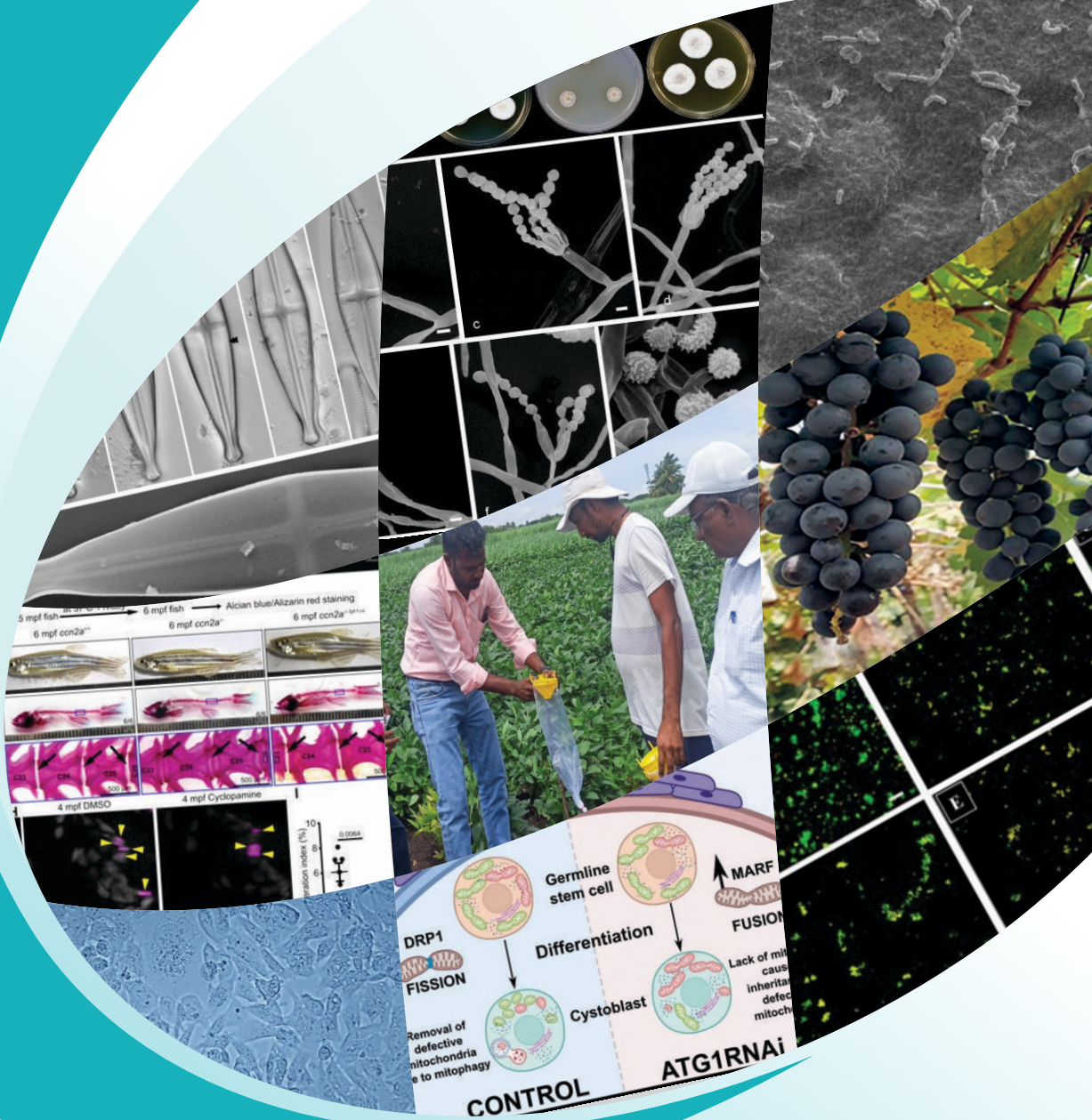


MACS



Annual Report 2022-23



Maharashtra Association for the Cultivation of Science
Agharkar Research Institute

Vision

To excel as an internationally recognized centre of multi-disciplinary research in science and technology

Mission

- a. Conduct basic and applied research in life and related sciences for human betterment
- b. Explore the genetic diversity of microbes, plants and animals
- c. Develop sustainable technologies for a cleaner environment, agriculture and better health

Objectives

- a. Undertake research in cutting-edge science and its applications
- b. Develop and translate technologies for cleaner environment and better health
- c. Develop and adopt practices for sustainable agriculture



Annual Report 2022-23



Maharashtra Association for the Cultivation of Science
Agharkar Research Institute

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Dr G K Wagh, Technical Officer D, ARI



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Foreword



Dr Anil Kakodkar

President

Maharashtra Association for the Cultivation of Science
Pune

As we approach the culmination of the 'Azadi ka Amrit Mahotsav,' a momentous initiative by the Government of India commemorating 75 illustrious years of an independent and progressive nation, we stand witness to remarkable accomplishments at MACS-ARI during the year 2022-23. It is with great pleasure that I share some of these achievements.

The persistent endeavours invested in advancing the utilisation of Rajbhasha Hindi have garnered commendation from the Parliamentary Rajbhasha Committee. My heartfelt congratulations go out to the dedicated personnel of the Institute for their unwavering commitment. This milestone attained reflects an aspiration cherished by every institution.

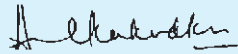
A significant stride was made by signing a Memorandum of Understanding with the National Research Development Corporation. This agreement enables the establishment of NRDC's Pune Outreach Centre at MACS-ARI, fostering MACS-ARI's pursuits in knowledge to wealth translation. Serving the western region of our nation, NRDC's Pune Outreach Centre is poised to make a substantial impact in terms of intellectual property creation and management. Another MoU was signed between the Bioenergy Group of ARI and the Institute of Engineering and Ocean Technology of the Oil and Natural Gas Corporation to develop and apply microbial technology to mitigate microbial-induced corrosion. Other agreements signed during the year focus on research and development in bioenergy and the production of wheat and soybean breeder seeds. These initiatives stand as a testament to our resolute commitment to translating research outcomes into meaningful societal contributions.

In the realm of intellectual property, our endeavours have extended beyond patents, as evidenced by our inclusion under the "Protection of Plant Varieties and Farmers Rights Authority." Notably, grape variety ARI 516 and three soybean varieties—MACS 1407, MACS 1460, and MACS 1520—have gained recognition. This valuable addition complements our existing portfolio of patents, underscoring our multidimensional

approach to innovation. The Indian Council of Agricultural Research has acknowledged the invaluable contributions of our scientists in developing soybean varieties and agronomic technologies tailored to soybean cultivation.

Visits of ARI scientists to Mexico, Japan, and Greece, focusing on advancements in wheat cultivation and developmental biology, have consolidated our efforts in enhancing our institutional scientific capacity.

