis"	Centre National de la Recherche Scientifique (CNRS), France	02-07-2019
4.	Development of bi-herbal formulation for the management of diabetes and associated complications	Adamya Herbal Care Pvt. Ltd, Lucknow	01-03-2019
Testing Services			
1.	(i) Osteocalcin marker measurement of serum samples (ii) Bone density measurement of femur samples	Sphaera Pharma Pvt. Ltd., New Delhi	13-11-2019
2.	*In vivo* testing: Primary model for blood schizonticidal assay for malaria for 30 days	Amity University, Lucknow	18-10-2019
3.	Sameness of Chhaya and film coated tablets	Ministry of Health & Family Welfare, Government of India, New Delhi	16-08-2019
4.	Technical services on "Bone Mineral Density and BV/TB"	Sphaera Pharma Private Limited, Gurgaon	28-08-2019
5.	Technical Services on "Determination of absolute stereochemistry of single crystal X-ray analysis"	Sun Pharmaceutical Industries Ltd R&D Centre, Gurgaon	02-01-2019
6.	Testing of FNDR sample as *in vivo* assay in *Leishmania donovani* Golden hamster chronic model	Foundation for Neglected Disease Research, Bengaluru	07-08-2019
7.	*In vivo* testing of samples	University of Lucknow, Lucknow	20-12-2018
8.	Sub-acute toxicity testing of sample	Defence Institute of Bio-Energy Research, DRDO, Haldwani	01-08-2019
Secrecy Agreements			
1.	CSIR-CDRI standardized- extract of 4597-C002 for the management of osteoporosis and fracture healing & -bioactive fraction 1703-F003 from single herb indicated for the management of polycystic ovarian syndrome (PCOS)	Laila Nutraceuticals, Hyderabad	27-11-2019
2.	Outsourcing the analysis of samples of plant extracts for research work	Vimta Labs Ltd., Hyderabad	30-09-2019
3.	CSIR-CDRI standardized- fraction product4655/K09 as antidyslipidemic agent and bioactive fraction 1703-F003 for the management of polycystic ovarian syndrome (PCOS)	Roivant Sciences Inc., USA	09-10-2019
4.	CSIR-CDRI antimalarial synthetic candidate drug S001-1793	Medicines for Malaria Venture (MMV), Switzerland	01-10-2019
5.	Evaluation of Sphaera samples	Sphaera Pharma Pvt. Ltd., New Delhi	19-08-2019
6.	Outsourcing the synthesis of API and formulation of S007-867, 99/373 or any other candidate compounds prepared under GMP accredited facility as per requirement of drug regulatory authorities for conducting clinical trials.	Piramal Enterprises Limited, Mumbai	24-04-2019
7.	CSIR-CDRI small molecule inhibitor of PCSK9	Reagene Innovations Pvt. Ltd, Hyderabad	14-04-2019
8.	CDRI plant product enriched fraction from the Indian medicinal plant for the management of polycystic ovarian syndrome (PCOS) and other plant extract for the management of osteoporosis.	Fourrts (India) Laboratories Pvt. Ltd., Chennai	02-04-2019
9.	CSIR-CDRI developed enriched fraction from Indian medicinal plant for the management of polycystic ovarian syndrome (PCOS)	Bio-gen Extracts Pvt. Ltd, Bengaluru	19-03-2019

Sl. No.	Title of Contract / Agreement	Client / Collaborator	Signing Date
10.	CSIR-CDRI synthetic compound S007-1500 for bone health	Eurofins Advinus Ltd, Bengaluru	26-12-2018
Memorandum of Agreements			
1.	Bio prospecting of medicinal plants of Sikkim Himalaya against cancer angiogenesis	Department of Biotechnology, New Delhi	16-11-2019
2.	Bioinformatics Sub-DIC at CSIR-Centre Drug Research Institute, Lucknow	Department of Biotechnology, New Delhi	21-05-2019
3.	Exploration of role of ACE-2/Ang-(1-7) / Mas receptor (ACE2/Ang-(1-7)/MasR) axis in neuro-inflammation and glial activation in hypertension and neurodegeneration	Department of Biotechnology, New Delhi	22-02-2019
4.	Screening of phytochemical and bioactive compounds against human pathogenic bacteria from some selected indigenous medicinal plants of Arunachal Pradesh, India	Department of Biotechnology, New Delhi	30-01-2019
Material Transfer Agreements			
1.	Cat. No. T0764 (Immortalized Human Endometriotic Cell Line)	ABM, Canada	15-11-2019
2.	Original material *L. donovani* LD1S, Sudan strain wild type, lpg1-knockout (KO) complemented mutant of lpg1-KO (lpg1-KO+LPG1) strain: Progeny and unmodified derivatives	Institute National De La Recherche Scientifique, Canada	22-07-2019
3.	Derivatives of SRI-12742	Helmholtz Centre for Infection Research, Germany	25-11-2019
4.	Plasmids for development of screening systems for antimicrobial research	Addgene, USA	30-11-2019
5.	Plasmids pMAL-c4, pFA6-TRP1, pINIT-cat	Addgene, USA	16-09-2019
6.	Plasmids pKW08-Lx, pMEXC3GH & pACEC3GH	Addgene, USA	22-05-2019
7.	Recombinant plasmids clone with pcDNA-HA-TRAF3 (Plasmid#44032), mH2A1.1-CT-MYC (Plasmid#45166), pRL-SV40P (plasmid#27163), pLV-mitoDsRed (plasmid#44386), 3xAP-1 in pGL3-basic (plasmid#40342), GW1CMV-Perceval (plasmid#21737), pTRIPZ-hDDX5/17 (plasmid#71307)	Addgene, USA	03-05-2019
8.	Supplies of cell lines	National Centre for Cell Science, Pune	30-04-2019
9.	*Mycobacterium simiae* (new pathogenic mycobacterial strain)	ATCC, USA	19-03-2019
10.	pcDNA3.1(+)-GRP78/Bip & pAAV/D374Y-hPCSK9	Addgene, USA	25-03-2019
11.	RWPE-1 cell line is normal prostate cells derived from epithelial origin of human	ATCC, USA	06-03-2019
12.	Plasmids in agar pclbw-mito TagRFP, CFP-Parkin, pSuper-Retro-Puro-Drp1-shRNA, mCh-Drp1, pTY-EF1a-wild type mKdm2b-Flag, pUB_smFfag_KDM5B_MS2, RN3P-KDM5B-FLAG, PMRx-1P-GIP-LC3-RFP-LC3DG.	Addgene, USA	26-02-2019
13.	Plasmids DNA S0662 (pLX-Sg RNA) & S0661 (PCW-Cas9)	Addgene, USA	18-02-2019
14.	Plasmids (pMV306G13+Lux, pjV53, pkW08, pTEC15, pTEC18, pTEC27, pTEC19) for generating reporter bacteria	Addgene, USA	24-01-2019

7 Human Resource Development

1. Ph.D. Thesis Submitted in 2019

Sl. No.	Name of Student	Title	Name of Supervisor
	CSIR-CDRI-Jawaharlal Nehru University Ph.D. Program		
1.	Gatha Thacker	Probing role of E3 Ubiquitin ligases in Osteogenesis	Dr. Arun K Trivedi
2.	Nidhi Shukla	Mechanistic studies on Poly (ADP-ribose) polymerases inhibition in cancer cells	Dr. D P Mishra
3.	Kolle Shivalinga Sharanappa	Transition metal-catalyzed oxidative approaches toward the synthesis of possible anti-infective and anticancer agents	Dr. Sanjay Batra
4.	Hadi Hasan Choudhary	Genetic manipulation and functional characterization of *Plasmodium* cAMP dependent Protein Kinase A, Chorismate Synthase and SUFs	Dr. Satish Mishra
5.	Ekta Gupta	Novel strategies for the construction of densely substituted Fluorocarbon centers	Dr. Kishor Mohanan
6.	Pankaj Singh	*In-vitro* biosynthesis of selected cardiac glycosides from *Calotropis* sp. and effect of elicitors on their production and enrichment	Dr. D K Mishra
7.	Naseer Ahmad	Studies on the role of miRNA-672-5p identified at the time of weaning in postmenopausal induced osteoporosis and its mechanism of osteoprotection	Dr. Ritu Trivedi
8.	Danish Equbal	Development of green strategy for construction of C-C and C-heteroatom bonds towards synthesis of small organic molecules of biological importance	Dr. Arun K Sinha
9.	Tripti Kumari	Identification of biologically active segments from host defense proteins and their characterization	Dr.Jimut Kanti Ghosh
10.	Amit Kumar Rai	Role of Advanced Glycation End products(AGEs) in pathogenesis of *type 2 diabetes mellitus*	Dr. Akhilesh K Tamrakar
11.	Sneha Ratnapriya	Vaccination strategies with chimeric Th1 stimulatory proteins / peptides against experimental visceral leishmaniasis	Dr. Amogh A Sahrabuddhe
12.	Deepak Purohit	Synthesis and biological properties of flexible and rigid pyranones and their derived compounds	Dr. Atul Goel
13.	Richa Singh	Development of green strategies towards synthesis of small molecules via C-C and C-X bond transformation and their biological evaluation	Dr. Arun K Sinha
14.	Sonal Srivastava	Studies on the effect of natural bioactive compounds on the therapeutic efficacy of celecoxib in colon cancer	Dr. S K Rath
15.	Asha Ganeshar	Amino acids as Chirons: Approaches towards natural product-like molecules as anticancer and antitubercular agents	Dr. Gautam Panda
16.	Bidhu Bhushan Karakra	Quest for antimycobacterial agents from Trisubstituted Methanes and Nitrogens	Dr. Gautam Panda
17.	Kanchan Gupta	Functional role of Calcium binding protein in endometrial receptivity and embryo implantation	Dr. Anila Dwivedi