Before concluding, I want to express my appreciation for the efforts of MACS-ARI scientists and staff and the support and guidance of MACS life members. I also acknowledge the continuing support of the Department of Science and Technology, Government of India.



Anil Kakodkar

21 August 2023

Executive Summary



Dr PK Dhakephalkar

Director
MACS-Agharkar Research Institute
Pune, India

As the Director of the Agharkar Research Institute (ARI), MACS, Pune, I am honored to present an overview of our institute's remarkable achievements during the year 2022-23. ARI, as an autonomous institute under the Department of Science and Technology, Government of India, has focused on pioneering research in diverse life science domains. With a distinguished team comprising 32 scientists, ARI has made significant strides in the realms of Biodiversity & Palaeobiology, Bioenergy, Bioprospecting, Developmental Biology, Genetics & Plant Breeding, and Nanobioscience. Our dedicated efforts have yielded impactful results, leading to major breakthroughs that contribute to both scientific advancement and societal well-being. Our achievements encompass a diverse spectrum of accomplishments:

- **Crop Varieties for Enhanced Yield:** We have released two disease-resistant and high-yielding wheat varieties, 'MACS-SAKAS' and 'MACS-JEJURI', ideal for cultivation in Central and Peninsular Zones of India, respectively.
- **Innovative Solutions for Industry:** ARI developed a novel eco-friendly biocontrol method that inhibits sulfate-reducing bacteria (SRB) in oil reservoirs, enhancing crude oil quality and preventing Microbial Induced Corrosion in oil industry.
- **Microorganism Discoveries:** A previously undiscovered anaerobic bacterium, named as *Sporanaerobium hydrogeniformans* gen. nov. sp. nov. was isolated from the Aravali hot spring in India, and characterised for its remarkable capacity to produce hydrogen.
- **Advancements in Medical Science:** Through our research, we pinpointed a powerful antiangiogenic agent, a bimetallic compound combining Ruthenium and Ferrocene, with the potential to revolutionize solid tumour treatment. Our researchers innovatively designed gold nanoparticles linked with Tenofovir, offering a novel approach for a multifunctional, extended-release anti-HIV therapy, addressing limitations in drug delivery. Our scientists have investigated GPCR (G-

protein coupled receptor) signalling and the regulation of glial morphogenesis to unravel the intricacies of cellular communication, nervous system development, and neurological disorders. This knowledge has far-reaching implications for both basic science and potential clinical applications.

- **Commercial Potential in Biotechnology:** ARI scientists explored the potential of diverse biological resources to harness their benefits for the betterment of society. This included (i) the creation of disease-resistant, high-yield crop varieties; (ii) the designing of sustainable microbial processes for generating renewable energy from waste sources; and (iii) the development of biocontrol methods to combat microbial-induced corrosion within the oil industry, among others.
- **Evolutionary Insights:** Our research shed light on the origin of *Capparis* L., reclassifying it and deepening our understanding of plant evolution. Our scientists have revisited taxonomy for *Sarsaparilla*'s wild relatives in India by developing superbarcodes, utilizing phylogenomic tools. *Sarsaparilla* has found its way into culinary and beverage preparations, in addition to its medicinal uses. This investigation has broad implications for diverse fields, from conservation to medicine, agriculture, and scientific discovery.

The above accomplishments are further highlighted by collaborative efforts with esteemed institutions worldwide, such as CIMMYT, Rostock University, Tokyo Gakugei University, and more. Our collaborations extend to industry partners like ONGC, HiTech BioScience India Ltd., GPS Renewables Pvt. Ltd., Asian Paints, etc. enriching our research scope and societal impact.

ARI's commitment to knowledge dissemination is evident in the publication of research findings, the distribution of breeder seeds to promote agriculture, and the sharing of advanced research facilities with academia and industry. In the coming years, ARI remains dedicated to advancing research, developing sustainable agricultural practices, and contributing to renewable energy technologies. Our focus on biodiversity, bioenergy, nanotechnology, and innovative solutions remains steadfast, bolstered by the unwavering support of our dedicated team and collaborative partners.

The auditor's review of our financial accounts attests to our commitment to transparency and accountability. With 84 papers in refereed journals, award of Ph.D. degree to 12 students, 2 patents granted, and numerous collaborative ventures, ARI's impact is far-reaching. I extend my gratitude to all office bearers of MACS, researchers at ARI, collaborators, funding agencies, especially Department of Science and Technology, Government of India, for their continued and generous support. Together, we continue to push the boundaries of scientific exploration, striving for a better tomorrow.



PK Dhakephalkar

16 September 2023

ARI Scientists

Biodiversity and Palaeobiology Group



Dr Sanjay
K Singh



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Dr Paras
Nath Singh



Dr Ritesh
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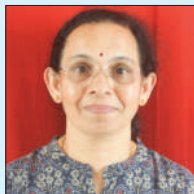


Dr Sudhir Navathe



Dr. Suresha P.
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Nanobioscience Group



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M Rajwade



Dr Dhananjay
S Bodas



Dr Vandana
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Dr Yogesh
A Karpe



Dr Sachin H Jadhav

Biodiversity and Palaeobiology

Biodiversity

Bacteria and Archaea

Applications of methanotrophs in rice agriculture for methane mitigation and plant growth promotion

We are trying to develop methanotrophs as bio-inoculants for rice agriculture, targeting to reduce methane emissions from rice while achieving plant growth promotion. In the present study we used four methanotroph formulations *Methylomagnum ishizawai* KRF4, *Methylobolus aquaticus* FWC3, Type II *Methylosinus-Methylocystis* consortia (four strains), Type I *Methylomonas* (four strains) as bio-inoculants. Three doses of the bio-inoculant (25 ml of 2×10^9 cells/ml) were added per pot (16 plants) at one-week intervals after transplantation. Sixteen plants per bio-inoculant and two control sets (sixteen plants) each were used.

An increase of (9-29%) in plant height was observed in methanotrophs inoculated Indrayani rice plants in which *Methylomagnum ishizawai* KRF4 > *Methylobolus aquaticus* FWC3 > Type II *Methylosinus-Methylocystis* consortia (four strains) > Type I *Methylomonas* (four strains) consortia compared to control without bio-inoculated rice plants. Around 25-38% increase in dry grain weight were seen in methanotrophs-inoculated rice plants compared to control. *Methylomagnum ishizawai* KRF4 and *Methylobolus aquaticus* FWC3 induced early flowering in the rice plants (14 and 11 days earlier than controls). Thus, all four inoculated methanotrophs positively affected Indrayani plants. Methanotroph bio-inoculants also increased the methane oxidation rates of the rhizospheric soils (~2-3 fold) compared to the controls.

Cultivation of methanotrophs from biogas reactors and cattle dung

In India, cattle dung and agricultural wastes are used as primary sources of waste required for operating biogas reactors. So far, very few studies report the diversity of methanotrophs from biogas reactors and cow dung or cow rumen. We used traditional well-developed cultivation protocol to isolate and cultivate methanotrophs serial endpoint dilution enrichments from cow dung as well as biogas reactors and successfully isolated *Methylocaldum gracile*, a thermotolerant methanotroph. The results were substantiated by sampling other reactors, viz., a small reactor of 20 L capacity and two 1000 L reactors. Additionally, enrichments were set up using fresh cow dung samples from two Indian cattle breeds (Tharparkar and Gir). All the enrichment bottles were incubated at 39°C, the reactors' in-situ temperature, and the rumen gut temperature. Four pure cultures related to *Methylocaldum gracile* VKM-14L^T, two strains from cattle dung samples (obtained from Tharparkar and Gir), and two from reactors. Additionally, four cultures of *Methylocaldum gracile* and *Methylocaldum tepidum*, which were non-axenic and identified by *pmoA* gene sequencing were identified. Pure cultures of *Methylocaldum gracile* RS-9 and CDP-2 were studied for their optimum temperature and oxygen concentration. Both the strains were thermotolerant and grew in the

25–45°C range, with the optima between 37°C and 45 °C. The cultures could grow under micro-oxic conditions (0.5–1% oxygen) and oxic conditions (10% oxygen).

To summarize, we report the cultivation and isolation of methanotrophs from biogas slurries and cattle dung samples. *Methylocaldum* was the dominant methanotroph cultured, probably due to its thermotolerant nature and the ability to grow under variable oxygen conditions. The present study also expands the knowledge about habitats known for the genus *Methylocaldum*. An analysis of the isolated cultures would help us design strategies for methane mitigation from ruminants.

Methane oxidation potential and associated methanotrophic bacterial community of tropical moist deciduous forest and grassland soils of Terai Ecozone

The study is targeted to generate valuable information on the methanotrophic diversity and methane oxidation potential of moist tropical deciduous forests and grasslands of the Terai ecosystem of India. Methanotrophs were isolated from three types of forest soil samples (marshy, grassland, and forest) from the Terai region, in summer and rainy seasons of 2022. The cultured members were all from the genus *Methylocystis* as characterized by *pmoA* gene sequencing and on the basis of morphology.

Isolation and characterization of a novel genus of hydrogen producing anaerobic bacterium *Sporanaerobium hydrogeniformans* gen. nov., sp. nov., isolated from Aravali hot spring in India

An obligately anaerobic bacterium XHS1971^T was isolated from a sediment sample of the Aravali hot spring in the Ratnagiri district of India. Cells of strain XHS1971^T were motile long-rods, spore-forming and showed Gram-stain-negative reaction. Growth was observed at temperatures 30–50°C (optimum 40–45°C), pH 5.0–10.0 (optimum pH 8.0) and NaCl concentrations 0–0.5% (optimum 0%). The generation time of strain XHS1971^T was 5 h under optimized growth conditions. Phylogenetic analyses based on 16S rRNA gene sequences showed that the strain shared the highest homology of <94.5% with *Cellulosilyticum lentocellum* DSM5427^T, identifying the strain as a distinct member of the family *Lachnospiraceae*. The major cellular fatty acids (>5%) were C_{14:0}, C_{16:0}, C_{18:0}, and C_{16:1} ω7c. Strain XHS1971^T fermented glucose into hydrogen, formic acid, acetic acid, and ethanol and metabolized different complex and simple sugars constituting lignocellulosic biomass. The genome size of the strain was 3.74 Mb with 35.3 mol% G+C content, and genes were annotated to carbohydrate metabolism, including genes involved in the degradation of cellulose and xylan and the production of hydrogen, ethanol and acetate. The digital DNA-DNA hybridization (dDDH), Average Nucleotide Identity (ANI), and Average Amino Acid Identity (AAI) values of 22%, 80%, and 63%, respectively, with nearest phylogenetic affiliates further validated the novel status of strain.

A novel, obligately anaerobic, halotolerant, thermotolerant, sulfate reducing bacterium was isolated in an Indian offshore hydrocarbon reservoir

A novel sulfate reducing bacterium was isolated from produced water of India's western offshore hydrocarbon reservoir. The polyphasic method often used in bacterial systematics was used to conclusively identify the strain MCM B-1480^T. Standard microbiological methods were used to characterize the morphology and biochemistry of strain MCM B-1480^T. The strain MCM B-1480^T was a Gram-stain-negative, motile, non-spore-forming, curved-rod-shaped bacterium. Strain MCM B-1480^T could grow at temperatures between 20–60 °C (optimum 37 °C), pH 6–8 (optimum 7), and required 1–6% NaCl (optimum 3%) for growth. Strain MCM B-1480^T was reducing sulfate to produce hydrogen sulfide during growth. This strain used lactate and pyruvate as prominent electron donors, whereas sulfate, sulfite, thiosulfate, and nitrate served as

electron acceptors. The maximum 16S rRNA gene sequence homology between MCM B-1480^T and *Pseudodesulfovibrio* members was 98.65%. The 3.87 Mb long genome of MCM B-1480^T had a G+C content of 60.39%. Its distinctiveness was verified by average nucleotide identity (ANI, 84%) and digital DDH (27.7%) with the nearest phylogenetic affiliation (less than 70% and 95%, respectively). The major cellular fatty acids components, namely iso-C_{15:0r}, anteiso-C_{15:0r}, C_{16:0}, and anteiso-C_{17:0r}, differentiated strain MCM B-1480^T from other species of *Pseudodesulfovibrio*. In strain, MCM B-1480^T, genome annotation identified the presence of genes that encode dissimilatory sulfate reduction and nitrate reduction. The strain MCM B-1480^T was identified as a novel taxon by the polyphasic analysis, which included SSU rRNA gene sequencing, average nucleotide identity, Digital DNA hybridization, cell wall fatty acids analysis, etc. The name *Pseudodesulfovibrio thermohalotolerans* sp. nov. (= JCM 39269^T = MCC 4711^T) was proposed (Figure 1).