18.	Banala Venkatesh Teja	Rational design and evaluation of nano engineered hybrid drug carriers against cancer	Dr. Prabhat R Mishra
19.	Indira Singh Chauhan	Molecular and functional characterization of GTP binding Rab6 protein of *Leishmania donovani*	Dr. Neeloo Singh
20.	Anand Prakash Gupta	Exploration and evaluation of pancreastatin inhibitor(s) against metabolic syndrome	Dr. Jiaur R Gayen
21.	Rikesh Kumar Dubey	Understanding the mitochondrial arbitrations in intracellular survival of mycobacteria	Dr. Kishore K Srivastava
22.	Ankit Gupta	Investigation of putative RNA polymerase subunits and ribosome biogenesis factors involved in organellar transcription and translation in *Plasmodium falciparum*	Dr. Saman Habib
23.	Sushobhan Mukhopadhyay	Decarboxylative coupling-and Sodium Nitrate mediated synthesis of heterocycles of biological interest	Dr. Sanjay Batra
24.	Tripti Mishra	Studies towards isolation, chemical transformation and synthesis of biologically important natural products	Dr. T Narender
25.	Bilal Ahmad Hakim	Characterization of regulatory miRNA and their regulated genes during oocyte maturation in mouse model	Dr. Monika Sachdev
26.	Mohammed Riyazuddin	Investigation of preclinical pharmacokinetics of novel anticancer molecules	Dr. Jiaur R Gayen
27.	Showkat Ahmad Malik	A study to devise selective mTORC2 inhibitory strategy and evaluation of its anticancer efficacy	Dr. Smrati Bhadauria
28.	Amit Kumar	Elucidation of novel immunometabolic signaling mechanism regulating macrophage function and phenotype: Implications in cardiometabolic disorders	Dr. Manoj K Barthwal
29.	Harikesh Kumar	Design and synthetic studies towards carbohydrate based biodynamic molecules as anticancer agent	Dr. Pintu Kumar Mandal
30.	Mamunur Rashid	Preclinical pharmacokinetic characterization of Cladrin, a potential anti-osteoporotic agent: its human pharmacokinetics prediction based on allometry concept	Dr. Wahajuddin
31.	Sudha Bhagwati	Computational modeling and structural bioinformatics studies on cardiovascular disorder associated proteins and identification & design of potential therapeutic agents for cardiovascular disorders	Dr. Mohammad Imran Siddiqi
32.	Sneha Raj	Exploring the functional spectrum of host defense peptides (Hdps) other than antimicrobial actions	Dr. Mukesh Pasupuleti
33.	Mayank Maheswari	Deciphering the role of p21 (CIP 1/WAF 1) in regulation of autophagy	Dr. Jayanta Sarkar
34.	Farheen Fatma	Characterization of potential immunogenic proteins and their chimeric constructs from *Mycobacterium tuberculosis*H37Rv	Dr. Ashish Arora
35.	Mamta Gangwar	Molecular and immunological characterization of immunoprophylactic protein(s) of *B.malayi* and its endosymbiont *Wolbachia*	Dr. Mrigank Srivastava
36.	Samreen Sadaf	Deciphering the role of Nitric Oxide/Nitric Oxide Synthase in the differentiation of hematopoietic stem cells to Neutrophils	Dr. Manoj K Barthwal
37.	Sushila Kumari	Molecular mechanism of vesicular trafficking regulating immune response by host – pathogen interaction	Dr. Raj Kamal Tripathi

CSIR-CDRI-Academy of Scientific and Innovative Research (AcSIR) PhD Program			
38.	Vinay Shukla	Role of microtubule polymerization and related protein TPPP3 in embryo implantation	Dr. Anila Dwivedi
39.	Kavita Rawat	Elucidation of host-directed anti-mycobacterial potential of β-casein derived peptide and BTF3a in Macrophages	Dr. Raj Kamal Tripathi
40.	Mohammad Hasanain	Determining the molecular mechanism of cell death in response to disruption of microtubule dynamics	Dr. Jayanta Sarkar
41.	Geeta Karki	Synthesis of oligosaccharides related to bacterial cell wall polysaccharides, steroidal glycosides and blood group antigens	Dr. Pintu K Mandal
42.	Salil Varshney	Adipocyte biology and insulin resistance: Ameliorating metabolic homeostasis using novel dietary lipids and natural product inspired molecules	Dr. Anil N Gaikwad
43.	Deepika Saini	Phytochemical investigation of *Tinospora cordifolia* and *Withania coagulans* towards isolation of bioactive compounds	Dr. P P Yadav
44.	Tushar Pandey	Cloning and characterization of CpWRKY transcription factors from *Calotropis procera* (Aiton) Dryand	Dr. Vineeta Tripathi
45.	Faiyaz Alam	Conformational studies of linear Gramicidin-S analogues, Sugar amino acid based linear and cyclic glycopeptide foldamers and structural studies of BRCT domain of MTB DNA ligase by solution NMR spectroscopy	Dr. Ravi S Ampapathi
46.	Ashish Srivastava	Development and evaluation of inhalable particles containing kanamycin monosulphate and pyrazinoic acid for the treatment of drug resistant tuberculosis	Dr. Amit Misra
47.	Akanksha Mishra	Investigating the role of Dopamine D1 and D2 receptors during adult neurogenesis in Parkinsonian rats	Dr. Shubha Shukla
48.	Rekha Sangwan	Synthetic studies on carbohydrate derived biodynamic molecules and their applications toward bioactive Glycoconjugates synthesis	Dr. Pintu K Mandal
49.	Raval Kavit Harsiddharay	Design and development of nano-sized formulation for oral delivery of Insulin and C-peptide	Dr. Manish K Chourasia

2. Skill Development Program (Healthcare & Life Science)

Skill India is an initiative launched to empower the youth of our country with skill sets which make them more employable and more productive in their work environment. We offer six certificate courses of level IV to VII under the CSIR-CDRI, Skill Development Program. Skill shortage remains one of the major constraints to continued growth of the Indian economy. We wish to address this knowledge-gap by professionally trained youth of India. The courses have been designed to meet the aspirations of students, young researchers and industry sponsored personnel looking for training. These courses provide an opportunity for skill development and hands-on experience in the area of healthcare and life science.

3. Skill Development Program for Postgraduate Students

The course meets the aspirations of students/young researchers looking for training and hands-on experience in the chosen area. Students pursuing their Post-graduation course from Universities/ Colleges in any of the relevant areas can improve skills through these courses. During the period 122 candidates have taken training for a duration of minimum 4 months upto 1 year depending upon the recommendation of his/her HOD.

4. Advance Training Courses for the employees of R & D Institutions/ Pharmaceutical Industry/ Government Laboratories etc.

Institute conducts different kinds of training of short duration in various disciplines against payment. The courses comprise both lectures and practical by our experienced scientists with emphasis on practical R & D aspects in a particular discipline. During the year 12 candidates from Indian Academy of Science, 1 from JNCR, 1 from academia/organizations and 3 research student took training.

5. International Students visiting CSIR-CDRI under various programs:

Over the years the institute has invited several foreign researchers visiting under fellowships such as TWAS, RTF-DCS etc. Research scholars are eligible for assistance from the Human Resource Development Unit towards conducting their research under international fellowships/scholarships.

During the period Mr. Adam Olaitan Abdulkareem, from Department of Zoology, University of Ilorin, Nigeria has been awarded CSIR TWAS Postgraduate Fellowship for a period of 1 year starting from 15th October, 2019 under the supervision of Dr. Kashif Hanif.

8 Honours & Awards

Dr. Atul Goel

- NASI-Reliance Industries Platinum Jubilee Award -2019
- Fellow of CMS Award-2019

Dr. Satish Mishra

- Shakuntala Amir Chand Prize by Indian Council of Medical Research
- Elected member, National Academy of Medical Sciences (India)

Dr. Prabhat Ranjan Mishra

- Elected Fellow of National Academy Sciences, India 2019
- TATA Innovation Fellowship 2019

Dr. Gautam Panda

- Bridge Fellowship by Japan Society for the Promotion of Science (JSPS)
- Fellow of Academy of Science & Technology (FAScT), West Bengal

Dr. Bidyut Purkait

- CSIR Young Scientist Award 2019

Dr. Shubha Shukla

- Indira Gandhi Samman-2019" for Commendable contribution by Women in the area of Science by Shilalekh Foundation, UP, India.

Dr. Kashif Hanif

- Dr. DN Prasad Memorial Oration Award by Indian Council of Medical Research

Dr. Shrikant Mulay

- Ramalingaswamy Re-entry Fellowship, Department of Biotechnology (DBT), Government of India

Dr. Renu Tripathi

- Dr. B.N. Singh Memorial Oration Award by the Indian Society for Parasitology 2018.

Mr. Sukka Santosh Reddy

(student of Dr. Manoj K Barthwal)

- 2019-Paul Dudley White International Scholar Award by American Heart Association, USA

Dr. Ritu Trivedi

- Dr. Sheel Memorial (Young Women Scientist) Lecture Award 2019 by NASI
- Prof. SPS Teotia Oration Award 2019 by ISBMR
- TATA Innovation Fellowship 2019-20

Ms. Khushboo Sinha

(Student of Dr. Dibyendu Banerjee)

- Artificial Intelligence and Molecular Screen (AIMS) Award" for 2019 for the project titled " Identification of small molecule inhibitors of MMP9" intended for breast cancer therapy. Awarded by Atomwise, Inc., San Francisco, CA 94103.

Dr. Anuradha Dube

- Kshanika Oration Award-2019 by Indian Council of Medical Research

Mr. Chandra Prakash Sharma
(Student of Dr. Atul Goel)

- Young Scientist Award for best poster presentation in the 2nd international conference Energy, Functional Materials and Nanotechnology & Sustainable Environment Management (ICEFN& SEM 2019), Kumaun University, Nainital

Mr. Arunabh Sarkar
(Student of Dr. Aamir Nazir)

- Gold medal for Oral Presentation at 2nd National Conference on Alternatives to Animal Experiments 2019 (NCAAE-2019) organized by Society for Alternatives to Animal Experiments- India, at Mumbai

Mr. Vinay Shukla
(Student of Dr. Anila Dwivedi)

- Prof. S.S. Guraya Young Scientist Award-2019, by Indian Society for the Study of Reproduction & Fertility (ISSRF)

Ms. Shikha Shukla

(Student of Dr. Aamir Nazir)

- Gold medal for Poster Presentation at 2nd National Conference on Alternatives to Animal Experiments 2019 (NCAAE-2019) organized by Society for Alternatives to Animal Experiments- India, at Mumbai.