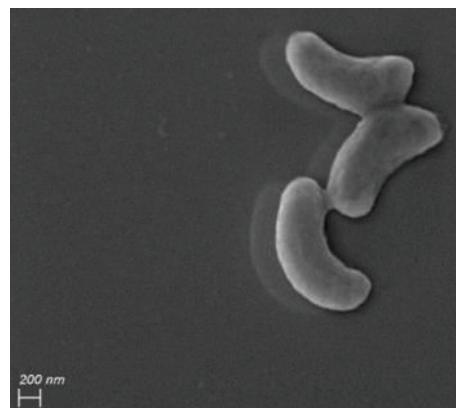


Figure 1

Scanning electron micrograph of strain MCM B-1480^T

Studies on methanogens at extreme eco-physiological conditions: Implications for life on Mars

The surface of Mars is presently dry and desiccated. It is also believed that water might still exist in liquid form in some regions on Mars. The moisture content on the surface of Mars is due to the melting of snow. The moisture content estimated by the Mars Odyssey remote sensing Gamma Ray Spectrometer (GRS) is between 0.25% for the driest part of Mars to 35 ± 15%. Due to the lack of atmosphere, the Martian surface is continuously bombarded with DNA-damaging UV radiations between 200-400 nm, and the intensity of the UV flux reaching the surface on Mars ranges from 3w/m²-13w/m². This causes the modification of chloride salts to chlorate salts which is toxic to all microbial life forms. The wide number of temperature variations over one sol often ranges from just above freezing to -100°C and lower. Temperature from primary Vikings data ranged between -143°C to 20°C making the Martian surface uninhabitable, however, if life has to sustain itself on Mars it should be in the subsurface or certain regions like salt brines or shaded regions which protect from the inhabitable conditions. In the present study, we have tested the methanogenic cultures to the individual extreme environmental conditions simulating the Martian environment and studied their response under stress conditions. It is observed that *M. formicicum* could grow at low moisture, in the presence of perchlorate salts and resist UV radiation.

Fungi

Biodiversity, Systematics, Documentation and Conservation of Fungi

Several foliar pathogens, mushrooms, bioagents, alkali tolerant and pigment producing filamentous fungi, aquatic fungi-like organisms and actinomycete genera like *Nocardioopsis* and genera of diverse interesting taxonomic groups of fungi were studied. Some of them were cultured *in vitro*, and their taxonomic identity was confirmed based on morphological and molecular multigene phylogenetic analysis. These include *Pseudocercospora*, *Mitteriella*, *Sclerotinia*, *Sarcinella*, *Hirsutella*, *Synnemellisia*, *Periconia*, *Inonotus*, *Acrostelagmus*, *Zasmidium*, *Drechslera*, *Conidiobolus*, *Pleurotus*, *Nomuraea*, *Pythium*, *Chaetomium*, *Pestalotiopsis*, *Bipolaris*, *Lasioidiplodia*, *Absidia*, *Saprolegnia*, *Fusarium*.

Four novel species *Keithomyces indicus*, *Passalora sicerariae*, *Pseudocercospora rauvolfiicola*, *Ps. morigena*, and one new genus/species *Neokamalomyces indicus*, were confirmed by biphasic approaches, morphological, cultural, and multigene phylogenetic analysis (Figure 2). After complete documentation and germplasm of these novel and interesting taxa of fungi are deposited and has been maintained in recognized repository, National Fungal Culture Collection of India (NFCCI).

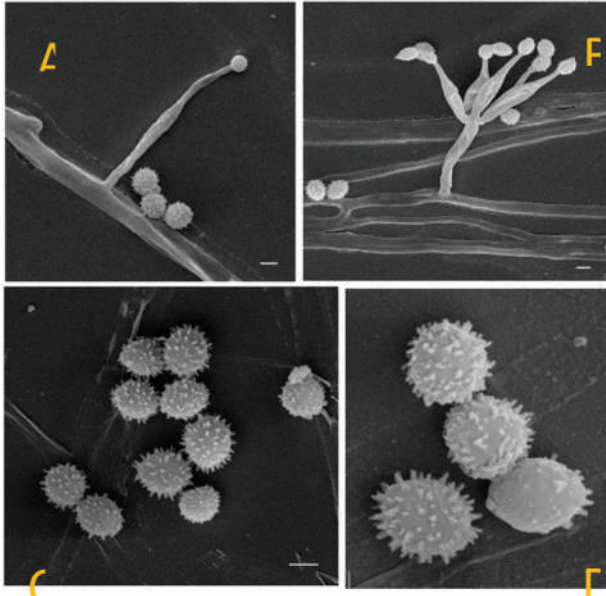


Figure 2

Keithomyces indicus (NFCCI-5106)-View of Scanning Electron Microscope: A. Conidiophore with a conidium and dispersed conidia. B. Vegetative hyphae with conidiophore and phialides in groups with conidia. C-D. Conidia in higher magnification. Scale bars 1-3 = 2µm

Discovery of a new *Penicillium* species from Maharashtra

A new *Penicillium* species isolated from soils in Yavatmal, India was named as *Penicillium sanjayi* sp. nov. and is classified in *Penicillium* section *Citrina*. The new species was named after Dr Sanjay K Singh, Coordinator, National Fungal Culture Collection of India, ARI, Pune. The new species is delimited using phenotypic characters and sequences of the nuclear ribosomal internal transcribed spacer (ITS) rDNA regions, partial beta-tubulin (BenA), calmodulin (CaM), and RNA polymerase II second largest subunit (RPB2) region. Phylogenetic analyses consistently resolved the new species in a well-delineated clade with its close relative *P. vascosobrinhoanum* (originally published as *P. vascosobrinhou*), distinct from all other series of section *Citrina*. As a result, we introduce the series *Vascosobrinhoana* for this unique lineage. Key distinguishing characteristics such as greyish ruby to ruby centre of colonies (obverse) on malt extract agar (MEA), presence of cream colour sclerotia on oatmeal agar (OA), growth rates on standardised media, growth at 30°C but lack

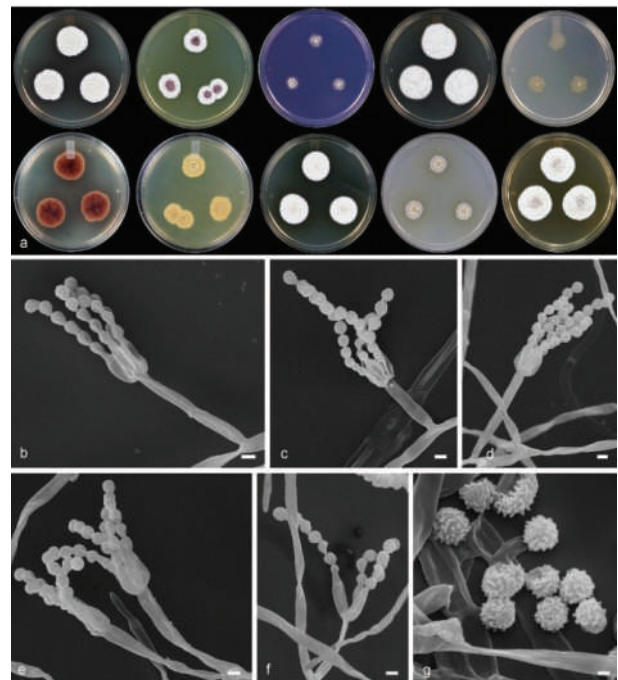


Figure 3

Penicillium sanjayii (NFCCI 5017) a Colonies on CYA, MEAbI (obverse and reverse), Colonies obverse on CREA, CYAS, CZA, DG18, OA, YES. b-f Monoverticillate penicilli. g Conidia. Scale bar (b-f) 2 µm; (g) 1 µm

of growth at 37°C, additional microscopic characters such as solitary or rarely with a subterminal branch other than predominant monoverticillate penicilli, and conspicuously roughened to verruculose conidial ornamentation distinguish the new species *P. sanjayi* from other monoverticillate section *Citrina* species (Figure 3).

The taxonomy of the genus *Fusarium* has been in flux because of ambiguous circumscription of species-level identification based on morpho-taxonomic criteria. In this study, multigene phylogeny was conducted to resolve the evolutionary relationships of 88 Indian *Fusarium* isolates based on the internal transcribed spacer region, 28S large subunit, translation elongation factor 1-alpha, RNA polymerase second largest subunit, beta-tubulin and calmodulin gene regions. *Fusarium* species are well known to produce metabolites such as beauvericin (BEA) and enniatins. These identified isolates were subjected to fermentation in *Fusarium*-defined media for BEA production and tested using TLC, HPLC and HRMS. Among 88 isolates studied, 50 were capable of producing BEA, which varied from 0.01 to 15.82 mg/g of biomass. *Fusarium tardicrescens* NFCCI 5201 showed maximum BEA production (15.82 mg/g of biomass). The extract of *F. tardicrescens* NFCCI 5201 showed promising antibacterial activity against *Staphylococcus aureus* MLS16 (MTCC 2940) and *Micrococcus luteus* (MTCC 2470) with MIC of 62.5 and 15.63 g/mL, respectively. The extract also showed satisfactory dose-dependent DPPH radical scavenging activity with an IC50 value of 0.675 mg/mL. This study reveals the correct identity of the Indian *Fusarium* isolates based on multigene phylogeny and throws light on BEA production potential, suggesting their possible applicability in medicine, agriculture and industry.

Lichens

Lichen family *Graphidaceae* including *Thelotremataceae* is the second largest family of lichenized fungi, next to *Parmeliaceae*, and one of the most important elements of lichen communities in tropical regions, with ca. 2100 species. As a group, thelotremoid lichens represent a significant component of corticolous rainforest microlichen biota, with some extending into temperate regimes. Based on the revised generic concept for *Graphidaceae* including *Thelotremataceae*, "Checklist of the lichen family Graphidaceae from South and Southeast Asia" has been published. It comprises 800 species in 59 genera.

To understand the lichen biodiversity of Andaman, Nicobar and Lakshadweep Islands after the natural disasters like Tsunami and cyclones, "Checklist and keys of the Andaman and Nicobar Islands" has been prepared. It comprises 468 taxa in 116 genera.

A booklet cum field guide in Hindi, of Lichens of Mahabaleshwar region has been published for the amateur naturalist.

Previously a study was carried out to explore the lichen diversity in and around the high-altitude sacred wetland Hemkund of Western Himalaya in Uttarakhand. The area belongs to the alpine region and the altitude ranges from 3200-4400 m. More than 150 hitherto collected lichen specimens (belonging to members crustose, foliose and fruticose) were processed for preservation in recognized Ajrekar Mycological Herbarium (AMH) at ARI, Pune. These specimens of lichens were collected from the different available substrates like soil, rock, bark, twigs etc. The specimens were identified based on their morphology, anatomy and chemistry. The study revealed an occurrence of 90 species of lichens belonging to 45 genera and 18 families. This preliminary study gives an ultimate outcome regarding the richness of the biodiversity of the wetland. The composition of the lichen species indicates that the area contains a rich and diverse assemblage of biodiversity including some valuable medicinal species. The present number of lichen species and their distribution will act as baseline data to carry out biomonitoring, glacier retreat studies, and conservation of fragile ecosystem.

Plants & Diatoms

Revisiting the taxonomy of the wild relatives of *Sarsaparilla* (*Smilax* L.) in India, developing super-barcodes, and understanding their diversification using phylogenomic tools

The genus *Smilax* L., also called Sarsaparilla or the greenbriers, is the type genus of the Smilacaceae plant family. It comprises ca. 262 species distributed throughout the tropical, subtropical, and temperate regions of the world. It is characterized as climbing vines that often show prickles on the stem and paired petiolar tendrils. Known for its medicinal importance, the genus is also commercially used as a flavoring agent in foods, beverages, and pharmaceuticals. In traditional medicine, rhizomes are used as anti-inflammatory, antihypertensive, antirheumatic, antifungal, anti-pruritic, antiseptic, healing, diuretic, and tonic. However, the identity of the genus *Smilax* is often difficult due to the close morphological similarity leading to adulteration practices.

Against this background, the present work is being carried out with the objectives to (i) revise the taxonomy of Smilacaceae in India, (ii) understand the morphological evolution and diversification of the genus *Smilax* in the Himalayan region, and (iii) to develop DNA super-barcodes of the important Indian *Smilax* species using phylogenomic data.

Data organization was done through scrutiny of relevant literature on the genus and examination of type and other authentic specimens or specimen images available in herbaria through in-person or online consultation. The Central National Herbarium (CAL), along with ASSAM and ARUN were consulted to study inter- and intra-specific morphological variations in *Smilax* spp, and to find their locations, phenology, usage and other relevant information.

For collection of *Smilax* species, field tours to Nagaland, Assam and Arunachal Pradesh were conducted and leaf samples of some important *Smilax* species were collected.

Systematic studies on the genus *Canscora* Lam. (Gentianaceae) in India

The genus *Canscora* Lam. belongs to the tribe Canscorinae under the family Gentianaceae. It comprises 14 species throughout the globe and represented by ten species in India. The genus *Canscora* is associated with many taxonomic complexities and none of the taxonomic treatments are molecularly examined. Also, there are some medicinally important plants belonging to the genus. One such plant is *Canscora alata* (Roth Wall.) which belongs to Shankpushpi group and known for its action on central nervous system. Despite having a lot of bioprospecting potential, no attempts have been made to understand the taxonomy and relationship of *Canscora* species within the genus after Thiv (2003). None of the works have validated the taxonomic treatments using the molecular tools. Also, no efforts have been made through anatomical approach to address the variations and investigate the transition of key floral patterns. Therefore, there is a need to understand the true systematic position of several *Canscora* species, and to resolve the complexities associated with many of the taxonomically doubtful species. Hence, this work is being carried out with the following objectives in mind: 1. Revisiting the taxonomy of the genus *Canscora* Lam. 2. Investigation of anatomical features to understand floral organization in *Canscora* with special reference to anisomorphy of androecium. 3. Resolving the species complexes in *Canscora* and validating the status of *Canscorinella* using molecular tools.