Mr Sunil Narwal
(Student of Dr. Satish Mishra)

- 2nd prize in Oral presentation at 2nd NBRCom-2019, PGIMER Chandigarh

Mr. Salil Varshney
(Student of Dr. Anil Gaikwad)

- Best Poster Award in 23rd National Convention of Society of Pharmacognosy and International Conference on New Age Opportunities and Challenges for Quality, Safety and GMPs in Herbal Drug Development

Ms. Anu Chauhan
(Student of Dr. Sudheer Kumar Singh)

- Best Poster Award in International Conference on New Horizons in Biotechnology, held at Thiruvananthapuram, India

Mr. Deepak Purohit
(Student of Dr. Atul Goel)

- Best Poster Award, International Symposium on Current Trends in Drug Discovery Research-2019, Lucknow

Ms. Kriti Sharma
(Student of Dr. Divya Singh)

- Best Poster Award in International Chemical Biology Society Conference 2019, IICT, Hyderabad

Mr. Kundan Singh Rawat
(Student of Dr. Atul Goel)

- Best Poster Award (ISAFBM - 2019) by Humboldt Academy Lucknow
- Best Poster Award (suCHEM YUVA 2019) by CSIR-Indian Institute of Chemical Technology Hyderabad, India

Ms. Fozia Khan
(Student of Dr. Madhav Nilakanth Mugale)

- Runners up Poster Award 10th annual Conference of Indian Society of lung cancer (NALCCON) - 2019, KGMU, Lucknow

Mr. Kuldeep Choyal
(Student of Dr. Jayanta Sarkar)

- Best poster award in 3rd international conference on IN SYNC-WITH NEXT GENERATION BIOSCIENCES (INGB)-2019

Mr. Ravi Saklani
(Student of Dr. Manish Chourasia)

- Newton-Bhabha Fellowship Program, British Council & DBT, India

Ms. Ayushi Verma

(Student of Dr. Dipak Datta)

- Best Oral Presentation Award by Indian Association for Cancer Research 2019

Mr. Subhashis Pal

(Student of Dr. Naibedya Chattopadhyay)

- Dr. MM DHAR Distinguished Career Achievement Award 2019 Biological Sciences (Jointly)

Ms. Shachi Mishra
(Student of Dr. Atul Goel)

- Dr. MM DHAR Distinguished Career Achievement Award 2019 Chemical Sciences (Jointly)

Mr. Durgesh Kumar
(Student of Dr. Anil Gaikwad)

- Dr. MM DHAR Distinguished Career Achievement Award 2019 Biological Sciences (Jointly)

Ms. Sampa Gupta

(Student of Dr. KV Sashidhara)

- Dr. MM DHAR Distinguished Career Achievement Award 2019 Chemical Sciences (Jointly)

Mr. Sandeep U.
(Student of Dr. PR Mishra)

- Dr. JM Khanna Memorial Early Career Achievement Award- 2019 (Jointly)

Mr. Sushobhan Mukhopadhyay
(Student of Dr. Sanjay Batra)

- Dr. JM Khanna Memorial Early Career Achievement Award- 2019 (Jointly)

Ms. Akanksha Mishra
(Student of Dr. Shubha Shukla)

- Dr. Swarn Nitya Anand Memorial Early Career Achievement Award-2109

Mr. Venkatesh Teja Banala
(Student of Dr. PR Mishra)

- Dr. D.L. Shrivastava Memorial Early Career Achievement Award -2019

Section
IV

Events & Activities Organized

1 Events & Activities

Institutional Events

68th Annual Day Celebrations and 44th Sir Edward Mellanby Memorial Oration

CSIR-CDRI, a constituent laboratory of Council of Scientific & Industrial Research, New Delhi was formally dedicated to the nation on February 17, 1951. Since inception, Institute is striving relentlessly in the pursuit of providing affordable drugs and health care to the entire populace of the country. Sir Edward Mellanby was the founder Director of CSIR-Central Drug Research Institute (1950-51). As a tribute to the contributions of Sir Mellanby, the Institute, during its Silver Jubilee Year in 1976 started "Sir Edward Mellanby Oration series. An eminent Scientist delivers this Oration every year in the Institute.

68th Annual Day of this premier drug research institute was celebrated on 17 February 2019. Dr. David G. Russel, the William Kaplan Professor of Infection Biology Cornell University, Ithaca, New York delivered 44th Sir Edward Mellanby Memorial Oration. Title of his oration was 'Next Generation Anti-Microbial Therapeutics'. Professor Vinay Kumar Pathak, Vice Chancellor, Dr. APJ Abdul Kalam Technical University, Uttar Pradesh, Lucknow graced the Annual Day celebration event as Chief Guest. Prof Pathak delivered Annual Day address, which was followed by felicitation of staff & students for their achievements. The day began with the felicitation ceremony of Annual Day Sports winners and concluded with colourful cultural event.

78th CSIR Foundation Day Celebrations and CSIR-CDRI Award Orations

The Council of Scientific & Industrial Research (CSIR), known for its cutting edge R&D knowledgebase in diverse S&T areas, is a contemporary R&D organization. Having a Pan-India presence, CSIR has a dynamic network of 38 national laboratories, 39 Outreach Centers, 3 Innovation Complexes and 5 units. Established on 26 September 1942, nearly 5 years before independence of the Nation, Today, CSIR India is amongst the largest scientific organizations in the world and oldest in India.

To commemorate the Foundation Day, Institute celebrated 78th CSIR Foundation Day on 27 September 2019. Prof. Shubha Tole, TIFR, Mumbai graced the occasion as chief guest and delivered foundation day lecture. On foundation day, besides other regular programs, Institute also felicitated the recipients of prestigious 'CDRI Awards for Excellence in Drug Research'. Awardees delivered award orations. As a part of Foundation Day Celebrations, an Outreach Program was organized on 25 September 2019. More than15000 students and faculties from various schools/institutions participated in this event & interacted with the scientists and visited the labs.

India International Science Festival (IISF-2019) Open Day Outreach Program

India International Science Festival (IISF), launched in 2015, is a celebration to promote Science and Technology and demonstrate how science could lead India towards a developed nation within a short span of time. The aim is to engage the public with science and celebrate the joy of science and show the ways how science, technology, engineering and mathematics (STEM) provide us with the solutions to improve our lives.

One Day Outreach Program, held on 31 October 2019 at CSIR-CDRI, as a part of the 5th Indian International Science Festival (IISF) 2019, was open to the students, the general public and local media and showcased the scientific achievements and research facilities of the Institute. More than 500 students and teachers from various schools and colleges have participated in the program. During the day, Lab tours, Exhibitions, Popular lectures and Scientist-student/public interaction was conducted.

To sensitize the students and participants of the outreach program three popular lectures were delivered. Dr Anil Gaikwad talked about "Healthy life style and metabolic disorders", Dr P N Yadav discussed the Mood disorders in younger population and Dr D. Banerjee briefed about "Genes and Cancer" and discussed the causes and consequences of cancer and how to protect ourselves from it. Dr. VP Kamboj, Ex-Director, CSIR-CDRi graced the occasion as Chief Guest.

73rd Independence Day Celebrations

As a part of 73rd Independence Day celebrations, on 15 August 2019, Prof. Tapas K. Kundu, Director, CSIR-CDRI hoisted the tricolour flag followed by national anthem by CSIR-CDRI staff and their family. During the occasion, Director reminded us about our valiant freedom fighters who fought selflessly and even sacrificed their lives for our country to attain freedom from the colonial rule. He appreciated the contributions of CSIR-CDRI in technological independence in the area of Pharmaceuticals and encouraged everyone to contribute more while aligning with the expectations of new India and future challenges.

71st Republic Day Celebrations

Institute celebrated 71st Republic Day on 26 January 2020, to commemorate the date on which the Constitution of India came into effect replacing the Government of India Act (1935). Prof. Tapas K Kundu, Director, CSIR-CDRI hoisted the National Flag and addressed all the staff members and students of the Institute.

Seminars, Symposium, Distinguished Lectures

7th International Symposium on Current Trends in Drug Discovery Research

The Central Drug Research Institute, Lucknow organized the 7th International Symposium on Current Trends in Drug Discovery Research from 20th to 23rd February, 2019. The Director, CDRI Prof Tapas K. Kundu, in his welcome address, briefed about the importance of this major event in drug discovery and development. The inaugural talk was delivered by Prof. Daniel Goldberg, USA on development of new antimalarials. There were 15 sessions covering topics from the area of parasitic and microbial diseases, Cancer, CNS and CVS including metabolic axis, medicinal and natural product chemistry, bone biology, biologics and peptides, delivery system etc. Besides there were three sessions for the oral presentations by the young faculties and research fellows. Three poster sessions comprising of approximately 200 posters spread over three days were also organized. There were more than 450 registered participants including speakers from 12 different countries. The conference provided an excellent opportunity for consultations, deliberations and exchange of ideas between professionals, young researchers and students and acted as catalyst towards building scientific relationships and foster collaborations across the borders and between academia and industry. The conference was supported by funds from several governmental, pharmaceutical, and other agencies.

CSIR-CDRI Faculty Colloquium

It is well proven fact that Scientific discussions and open interactive forums have positive impact on inculcating scientific temper, augmenting academic vigor, which in turn have long term impact on the performance of the R&D Institutes in the service of nation. During interactive meeting with the Scientists, it was decided to initiate CSIR-CDRI Faculty Colloquium, in which Popular Science Talk will be delivered by CDRI Scientist who have made outstanding contributions to the Science & Technology. Presentation on significant accomplishments will act as motivational force for younger generation of scientists and also to students.

The Faculty Colloquium Committee nominated Dr. Wahajul Haq, Chief Scientist & Head, Medicinal & Process Chemistry for his outstanding contributions in the area of small molecule drug discovery and technology development. Dr. Haq delivered a popular scientific talk on the topic 'Structure optimization of small molecules: Opportunities in new drug discovery research'. on 19 June 2019.

16th Dr. B. Mukerji Memorial Lecture

This lecture is held in the memory of Late Dr. Bishnupada Mukerji, the second Director of CSIR-CDRI. A distinguished scientist, Dr. Mukerji is widely acclaimed, admired and remembered for his organizational skills, foresight, and the vision with which he directed and shaped the destiny of CSIR-CDRI, in its formative stages, to help it achieve the status of a premiere centre for research on drugs and diseases internationally. Since inception of this lecture series, sponsored by Sachin & Sikta Pradhan Foundation, Bethesda, USA, several eminent scientists & academicians have delivered lectures. 16th lecture in this series was delivered by Prof. Usha Vijayraghavan, IISc, Bengaluru. She delivered lecture on "Codes for the making of a rice flowering stem: roles for evolutionarily conserved transcription factors". Prof. Tapas K. Kundu, Director, CSIR-CDRI presided over the program.

CSIR – CDRI Scientific Lecture Series

In January 2019, CSIR-CDRI Scientific Lecture Series were initiated with an aim to create an interacting platform among the scientists of the Institute and eminent contributors in the field of drug discovery and development/ disease biology/other related field. In this series monthly series of lectures, researchers from India and abroad, who have made pioneer contribution in the field of biomedical research towards unmet medical needs, will be delivering a scientific lecture covering their contribution in advancing the knowledge frontiers. During the year 2019, following distinguished researchers visited CSIR-CDRI and delivered lecture under this series:

- Dr. Roop Mallik, Tata Institute of Fundamental Research, Mumbai delivered lecture entitled “Insulin controls triglyceride secretion from the liver: Old problems, new mechanisms" on 23rd April 2019.
- Prof. Apurva Sarin, Director, InStem, Bangalore delivered lecture entitled “Cellular adaptations for survival: Metabolic signaling underpinning cell fate decisions in T-cells” on 28 June 2019.
- Prof. Vijay Kumar, JC Bose Fellow, Institute of Liver and Biliary Sciences, New Delhi delivered lecture on “Can microRNA signatures predict the stage and outcome of Hepatitis B infection?” on 21 August 2019.
- Prof. Vaskar Saha, Director, Tata Translational Cancer Research Centre, Tata Medical Centre, Kolkata delivered lecture entitled “Enigma of minimal residual disease and relapse in acute lymphoblastic leukaemia” on 12 December 2019.
- Prof. Satish Raghavan, Department of Biochemistry, Indian Institute of Science delivered lecture entitled "Understanding the mechanism of genomic instability in cancer and identification of therapeutically relevant chemical inhibitors” on 31 January 2020

CSIR-CDRI Nobel Symposium 2019

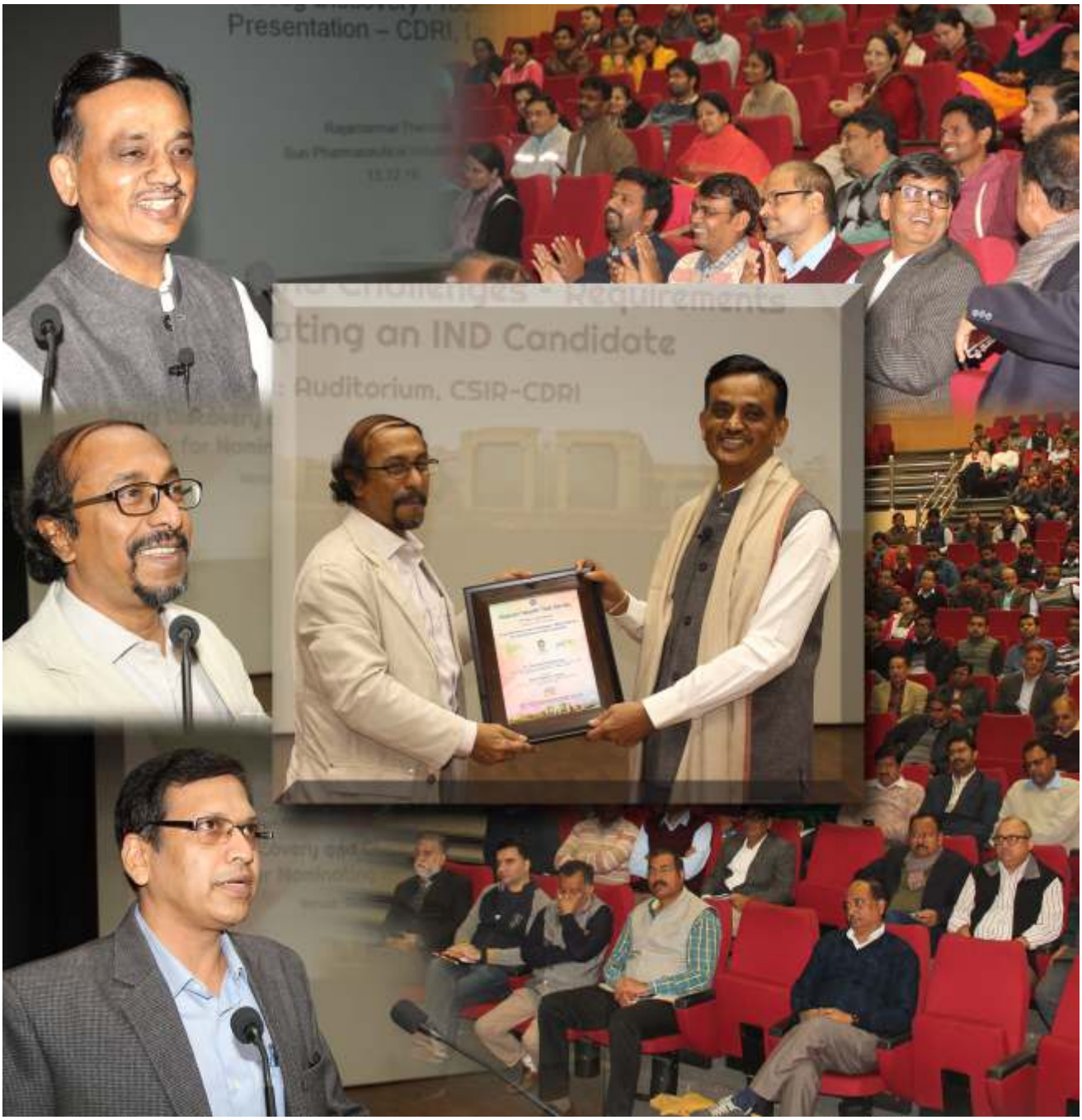
Research Scholars of CSIR-CDRI organized the 2nd CSIR-CDRI Nobel Symposium on December 11th, 2019 in honour of the Nobel Laureates in the fields of Chemistry and Physiology/Medicine 2019. This student-led symposium series, initiated in 2018, aimed at inspiring young scientific minds and encourage coming up with innovative ideas that will benefit the society. The symposium featured a series of lectures by Research Scholars on topics illustrating the discoveries in the fields of Chemistry and Physiology/Medicine, which received Nobel Prize in 2019.

In the session 1, CSIR-CDRI research scholars, Ms. Shaifali Tyagi, Mr. Rohit Singh and Mr. Anirban Ghoshal delivered lectures on discovery and development of batteries by Nobel laureates and also latest developments in the field. In the session 2 Ms. Shikha Shukla, Ms. Ayushi Verma and Ms. Hobby Aggarwal delivered lectures on the theme "Decoding the oxygen sensing: Impact on our well-being'. This symposium received wide accolades from all the Scientists and Students of Institute.

Popular Health Talk

Over the last more than six decades, CSIR – Central Drug Research Institute has significantly contributed to the growth of Pharmaceutical industry in India through new drugs of national importance, economic process technologies, national level policies and globally competitive human resource. During this period, several eminent clinicians immensely contributed to the growth & development of drug discovery programs of CSIR-CDRI. In order to enlighten the scientists by the real field clinical practices, Institute designed the popular health talk series, where the renowned physicians from all over the country will bring the realistic view of up-to-date therapeutic practices and future need of the nation.

Third lecture in this series, was delivered by Dr. Thennati Rajamannar, Executive Vice President, High Impact Innovations and Advisor to MD, Sun Pharmaceutical Industries Ltd on 13 December 2019. He spoke on "Drug discovery and challenges – Requirements for nominating an IND candidate.



Exhibitions and Expo

CSIR-CDRI Continued to participate in scientific exhibitions held across India to exhibit its accomplishments in the service of Nation, opportunities available for industry, academia, students, and others. During the year, Institute participated in following exhibitions and expo:

- Flower Exhibition, Drawing Competition & Dog Show of Lucknow Nagar Nigam at E Park, Mahanagar, Lucknow on 23-24 Feb. 2019. CSIR-CDRI received Best Exhibitors Award.
- Showcased CSIR-CDRI products in 7th International Symposium on Current Trends in Drug Discovery Research (CTDDR-2019) at CSIR-CDRI, Lucknow on 20-23 Feb. 2019
- IISF-2019 Outreach Program on October 31, 2019 at CSIR-CDRI.
- Generics and Healthcare Pavilion of CSIR at Science City, Kolkata during India International Science Festival (IISF-2019) during Nov. 5-8, 2019. This mega event was inaugurated by Dr. Harsh Vardhan, Minister of Science and Technology and Ministry of Earth Sciences. A large number of students and eminent personalities like DG, CSIR also visited & interacted with CSIR-CDRI team and discussed about the R&D activities in CSIR & CDRI.
- CSIR-CDRI has actively showcased R&D activities and products in "Pride of India Expo" under Genomics & Healthcare Pavilion of CSIR in 107th Indian Science Congress held at University of Agricultural Sciences, GKVK Campus, Bangalore, Karnataka from 3-7th January, 2020. Expo "Pride of India" was inaugurated by Hon'ble Dr. Harsh Vardhan, Union Minister of Health & Family Welfare, Science & Technology, Earth Sciences - Government of India on 3 January 2020 at 11.00 am.
- Kisan Mela organized by CSIR-CIMAP, Lucknow during 29 – 31 January 2020

Awareness Programs / Thematic Celebrations

Swachhata Pakhwada

Swachhata Pakhwada started in April 2016 with the objective of bringing a fortnight of intense focus on the issues and practices of Swachhata by engaging staff and students of the Institute. As per the practice in the past, Institute celebrated Swachhata Pakhwada during 1 – 15 May 2019 in and outside the campus. Staff and students enthusiastically participated in the campaign. As a part of the campaign, Staff and Students of the Institute took Swachhata Pledge. All the laboratories, administrative building, Divisions, colony premises were examined for cleanliness.

Anti-Terrorism day

As per the practice in the past, May 21, 2019 was observed as Anti-Terrorism day to wean away the youth from terrorism and showing as to how it is prejudicial to the national interest. Both English and Hindi version of Pledge were duly solemnized. The staff and students participated in Pledge taking ceremony.

Plantation

Plantation of Mango variety developed by Mango Man Haji Kalim ullah khan was held on 28-06-2019 in the Institute. During this Mango man has spoke about his journey of plantation, development of different varieties of Mango. His life and experience was very encouraging for the young researchers. Later he was felicitated by Prof Tapas Kumar Kundu, Director CSIR-CDRI.

5th International Yoga Day

As per the practice in the past, Institute celebrated International Yoga Day on 21 June 2019. Mr. Vivek Tiwari, Yoga Instructor, Divya Yoga Kendra, Lucknow conducted Yoga Practice session in the morning. During the day, Dr. Awadhesh Sharma, Ayangar Yoga Specialist, Samagra Yoga Sadhana and Research Centre, Lucknow delivered a lecture on Yoga and Health in the Auditorium of the Institute. Staff and students enthusiastically participated in celebration of Yoga Day with befitting participation.

Rashtriya Ekta Diwas (National Unity Day)

Rashtriya Ekta Diwas was organized on 16-10-2019. This day has been introduced by the Government of India in 2014. National Unity Day provide an opportunity to re-affirm the inherent strength and resilience of our nation to withstand the actual and potential threats to the unity, integrity and security of our country. As part of the Day, pledge was taken by the staff and students for National Unity, followed by Run for Unity and March past.