Field surveys were carried out in several locations throughout Kerala and Maharashtra during the reporting period, and DNA and herbarium samples were also gathered. By contrasting them with the pertinent literature and type specimens, the obtained specimens were identified. DNA was isolated using the CTAB method from silica-gel dried leaf material for molecular research.

Therapeutic investigations and isolation of bioactives from *Haplanthodes* species, the wild relatives of *Kalmegh*

The genus *Haplanthodes* Kuntze is a member of the family Acanthaceae belonging to Andrographideae tribe which has a close phylogenetic relationship with *Andrographis* Wall. ex Nees (*Kalmegh*). Despite being indigenous to India, this genus has not been studied in detail. Screening for phytochemicals and their standardization have never been done previously. Neither its pharmacological properties nor its standard marker compound have been investigated. The proposed research is being carried out with an aim to standardize and isolate some active principles from *Haplanthodes* and investigate their therapeutic properties.

Scrutiny of literature was done by consulting Floras and research articles. Various herbaria such as AHMA, BSI, BLAT, were consulted to study inter- and intra-specific morphological variations in *Haplanthodes* spp, and also to find their locations, phenology, usage, and other relevant information.

Desiccation-tolerant vascular plants from Western Ghats, India: review, updated checklist, future prospects and new insights

The Western Ghats (WG), a biodiversity hotspot in India, are characterised by frequent rock outcrops, but little is known about the desiccation tolerant plants (DT). This study gives a general review of Indian DT vascular plants with a focus on the WG and lists species along with their preferred habitats. Sixty-two DT species were discovered, far more than the nine species that were previously known. Seasonal field observations were used to examine the DT characteristics of outcrop species, and estimation for relative water content was done to determine the DT property in plants. Globally nine genera of DT plants are described as being novel, and *Tripogon capillatus* Jaub. & Spach is the first DT angiosperm to be found growing as an epiphyte. The DT features of the gesneriad *Corallodiscus lanuginosus* (Wall. ex R.Br.) B. L. Burt are demonstrated for the first time using field observations (Figure 4). Twelve of the 62 species are unique to Western Ghat outcrops, while 16 of the 62 are native to India, underscoring the significance of the WG as a global DT hotspot. For DT species, partially shaded forests are just as important as rock outcrops. This ground-breaking inventory fills a knowledge gap regarding DT plants in India and creates new research.

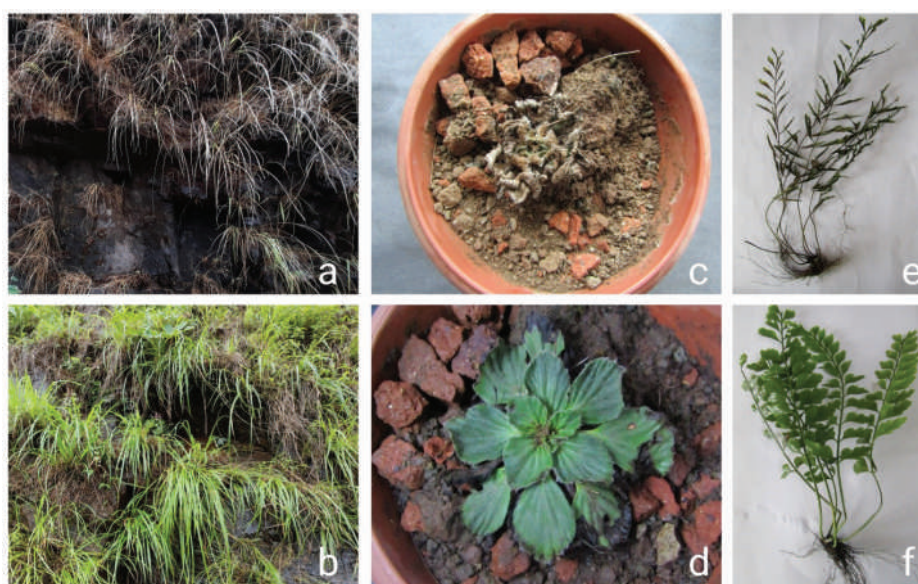


Figure 4 Dehydration and rehydration stages of desiccation tolerant plants. *Tripogon lisboae* (a-b) in natural habitat, *Corallodiscus lanuginosus* (c-d) and *Asplenium yoshinagae* subsp. Indicum (e-f)

In vitro regeneration of *Crinum* species for conservation: Optimization and establishment of bulb culture

Crinum is critically endangered medicinal plant. It is a promising source of alkaloids such as galantamine, lycorine, crinine etc. For the growth of *Crinum*, we created a successful sterilisation dosage (Figure 5). We investigated the relationship between sterilization treatments with explant survival rate. To achieve the greatest viability of explant, the combination treatment was preferred. For the purpose of inoculation, the twin scale method was used to maintain the bulb culture. To achieve shoot establishment and propagation, plant growth regulators were optimised. Plants that were completely grown were successfully acclimated to their natural habitat. The difficulties that arise in the restoration of endangered species are being addressed.

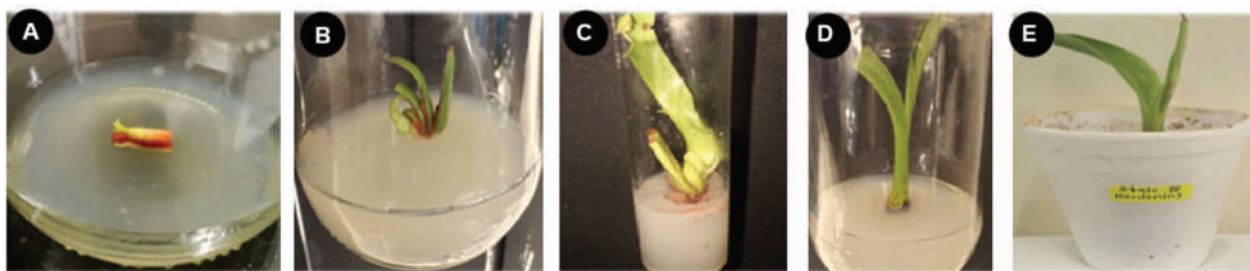


Figure 5 Stages of *in-vitro* regeneration of *Crinum woodrowii*: A) Twin scale culture, B) Shoot multiplication, C) Shootlet elongation, D) Rooting, E) Hardening

Algae based carbon dioxide sequestration

Microalgae are unicellular photosynthetic organisms that can be found in all aquatic habitats. Microalgae are a rich source of lipids, carbohydrates, proteins, and pigments. They also play an important role in global carbon dioxide sequestration and oxygen production. We have isolated green algae from anaerobic digestate, which is the liquid left over after the process of biodegradation of organic material by bacteria. The strains were then observed under the microscope to determine their morphological characteristics (Figure 6a). We isolated them using the streaking plate method on BG11 agar media. The single colonies were then picked and inoculated in the standard algal medium, i.e., BBM, to establish a monoculture (Figure 6b). The strains were then identified using molecular markers. For bioremediation, we looked at how the strains grew