Vigilance Awareness Week 2019

CSIR-CDRI celebrated the Vigilance Awareness week from 28-10-2019 to 02-11-2019 with a great enthusiasm. Inauguration of vigilance week was started with the Integrity pledge by all the staff members and scholars of this institute. Following activities were carried out as a part of this program:

Staff from CSIR-CDRI visited Primary School, Saraiyan, Bakshi ka Talaab, Lucknow and created awareness among school children. Mr. Santosh Kumar Tripathi, Block Education Officer, Bakshi ka Talab was chief guest.

On 22-10-2019, Essay writing competition and debate completion was organized by CSIR-CDRI at Kuraon Inter College, Itaunja on "Corruption is a problem and its solution".

On 25-10-2019 CSIR-CDRI staff visited Kharagpur village to spread awareness on vigilance and anti-corruption among the village population. During the program, Sh. Pradip Kumar, Administrative Officer, CSIR-CDRI delivered the importance of Vigilance awareness among the villagers. This program was organized with support from Mrs. Ravila Mishra, Village Head.

On 30-10-2019 slogan competition and on 31-10-2019 Quiz Competition was organized for staff and students of CSIR-CDRI.

For concluding session of the week, Mr Sanjay Tripathi, IRTS, DRM Northern Railways Lucknow was Chief Guest and he spoke on "Integrity- A Way of Life ". Winners of various competitions organized as part of awareness week were felicitated with Certificates and Memento.

On the occasion of vigilance Awareness week-2019 it was made compulsory to take E-Pledge for Staff and Students.

Further, as a part of the Vigilance Awareness week, half day workshop on RTI was organized at CSIR-CDRI on 4 November 2019. Sh. Mukul Sahai, Ex – Controller of Administration, CSIR-NBRI delivered lecture on Right to Information.

Qaumi Ekta Week

With a view to foster and reinforce the spirit of Communal Harmony, National Integration and pride in vibrant, composite culture and nationhood, the "Qaumi Ekta Week" (National Integration Week) was observed at CSIR-CDRI from the 19 to 25 November, 2017.

राजभाषा अनुभाग

केन्द्रीय औषधि अनुसंधान संस्थान, लखनऊ में राजभाषा अनुभाग द्वारा प्रत्येक तिमाही में राजभाषा कार्यान्वयन समिति की तिमाही बैठकों का एवं प्रत्येक तिमाही में एक कार्यशाला का आयोजन किया गया जिसमें राजभाषा कर्यान्वयन से संबंधित प्रत्येक विषय पर चर्चा हुई तथा कंप्यूटरों पर यूनीकोड में काम करने एवं वाइस टाइपिंग का भी प्रशिक्षण दिया गया।

राजभाषा अनुभाग द्वारा प्रत्येक तिमाही में राजभाषा कार्यान्वयन की प्रगति रिपोर्ट को गृह मंत्रालय, राजभाषा विभाग एवं सीएसआईआर मुख्यालय को समय से भेजा गया। राजभाषा अनुभाग द्वारा प्रत्येक छमाही में संस्थान की छमाही रिपोर्ट नराकास लखनऊ को भेजी गई एवं नराकास की छमाही बैठको में भाग भी लिया गया।

राजभाषा अनुभाग एवं अनुभाग अधिकारी स्था0–। श्री कृष्ण राज सिंह के सहयोग से संस्थान की वेबसाइट को द्विभाषीय किया गया।

निदेशक महोदय के निर्देश से संस्थान की राजभाषा पत्रिका ज्ञान–विज्ञान के लिए एक एडिटोरियल बोर्ड का गठन किया गया।

केन्द्रीय औषधि अनुसंधान संस्थान, लखनऊ में राजभाषा अनुभाग द्वारा दिनांक 13 सितम्बर, 2019 से 20 सितम्बर, 2019 के मध्य हिन्दी सप्ताह का आयोजन किया गया। हिन्दी सप्ताह का उद्घाटन दिनांक 13 सितम्बर, 2019 को पूर्वाह्न 11.00 बजे संस्थान के लघु प्रेक्षागृह में किया गया। इस अवसर पर **प्रो. रूप रेखा वर्मा, पूर्व कुलपति,** लखनऊ विश्वविद्यालय, लखनऊ ने मुख्य अतिथि के रूप में व्याख्यान दिया। हिन्दी सप्ताह के दौरान विभिन्न प्रतियोगिताओं का आयोजन किया गया जिसमें संस्थान के कर्मचारियों ने भाग लिया। दिनांक 20 सितम्बर, 2019 को हिन्दी सप्ताह का समापन समारोह आयोजित किया गया जिसमें निदेशक महोदय द्वारा प्रतियोगिताओं में विजयी प्रतिभागियों को पुरस्कृत किया गया। संस्थान के प्रशासनिक अधिकारी श्री प्रदीप कुमार के धन्यवाद ज्ञापन के पश्चात हिन्दी सप्ताह का समापान किया गया।

Workshop & Trainings

Intellectual Property Awareness Workshop

IP Awareness workshop was organized at CSIR-CDRI on 14 March 2019. Dr. Patrali Banerjee, CSIR-IPU, New Delhi delivered lecture on Patentability; Inventorship and responsibility of inventors and also on Comparative IN, US and EP laws. Dr. Rahul Mishra, CSIR-IPU, New Delhi spoke about Patent strategies – Infringements and FTO; Patent Strategies – Drafting of Patent.

iThenticate Training Program

An Onsite training program was conducted on 18-07-2019 for using iThenticate – a plagiarism checking software. This program was conducted by Knowledge Resource Centre of CSIR-CDRI. Large number of Scientists and Students attended this program.

Two Day HPLC/UPLC Workshop

Sophisticated Analytical Instrument Facility conducted a Two-Day workshop on HPLC / UPLC during 28-29 May 2019. Participants received hands-on experience on Liquid Chromatography; Column Chemistry Technologies - Selection Criteria & Critical Parameters; Method Development on HPLC; UPLC Basics and Method development; Robust Method Development - Critical Parameters; method development on UPLC.

3rd National Workshop on "Applications of Electron Microscopy in Life Sciences"

Electron Microscopy Unit of Sophisticated Analytical Instrument Facility of Institute organized 3rd National Workshop on "Applications of Electron Microscopy in Life Sciences" during 16-18 July 2019. This three day workshop was aimed at enhancing the knowledge and skill set of students, research fellows, faculty and staff working in the area of life sciences and included both theory and practical sessions. The focus was on various techniques, applications and their sample preparation methods with intensive practical sessions including hands on sessions. Sessions covered TEM & SEM principles and applications, practical sessions on TEM & SEM sample preparation techniques including negative staining, cell/tissue embedding, ultra microtomy, imaging and recording data and image interpretation; Recent developments in the area of CryoEM was discussed.

Workshop on separation of proteins and their detection by fluorescent immunoblotting

One-day workshop on Separation of proteins and their detection by fluorescent immunoblotting was organized on 19th July 2019 at Proteomics and cancer biology lab of CSIR-CDRI jointly by Bio-Rad and CSIR-CDRI. This workshop was participated by 15 Research Scholars of CSIR-CDRI

National Conference / Workshop on Use of LC-MS/MS and HRMS in the analysis of Secondary Metabolites.

Three-day workshop from 14th-16th October 2019 was organized to increase awareness of using LC-MS and HRMS instruments for natural product chemists. Total 21 participants came from different parts of India to participate in it. This workshop was aimed to cover basics of liquid chromatography (LC) followed by High resolution mass spectrometry (HRMS). HRMS and LC-MS/MS in combination are the best and suitable tools to identify, characterize and quantify the molecules. All the participants were able to see the HPLC/UPLC-HRMS experiments on the instrument and interpretation of data by expert.

National Workshop on "Small Molecule Analysis by NMR Spectroscopy & Mass Spectrometry"

SAIF, CSIR-CDRI has organized a National Workshop on "Small Molecule Analysis by NMR Spectroscopy & Mass Spectrometry" during 11th-13th December, 2019. The workshop has provided an opportunity to experience the state-of-the-art NMR, LC-MS and LC-MS/MS techniques and initiate lively discussion among research scientists, academicians and young researchers to share their knowledge in the frontier areas of chemical sciences. The beginners got a chance to familiarize themselves with NMR and LC-MS techniques and gain confidence by observing their applications and data interpretation as done in real situation. This Workshop was focused on the structure characterization of small moleculeS using NMR, LC-MS and MS/MS techniques. Total 21 participants (research scholars, faculty and industry participants) from different part of country attended the workshop.

Short Term Workshop on "ADVERSE OUTCOME PATHWAY (AOP)"

Institute organized a short term training Workshop on "ADVERSE OUTCOME PATHWAY (AOP)" on 20th December 2019 at CDRI under the aegis of Atal Incubation Centre, Centre for Cellular & Molecular Biology, Hyderabad with an aim to train and guide the aspirants enabling them to distinguish a shift in science by focusing on new approach methodologies instead of animal models in biomedical research as per following programme. In the workshop, Dr. Surat Parvatam Centre for Predictive Human Model Systems, AIC-CCMB, HIS-India spoke about AOP's. Dr. DS Upadhyay, Chief Scientist & Head, Laboratory Animal Facility spoke about use of Animals in research.

CSIR-HRDC Training Programme on the new CSIR Manual of Procurement of Goods 2019

A Five-Day training program on new CSIR Manual of Procurement of Goods 2019 was organized by CSIR-HRDC during 19-23 August 2019 at CSIR-CDRI Lucknow. This programme was meant for participants from CSIR-CDRI, IITR, CIMAP, NBRI, CIMFR, NML, CBRI and IIP. More than 120 participants from above Institutes participated in this workshop. Faculty of the program included Shri R K Rao, Shri U S Das, Dr. Alok Kumar Goel, Shri Rajesh Gupta, Shri Bhaskar Narang, Shri Satish Chandra, Shri Praveen Rawat & Shri H. K. Sharma. Prof. Tapas K. Kundu, Director, CSIR-CDRI inaugurated the training program.

Zonal Workshop on OneCSIR ERP Portal

Two-Day zonal workshop on OneCSIR ERP portal, including HR, R&D, Finance and Stores and Purchase Module was organized at CSIR-CDRI, Lucknow during 11 & 12 September 2019 for the participants from CSIR laboratories CDRI, NBRI, IITR, CIMAP, & AMPRI. More than 100 concerned Officers and Scientists attended this training program. Dr. G. Radhakrishnan, Dr.Satyajit Rath, Mr.Sundar and Mr. Anand Bharti gave Onsite training to participants on different aspects of ERP portal.

Workshop on RTI

One-Day workshop on Right to Information topics like RTI online portal, uploading quarterly returns, proactive disclosure and third party audit was organized on 14 November 2019. Mr Vimal Kumar Varul, Scientist F, CPIO, DSIR, New Delhi interacted with the scientists and staff.

Health Awareness and Outreach Program at villages

Menstrual Hygiene and Bone Health is a serious concern for Women Health

A Health Awareness Program and free health check-up camp was organized at Fakharpur, Distt. Bahraich on 30th July 2019 in association with CARE India to sensitize the villagers for health, education and cleanliness during Health Awareness Program and free health check-up. This program was conceptualized under the aegis of Aspirational Districts Programme of NITI Aayog.

A nine-member team lead by Dr Sanjeev Yadav including Dr Sharad Sharma, Dr Ritu Trivedi, Dr P. R. Mishra and research scholars Mr Ashish K Tripathi, Ms Divya Rai, Ms Priya Gupta, Ms Geeta Dhaniya and Mr Shahzad Jalal visited Fakharpur village to sensitize the villagers for health, education and cleanliness and interacted with people about health awareness and did free health check-up. Program Manager, Girls Education, Care India, UP, Dr. Vandana Mishra and her team arranged the interaction with villagers and contributed open heartedly for successfully organizing the event. More than 120 villagers participated and get benefited by free health check-up and consultancy.

A follow up program was organized to assess the impact of our previous program organized for marginal rural girls from Kasturba Gandhi Balika Vidyalaya Jarbal, district Bahraich

An online Mental Health Awareness survey to evaluate the stressed condition/ mental health of participant and to raise awareness among them was initiated on the occasion of CSIR Foundation Day and being conducted by Ms Parul, Dr. Sanjeev Yadav and Dr. Shubha Shukla in association with renowned Psychiatrists, Dr. SS Lal Srivastava. Anyone interested to evaluate his/her mental health status can fill up this online test which is available on institute's website and on Social media platforms (Twitter, Facebook and WhatsApp) and can benefited from it.

JIGYASA – Quest for Curiosity

JIGYASA, a student-scientist connect programme, initiated by Council of Scientific and Industrial Research (CSIR) and Kendriya Vidyalaya Sangathan (KVS) in year 2017, however now Navoday Vidyalaya and other Government Schools have also been added in it. The objective of the programme is to expose students with practical activities to get a flavor of research in CSIR-CDRI by extending classroom learning to research and laboratory-based learning at early age. In the reporting period, 30 Kendriya Vidyalaya visited CSIR-CDRI under the aegis of JIGYASA Program, out of that 104 faculty and 1121 students get benefitted with these program.

Students Motivation Programs for various Schools & Colleges

To initiate and promote experimentation and innovativeness in education and bringing confidence to society about relevance of Institute in terms of Social Impact various student motivation program were organized to inculcate the scientific temperament. During the reporting period, Total 22 Student Motivation Programs (SMP) for 69 Schools and Colleges other than Kendriya Vidyalaya were organized in which total 226 faculties and 2486 students get benefitted with these program.

Sports & Recreational Activities

69th CSIR-CDRI Annual Day Sports Events

As a part of the 69th CSIR-CDRI Annual Day, Staff Club of the Institute organized various Indoor and Outdoor sports activities, including Badminton, Bridge, Campus Run, Carom, Chess, Cricket, Football, Kabaddi, Table Tennis, Volleyball for the staff and students of the Institute. Activities like field events and painting competition was organized for the children of CSIR-CDRI staff and scholars.

2 Distinguished Visitors and Lectures

Distinguished Visitor	Title of Lecture	Date
Dr. Budhaditya Mukherjee Department of Microbiology and Molecular Medicine University of Geneva CMU, Switzerland	Dissection of the fundamental roles played by Apicomplexan Aspartyl Proteases in establishment of parasitism	04-02-2019
Prof. Vinod Kumar Singh IIT, Kanpur	Enantioselective conjugate addition reactions	06-02-2019
Dr. Basudeb Maji Harvard Medical School	Chemical control of CRISPR-Cas9in genome engineering and transcriptional regulations	07-02-2019
Dr. Syamal Roy JC Bose National Fellow Professor and Dean, NIPER, Kolkata	On the edge of unknown: Infectious disease as metaphor to understand creativity	19-02-2019
Prof. Anthony J. Wilkinson Department of Chemistry University of York, UK	Protein Lipidation as a target for drug discovery in leishmaniasis and malaria	11-03-2019
Dr. Nidhi Bansal Editor-in-Chief, Cancer Reports (Wiley)	Scientific publishing –A view from the other side	12-03-2019
Dr. Ashutosh Srivastava Postdoctoral Researcher Institute of Transformative Biomolecules Nagoya University, Japan	Structural and dynamical insights into mammalian circadian clock proteins	28-03-2019
Dr. Ajeet Singh Novartis Institute for Biomedical Research, USA	Genetics of aging and age-related disorders in zebrafish	08-04-2019
Dr. Dinesh Pathak Editor, Hindustan daily	Parenting	24-05-2019
Dr. Rizwan Ahmed Post-Doctoral Fellow Johns Hopkins University	Discovery of a new lymphocyte that challenges current dogma in autoimmunity	30-05-2019
Dr. Abdul Malik Tyagi Staff Scientist School of Medicine Emory University	Role of gut microbiota and its metabolite on bone health	24-06-2019
Dr. Debojit Bose Free University, Berlin, Germany	RNA biology: From basic understanding to therapeutic interventions	01-07-2019
Prof. Pierre Goloubinoff University of Lausanne Switzerland	Evolutionary-inferred functional hierarchy of Chaperones that control the increasing protein complexity along the tree of life	25-07-2019
Mr. Soumya Sikder Entrepreneur / Agile Evangelist / Technology Enthusiast	Re-engineering healthcare regulation in India using Pharmacovigilance	26-07-2019
Prof. Alok Bhattacharya Ashoka University Sonepat, Haryana	Rare genetic disorders: A goldmine for drug discovery	05-08-2019
Dr. Sourav Banerjee National Brain Research Centre Manesar, Haryana	Non-coding RNAs in synaptic plasticity and memory	06-08-2019

Distinguished Visitor	Title of Lecture	Date
Prof. Vinod Kumar Tiwari Department of Chemistry Banaras Hindu University Varanasi	Synthesis of carbohydrate – containing molecules of great chemotherapeutic values	21-08-2019
Dr. Puneet Sexena Excelra Knowledge Solutions Pvt. Ltd., Hyderabad	Role of computational chemistry in drug discovery and development	22-08-2019
Dr. Shilpa Buch Professor & Vice Chair for Research University of Nebraska Medical Centre NE 68198	Role of extracellular vesicles in HIV infection and drug abuse	22-08-2019
Dr. Poonam Thakur Post-Doctoral Fellow Institute of Neurophysiology, Neuroscience Centre, Goethe University, Germany	Parkinson's disease- Understanding the pathophysiology to develop therapeutic targets	23-08-2019
Dr. Kamakshi Sureka Paul DBT-Wellcome Trust Early Career Fellow	Cyclic di-AMP: A regulator of bacterial metabolism and virulence	19-09-2019
Dr. Birendra Kumar Yadav Manager National Liver Disease Biobank	National Liver Disease Biobank: A national facility for fostering research across India and abroad	23-09-2019
Dr. Anshika Srivastava Assistant Professor Department of Medical Genetics SGPGIMS, Lucknow	ASXL3 links chromatin to developmental defects	10-10-2019
Dr. Ali Nakhi Post-Doctoral Associate Institute for Therapeutics Discovery & Development University of Minnesota, USA	Development of bile acid analogues- A reliable therapeutic approach to combat C. *difficile* Infection	22-11-2019
Prof. Devendra K. Agrawal Senior Vice President for Research & Biotechnology Professor, Department of Translational Research Western University of Health Sciences	Novel therapy to prevent intimal hyperplasia and Restenosis following balloon angioplasty in coronary disease	25-11-2019
Prof. Roland J Pieters Department of Chemical Biology and Drug Discovery Utrecht University Netherlands	Glycodrugs to interfere with protein-carbohydrate interactions	04-12-2019
Dr. Ankur Singh Associate Professor of Mechanical Engineering and Biomedical Engineering Cornell University, NY 14850	Immune organoids and lymphatics like technologies for discovering cell mechanism and therapeutics	17-12-2019
Dr. M. Balasubramanyam Dean of Research Studies & Senior Scientist Madras Diabetes Research Foundation, Chennai	Omics advancements in diabetes – Driving force for novel drug targets & defining logistics for precision medicine	23-12-2019

3 Visits & Deputations Abroad

	Name of Scientist	Country of Visit	Purpose of visit	Period of Deputation
1	Prof. Tapas K. Kundu	Germany Japan	To participate in the Visitors Programme of the Federal Foreign Office To participate in the Kick-off Symposium of Advanced Graduate Program for Future Medicine and Health Care.	20-26 October, 2019 05-07 March, 2019
2	Dr. Amit Misra	Netherland	To attend 5th International TB Meeting on Inhaled Therapies for Tuberculosis and Other Infectious Diseases	25-27 August, 2019
3	Dr. Atul Goel	UAE	To attend the 4th Global Summit & Expo on Laser Optics & Photonics	15-17 April, 2019
4	Dr. J. Venkatesh Pratap	Italy	Invited for experimental data collection	19-21 February 2019 & 04-08 December, 2019
5	Dr. Sidharth Chopra	Germany	Invited for Joint Conference for Indian and German Scientists, Indo-German Meeting	25-27 September, 2019
6	Dr. Wahajuddin	China	To attend seminar on China Innovation Tour for Indian Young Scientists	22-29 September, 2019
7	Dr. Sripathi Rao Kulkarni	Japan	Invited to attend JPO/IPR Training Course for Practitioners Specializing in Patents	16 October - 01 November, 2019

Prof. Tapas K. Kundu, Director, CSIR-CDRI; Prof. Samit Chattopadhyay, Director, CSIR-IICB; & Dr. Anurag Agrawal, Director, CSIR-IGIB visited Germany as a guest of the Federal Government during 21-25 October 2019. Places of visit: DFG German Research Foundation, Alexander von Humboldt Foundation and DAAD at Bonn; Max Planck Institute of Molecular Physiology and Lead Discovery Centre at Dortmund; India Office of the University of Gottingen, Faculty of Chemistry, Medical Centre of the University of Gottingen at Gottingen; Berlin Institute of Health, Federal Ministry of Education & Research and Federal Foreign Office at Berlin, Germany.

The Staff

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FNASc., FASc., FNA, Sir J. C. Bose National Fellow

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Raju Arora, B.Sc.
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Deepak, M.Sc.

Sr. Technician (3)
S K Bhatnagar, B.Sc. *(Superannuated on 30.6.2019)*

Sr. Technician (2)
Narendra Kumar, B.Sc.