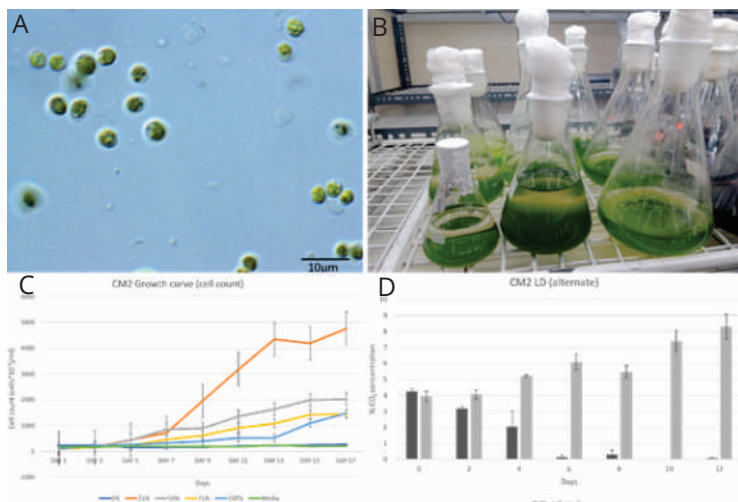


Figure 6

(a) Live image of *Chlorella* sp.;
 (b) Monocultures of green algae;
 (c) Growth curve of green algae;
 (d) Graph depicting the CO₂ sequestration by green algae

in Bold's Basal medium and at concentrations of 25%, 50%, 75%, and 100% of anaerobic digestate (Figure 6c). This green algae strain shows good growth at a 25% anaerobic digestate concentration. Hence, this concentration is used for further CO₂ sequestration experiments. We also checked the capacity of these microalgal strains for CO₂ sequestration. We found out that these green algae sequester the CO₂ within 2 days at 5% CO₂ (Figure 6d). Experiments on lipid, carbohydrate, and pigment extraction are continuing.

Discovering and rediscovering diatoms from India

In the last decade, an elevated interest in the Western Ghats of India, the eighth-highest hotspot of biological diversity in the world, has resulted in the discovery of biodiversity. Among algae, diatoms have been found in the Western Ghats' ecosystems, including marshes, plateaus, rivers, and streams. Our study documents a new species *Hippodonta mudumalaiensis*, from Mudumalai, Western Ghats, Tamil Nadu, India. The detailed morphology, using light microscopy and scanning electron microscopy, of *H. mudumalaiensis* (Figure 7a) was investigated.

Hemendrakumar Prithivraj Gandhi, a pioneer in Indian diatom studies, has described several diatom species from western India and its surrounding regions. Agharkar Research Institute Herbarium (AHMA) Diatom Collection, Pune, India, is home to the majority of micrographs in Gandhi's collection. To build a modern diatom flora of India, we attempted to re-analyze the specimens of the genus *Stauroneis* Ehrenberg identified by Gandhi. We amended Gandhi's taxonomy in accordance with the recent nomenclatural guidelines after carefully reviewing his original papers and slides. As a result, *Stauroneis dharwarensis* Wadmare & B.Karthick nom. nov., stat. nov. (Figure 7b) and *Stauroneis lacuspowaiensis* Wadmare & B.Karthick nom. nov., stat. nov. (Figure 7c) were proposed. The current work intends to revisit Gandhi's specimen through light and scanning electron microscopy and derive new morphological information.

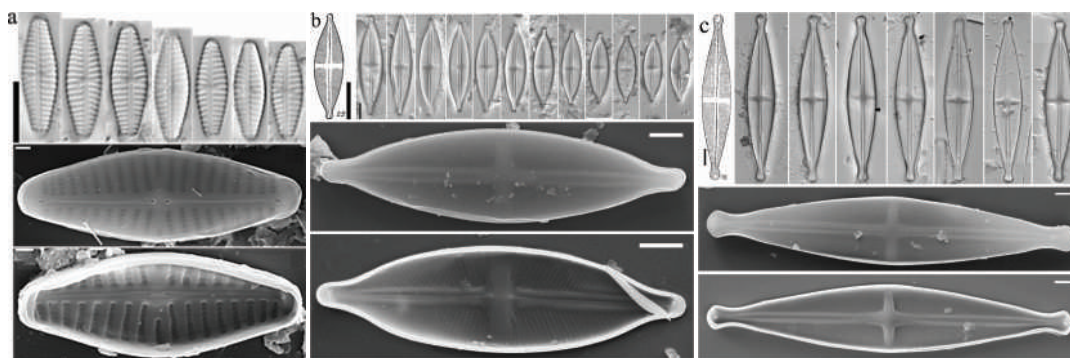


Figure 7 Light and scanning electron microscopy a) *Hippodonta mudumalaiensis* A. Vigneshwaran and B. Karthick; b) *Stauroneis dharwarensis* Wadmare and B. Karthick; c) *Stauroneis lacuspowaiensis* Wadmare & B. Karthick

Diatom inferred paleoenvironmental conditions in an ancient channel at the Sivakalai archaeological site in Tamil Nadu

The ubiquitous presence, environmental specificity, and siliceous cell wall preservative nature of diatoms makes them one of the best proxies in paleoecological and archaeological works. In archaeological contexts, diatoms are often used in site-based paleoenvironmental reconstruction. In the present study, we analyzed the diatom community recovered from the external surface of the bricks that were part of the ancient channel unearthed at Sivakalai, Thuthukudi district, Tamil Nadu. Altogether, 1424 diatom individuals were

enumerated, representing 31 diatom taxa belonging to 16 genera. The present study documented both aquatic (3.79%) as well as terrestrial or desiccation-tolerant (96.21%) diatom taxa from the channel (Figure 8a). The most dominant genera reported were *Luticola*, *Nitzschia*, *Pinnularia*, *Ulnaria*, and *Hantzschia* (Figure 8b). The presence of the aquatic diatom community suggests that this channel was used to supply freshwater to the settlement from the nearby reservoir. Further, a higher amount of terrestrial diatom suggests the abandonment of the channel in subsequent years. This work is the first attempt to use diatoms in an archaeological context on the Indian subcontinent.