Sr. Technician (1)
Akhilesh Kumar, Intermediate

Lab. Attendant (2)
Ram Bhajan Shukla, Intermediate
Ram Kumar
Ram Sundar Lal, BA (*Superannuated on 30.7.2019*)
Chandramani

DIVISION OF PHARMACOLOGY

Principal Scientist
Manoj K. Barthwal, M.Sc., Ph.D., *Chairperson*
Anil Gaikwad, M.S. (Pharma.), Ph.D.
Kumaravelu Jagavelu, M.Sc., Ph.D.
Kashif Hanif, M.Sc., Ph.D.

Senior Scientist
Sachin Kumar, M.Sc., Ph.D.
Amit Lahiri, M.Sc., Ph.D.

Scientist
Baisakhi Mohrana, M.V.Sc., Ph.D.
Shrikant R. Mulay, M.S., Ph.D.
Shashi Kumar Gupta, M.Sc., Ph.D.

Principal Technical Officer
C.P. Pandey, M.Sc., Ph.D.

Sr. Technical Officer (1)
Sheeba Saji Samuel, M.Sc., Ph.D.

Technical Officer
Smriti, M.Sc.
Pankaj Kumar Shukla, B.Sc., P.G.D.B.T.

Sr. Technician (3)
Bharti Bhushan, B.Sc.

Sr. Technician (2)
Ramesh Chandra, M.Sc.

Sr. Stenographer
Renuka Mushran, B.A.

Lab. Attendent (2)
Pankaj Sengupta

DIVISION OF TOXICOLOGY & EXPERIMENTAL MEDICINE

Senior Principal Scientist
Sharad Sharma, M.B.B.S., M.D., *In-Charge*
S.K. Rath, M.Sc., Ph.D.

Principal Scientist
R.K. Tripathi, M.Sc., Ph.D.
Sarika Singh, M.Sc., Ph.D.

Senior Scientist
Madhav Nilakanth Mugale, M.V.Sc., Ph.D.
Vivek Vidyadhar Bhosale, M.B.B.S., M.D.

Principal Technical Officer
Mukesh Srivastava, M.Sc., Ph.D. (Biometry & Statistics)
P.K. Agnihotri, M.Sc., Ph.D.
Sadan Kumar, M.Sc.

Sr Technical Officer
Anurag Kumar Srivastava, M.Sc.
Shail Singh, M.Sc., Ph.D.

Technical Officer
Anil Kumar Meena, M.Sc., B.Ed.
Navodayam Kalleti, M.Sc.
Sudhaker Yadav, M.Sc., M.L.T.

Technical Assistant
Akhilesh Kumar, M.Sc., Ph.D.

Sr. Technician (3)
M.P.S. Negi, B.Sc., PGDC (Biometry & Statistics)

Sr. Technician (2)
Anupma, B.Sc.

Sr. Stenographer
Nandita Pandey, B.A., Diploma in Secretarial Practice

Lab. Assistant
R.B. Pawar, *Clinical Pharmacology Unit (CDRI), Seth G.S. Medical College, Mumbai*
Umesh Kumar, Intermediate
Savitri Devi
Shree Krishna (Superannuated on 31-12-2019)

Lab. Attendant (2)
Ram Kumar, High School (Science)
Nand Pal Yadav, Intermediate

INFRASTRUCTURE FACILITIES AND MANAGEMENT GROUP

NATIONAL LABORATORY ANIMALS FACILITY

Chief Scientist
D.S. Upadhyay, M.V.Sc., Ph.D., *In-Charge*

Principal Scientist
S. Raja Kumar, M.Sc .
Dhananjoy Hansda, M.V.Sc.

Senior Scientist
Rajdeep Guha, M.V.Sc., Ph.D.
H.K. Bora, M.V.Sc.

Scientist
Shishir Kumar Gupta, M.V.Sc., Ph.D.

Principal Technical Officer
Karunesh Rai, M.Sc.

Technical Officer
Chandra Shekhar Yadav, M.Sc., PGDCA

Technical Assistant
Vijay Kumar Verma, M.Sc., Ph.D.

Sr. Technician (3)
Ravinder Singh, M.Sc., Ph.D.

Sr. Technician (2)
Sanjeev Kumar Saxena, B.Sc.
Ravi Kumar Shukla

Narendra Kumar, B.A.
Dinesh Kumar, B.A.
Pradeep Tirkey, Intermediate
Arun Sharma, B.Sc.

Lab. Assistant
V.B.L. Srivastava
S.K. Verma
O.P. Verma, B.A.

Lab. Attendants (2)
Jameel Beg
Najibullah

Lab. Attendants (1)
Changa Lal *(Superannuated on 30.3.2019)*

SOPHISTICATED ANALYTICAL INSTRUMENTS BASED FACILITY AND RESEARCH

Chief Scientist
Brijesh Kumar, M.Sc., Ph.D., *Mass Unit In-charge and Overall Facility In-charge (superannuated on 31-01-2020)*

Principal Scientist
Ravi Sankar Ampapathi, M.Sc., Ph.D., *NMR Facility In-charge*
Sanjeev Kumar Shukla, M.Sc., Ph.D.
Sanjeev Kanojiya, M.Sc., Ph.D. *Mass Facility In-charge*
Kalyan Mitra, M.Sc., Ph.D., *Microscopy Facility In-charge*

Principal Technical Officer
H.M. Gauniyal, M.Sc., Ph.D.
A.K. Mandwal, M.Sc., Ph.D.
Sunil Kumar, B.Sc.
Pramod Kumar, M.Sc.

Sr. Technical Officer (2)
R K Purshuttom , B.Sc. (*Superannuated on 30.9.2019*)

Sr. Technical Officer (1)
Kavita Singh, M.Sc., Ph.D.
Binod Kumar Saw, M.Sc.

Technical Officer
Garima Pant, M.Sc.
Pooja Soni, Diploma
Tofan Kumar Rout, M.Sc., Ph.D.
Amit Kumar, M.Tech.

Technical Assistant
Vipin Kumar, M.Sc.
Pooja Singh, M.Sc. (Pharmaceutical Chem.)
Mohan Kumar A.S., M.Sc.

Sr. Technician (3)
Ashok Pandey, B.Sc.
Sandeep Sengupta, B.Sc.
Madhu Chaturvedi, Diploma (Electronics)

Sr. Technician (2)
Akhilesh Kumar Srivastava B.Sc. *(Superannuated on 30.12.2019)*
V.K. Maurya, ITI
Akhilesh Kumar Srivastava, B.Sc.
Madhuli Srivastava, B.A.
O.P. Gupta, B.Sc.
S.A. Singh, B.Sc., PGDCA
D.N. Vishwakarma

DIVISION OF INSTITUTE CORE FACILITIES

Senior Principal Scientist
N.K. Agarwal, M.Sc.

Principal Scientist
Manoj Kumar Rawat, M.Tech.

Sr. Technical Officer (2)
Ram Karan Harijan, AMIE
Sanjay Kumar, B.Tech. (Civil Engg.)

Technical Officer
Arbind Kumar, B.C.A., PGDAM

Sr. Technician (3)
J.K. Joshi, B.Sc.

Sr. Technician (2)
V K Mishra, Diploma *(Superannuated on 30.6.2019)*
Kamal Singh, ITI (Instrument Mechanic)
Shailendra Mohan, M.Sc. (Maths), PGDCA
K.M. Shukla, B.Sc.
Suresh S. Bhakuni, Intermediate, ITI, Dip.

Technician (1)
Sumit Khichi , Intermediate, ITI Jodhpur
Kul Bahadur Thapa, BCA, ITI Trade Electronics, Diploma (Electronics)

Lab. Assistant
Mohd. Islam
Satya Narayan Maurya
Makkhan Lal

Lab. Attendant
Lakhana Devi
Ashok Kumar

SCIENTIFIC DIRECTORATE

Principal Scientist
Anand P. Kulkarni, M.Sc., Ph.D., Head, PME

Sr. Technical Officer (3)
Ravindranath S. Londhe, GD Art (Commercial), Art Teachers Dip.

Technical Officer
Farha khan, M.C.A.
S. Mehazabeen, M.Sc.

Technical Assistant
Ashok Kumar, Diploma in Mechanical Engineering

Sr. Stenographer
Himanshu Upadhyay, B.A. (Afternoon with HRD & KRC)

ACADEMIC AFFAIRS UNIT

Scientist
Sanjeev Yadav, M.Sc., Ph.D., PG Diploma in Bioinformatics

Sr. Technician (2)
A.K. Pandey, B.Sc.

BUSINESS DEVELOPMENT& INTELLECTUAL PROPERTY UNIT

Principal Scientist
Naseem Ahmed Siddiqui., B. Pharma (Hons), M.B.A., *Head*
Sripathi Rao Kulkarni, M.Sc., Ph.D., P.G. Dip. in Patents Law

Sr. Technical Officer (3)
A.S. Kushwaha, B.Sc.

Technical Officer
Neelima Srivastava, M.C.A.

Technician (2)
Preeti Agarwal, M.C.A.

COMPUTER CENTRE

Sr. Principal Scientist
Kural, B.E., *Centre In-Charge*

Scientist
Santhosh Shukla, B.Tech.

Sr. Technical Officer (1)
Ajay Kumar Maurya, M.Tech.

HUMAN RESOURCE DEVELOPMENT & KNOWLEDGE RESOURCE CENTRE

Chief Scientist
Vinay Tripathi, M.Sc., M.B.A., P.G. Dip., *In-Charge*

Sr. Principal Scientist
Prem Prakash, M.Pharm.

Principal Technical Officer
Sanjay Kumar, M.L.I.Sc (*Head, KRC from 01/02/2019 to 15/12/2019*)

Sr. Technical Officer (1)
Savita Tripathi, M.Sc., B.Ed.
Ramesh Chandra Gupta, M.L.I.Sc.

Technical Officer
Pankaj Upreti, M.L.I.Sc.

Sr Technician (2)
Chandrika Singh, B.Sc., LLB *(Superannuated on 30.7.2019)*

Technician (2)
Susheel Kumar, Intermediate

Sr. Stenogrpaher
Surendra Kumar, B.Com.

Lab. Attendant (1)
Pradeep Kumar Srivastava, B.Sc.

LABORATORY ENGINEERING SERVICES

Senior Superintending Engineer
Parvez Mahmood, B.Sc., Engineering (Civil), *In-Charge*
Kamal Jain, B.E., (Electrical)

Executive Engineer
Mohit Kumar Shukla, A.M.I.C.E. (Civil)
Jai Prakash, Diploma in Mech. Engg. (Rref. & AC)
Sidho Hembrom, Diploma in Mech. Engg.

Assistant Executive Engineer
D.K. Vishwakarma, Diploma in Civil Engg.
Brahma Singh, AMIE in Electrical Engg.

Assistant Engineer
Madhukar Saroj, Diploma, B.Tech. (Civil)
Ajay Kumar, B.Sc., Diploma in Electronics Engg.

Sr. Stenographer (Hindi)
Raj Kumar, B.A.

Multi-Tasking Staff
Hanuman
Maikulal-II
Hari Prasad

Sr. Technician (2)
M.S. Verma, B.A., ITI
Harish Kumar, Intermediate, ITI
Vijay Kumar, High School, ITI
Swapan Karmi
Ramesh Kunwar, Intermediate, ITI
Arun Kumar Srivastava, ITI

Technician (2)
R A Prajapati, MA *(Superannuated on 30.12.2019)*

Lab. Assistants
Popinder Singh
S.K. Bhattacharya
S.K. Yadav
Bishan Singh Negi
A.K. Misra

Lab Attendant (2)
Sandeep Roy, High School

Dhirendra Misra, Intermediate
Mohd. Irfan, Intermediate, ITI
Raju Vishwakarma
Ram Autar
Hari Om Garg
Ram Samujh, Intermediate
Bindeswari Prasad
Suresh Kumar
Gaya Prasad
Ram Asrey

Lab. Attendant (1)
Darshan Lal

MTS (Non-Technical)
Faizi

ADMINISTRATION

COA OFFICE

Controller of Administration
C P Arunan, BA *(Superannuated on 30.3.2019)*

Administrative Officer
Pradip Kumar, B.E.

Asstt. Section Officer
Kamla Kandpal, M.A.

Jr. Stenographer
Kshma Bajpai, B.A.

Multi-Tasking Staff
Saurav Sarkar, Intermediate

DIRECTOR'S OFFICE

Private Secretary
Sumit Srivastava, B.Com.
V.P. Singh, B.A.
Sunita Chopra, B.A.

Sr. Technician (2) (Driver)
Shakeel Ahmad Khan

Lab. Attendant (2)
Nand Kishore, ITI

Trainee
Rajesh

ESTABLISHMENT I

Section Officer (G)
Krishna Raj Singh, B.Sc., MSW

Assistant Section Officer (G)
Vibhash Kumar, B.A. (Hons), CIC
Jagdish Prasad, B.Sc., MPA
Saju P. Nair
Reena Bisaria, B.A.
Riti Chaudhary, B.A.

Junior Secretariat Assistant (G)
Anjali Singh, B.A.
Vinay Singh, B.C.A.

Sr. Stenographer
Deepak Dhawan, B.A.

Lab. Assistant
Vinod Kumar

Group-"C" of "D"
Manju Yadav

ESTABLISHMENT II

Section Officer (G)
Ishwar Nath Jha, B.A., M.B.A.

Assistant Section Officer (G)
Vivek Bajpai, M.A. (*Transferred to CSIR-CIMAP*)
Rashmi Srivastava, B.A., B.Ed.
Dilip Kumar Sen, B.Com.
Gangadin Yadav, B.A . (*Superannuated on 30.6.2019*)
Kailash Chandra, Intermmediate *(Superannuated on 30.9.2019)*
Neena Raizada, B.A.
Aparna Bajpai, B.A.
Ajai Shukla, M.Com.

Junior Secretariat Assistant (G)
Anoop Thakur, B.Tech. (ECE)

Sr. Stenographer
Vinod Kumar Yadav, B.A.

Multi-Tasking Staff
Ram Kumar, B.Com.

GENERAL SECTION

Section Officer (G)
Anil Kumar, B.Sc.

Assistant Section Officer (G)
Rajendra Prasad, B.A.
Rani, High School
Mohd. Irfan, Madhyama Visharad

Junior Secretariat Assistant (G)
Deepak Kumar Gupta, M.Com.
Rishi Kant, M.Sc., B.Ed., O-Level
Mohd. Saleem, Prathama (equi. to High School)

Sr. Stenographer
Seema Srivastava, M.A

Sr. Technician (2) (Driver)
K.K. Kashyap
Driver
Daya Shankar Singh

Multi-Tasking Staff
Kalpanath Sharma

Lab. Attendant
K.P. Mishra

BILL SECTION

Section Officer (G)
Nitu Kumari, B.Sc., M.A.

Assistant Section Officer (G)
H K Johar, B.A. (*Superannuated on 30.9.2019)*
Dilip Kumar (Cash), B.A, LLB

Senior Secretariat Assistant (G)
Nida Parveen, B.Com.

Junior Secretariat Assistant (G)
Indra Prakash Singh, B.A.
Kumar Saurabh, B.Com.

Sr. Stenographer
Vineet Pandey, B.A., P.G. Comp.

Jr. Stenographer
Lalit Kumar, BA

Lab Assistant
V.P. Mishra

Lab. Assistant
Vinod Kumar Sharma

VIGILANCE

Assistant Section Officer (G)
Ajay Kumar, B.A., LLB

Junior Secretariat Assistant (G)
Jaya Singh

Lab. Assistants
Ramesh Chandra

RECORDS

Assistant Section Officer (G)
Md. Irfan

HINDI SECTION

Sr. Stenographer (Hindi)
Anil Kumar, B.Com.

SECURITY

Security Officer
Anil Kumar Upadhyay, M.A.

FINANCE & ACCOUNTS

Finance & Accounts Officer
I.B. Dixit, M.Sc., M.B.A

Section Officer (F&A)
Mahesh Babu, B.A.

Assistant Section Officer (F&A)
Ajay Kumar, B.A.
D.K. Khare, B.Com.
Sasidharan Radha (*Superannuated on 30.11.2019)*
U K Tiwari, B.Sc. *(Superannuated on 30.4.2019)*
Mahender Kumar, B.Com.
Sanjay Kumar, B.A.

Senior Secretariat Assistant (F&A)
Tahseen Tilat, B.A.
S.A. Siddiqui, B.A
Chandrashekhar, Intermediate
Abhishek Kumar, Intermediate

Sr. Stenographer (H)
Jitendra Patel, M.A.

Junior Secretariat Assistant (F&A)
Mamata Chourasia, M.A.

Lab. Attendant (2)
Vikramaditya, High School

Lab. Assistant
Satish Chandra Yadav, B.Sc.
Angad Prasad *(Superannuated on 30.10.2019)*

Multi-Tasking Staff
Mohd. Firoz, B.A.
Shekhar Singh, B.Com.. M.B.A.

STORE & PURCHASE

Store & Purchase Officer
M.P. Singh, M.A., PGDBA, MBA
Prasenjeet Mitra, B.Sc.
Krishna Kumar

Section Officer
Amit Kumar, M.A.

Assistant Section Officer (S&P)
P.S. Chauhan, B.Sc.
Arun Wadhera, Intermediate
H.B. Neolia, M.A.
R.C. Dwivedi, B.Com.
Md. Rizwan, B.Tech, MPA
Mahesh Kumar, M.A.

Senior Secretariat Assistant (S&P)
M.C. Verma, B.Com.
Srikant Mishra, B.A. (*Superannuated on 30.6.2019*)
Kanchan Bala, B.A.

Junior Secretariat Assistant (S&P)
Vandana Parwani, B.A. (*Superannuated on 31-01-2020*)
G.P. Tripathi, Intermediate
Anil Kumar, B.A.

Sr. Technician (3)
Ram Pal, B.Sc., LLB

Sr. Technician (2)
Ravi Kumar Mehra, B.A.

Attendant
Hardwari

Multi-Tasking Staff
Sudhir Kumar Yadav, Intermediate

CSIR DISPENSARY

Medical Officer Group III (6)
N.K. Srivastava, M.B.B.S., *In-Charge*

Medical Officer Group III (4)
Kunal Gupta, M.B.B.S.
Shalini Gupta, M.B.B.S., PGDHHM

Technician (2)
Shraddha, M.A., Diploma in Nursing, Post Basic Diploma in Dialysis, Certificate in child care nutrition
Shabana, B.A., Diploma in Pharmacy

Technician (1)
Shahzada Jalal (Pharmacist)
Shimpi Gupta (Pharmacist)

Lab. Assistant
S.K. Paswan

Lab. Attendant (2)
Lalji Prasad (*Superannuated on 31-01-2020*)
Shubhendra Kumar

CANTEEN

Manager Gr. II (ACP)
J.P. Sati, B.A.

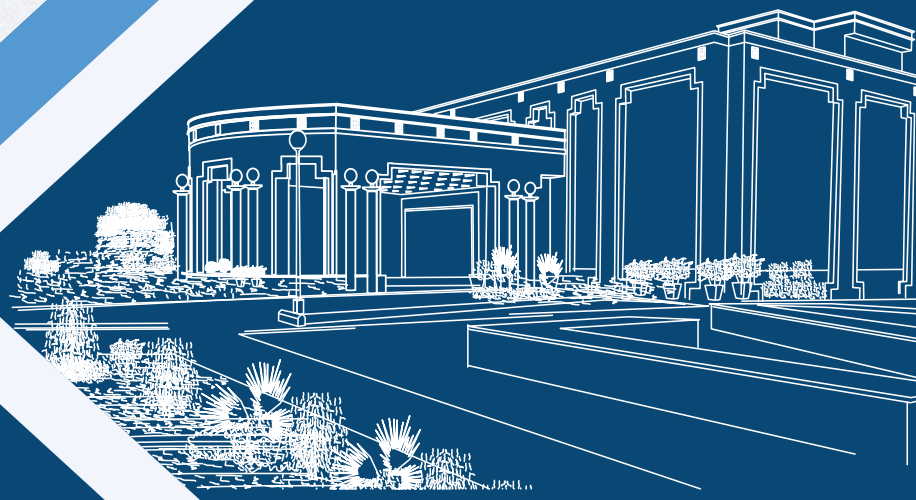
Clerk (ACP)
Ram Jiyawan Tewari (Coupon Clerk), Acharya Y.K. Singh, B.A. (Count Clerk)

Asstt. Halwai
Uma Shanker Tewari

Bearer
Ganga Ram
Rajender
Sukhdev Prasad

S/Man
Raj Kumar

Wash Boys
Ram Murat
Dinesh Pal Singh, Intermediate



CSIR-Central Drug Research Institute

सीएसआईआर-केन्द्रीय औषधि अनुसंधान संस्थान
CSIR-CENTRAL DRUG RESEARCH INSTITUTE

सेक्टर 10, जानकीपुरम विस्तार, सीतापुर रोड, लखनऊ-226031, भारत
Sector 10, Jankipuram Extension Sitapur Road, Lucknow-226031, India

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E-mail: director@cdri.res.in; Web: www.cdri.res.in