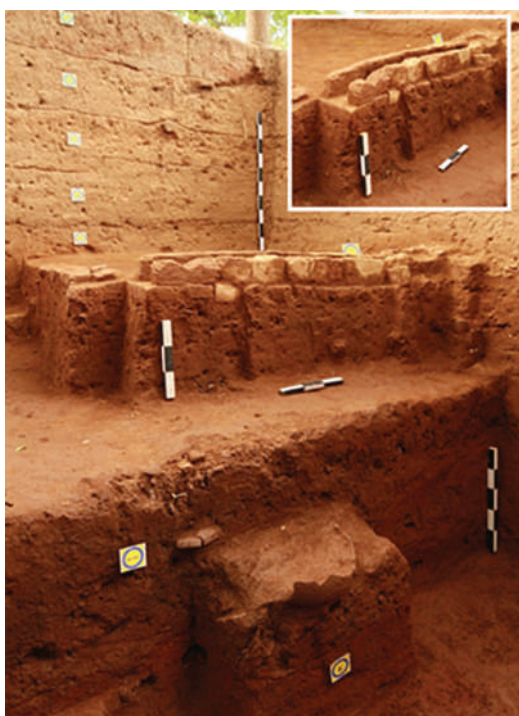


Figure 8a

Figure showing the site along with its layer and inset displaying the channel from another angle

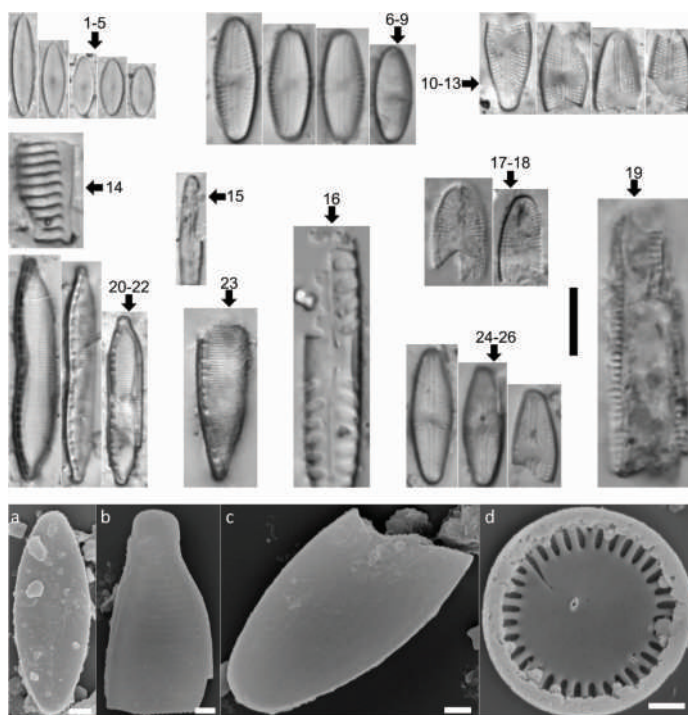


Figure 8b

A figure showing the light and scanning electron microscopic images of diatoms found in the layers of an ancient channel at an archaeological site

Exploring the seasonal diatom diversity across the pollution gradient of the Mula-Mutha river basin

The Mula-Mutha river basin is one of the major river systems in Pune, formed by the merging of the Mula and Mutha rivers, later joining the Bhima and Krishna rivers, and finally confluencing with the Bay of Bengal. The Mula-Mutha river has been subjected to intense pollution by man-made activities, and to restore its quality, different biological organisms inhabiting the river are being investigated. We explored the diatom diversity of this river basin across environmental gradients. The sampling has been conducted in the Mula-Mutha river basin from upstream to downstream locations. Diatom samples were collected across seasons, viz., a. May 2022 (pre-monsoon), b. August 2022 (monsoon), and c. November 2022 (post-monsoon). A total of 87 samples were collected from 19 sampling locations covering the river basin. The diatom samples included 35 epilithic (surface of the rock or boulder), 22 episammic (on the sediment), and 30 epiphytic (surface of the submerged plant). The water quality parameters such as electrical conductivity, pH, dissolved oxygen, and

total dissolved solids are measured across sites and seasons. For one of the parameters, i.e., electric conductivity, a graphical representation of its variation in all three seasons spanning all the sites is plotted (Figure 9a). Preliminary analysis suggests that the middle stretches of the river are highly polluted and need immediate restoration attention. Some of the dominant diatoms found in these waters include *Discostella* sp., *Pantocsekiella* sp., *Aulacoseira* sp., and many Naviculoid diatoms (Figure 9b). Despite being in highly polluted conditions, the Mula-Mutha river basin supports some interesting taxa, such as *Reimeria uniseriata*, which was recorded for the first time in the Western Ghats. This taxon is typically found at high altitudes and in colder waters, but these were recorded in warmer waters. Additionally, we found a novel species belonging to the genus *Geissleria* that is currently being studied.

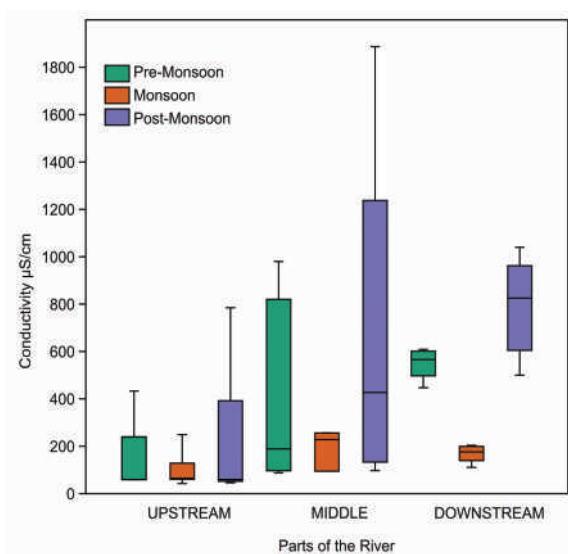
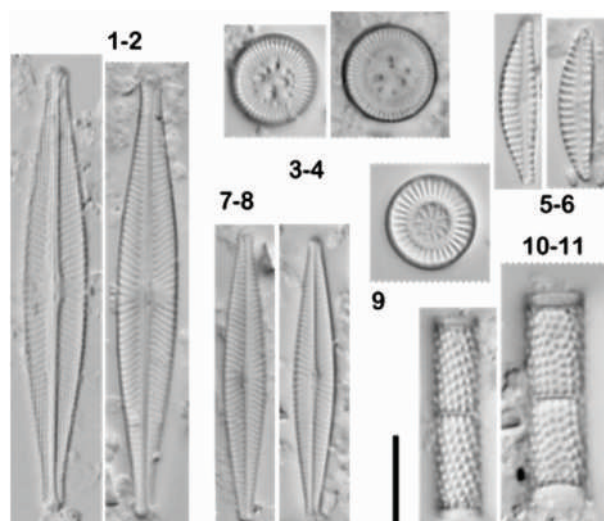


Figure 9a shows the season-wise variation in electrical conductivity across the upstream, middle, and downstream stretches of the Mula-Mutha River Basin.

Figure 9b A figure showing dominant taxa across the sampling sites. 1-2 *Navicula* sp. 1; 3-4 *Pantocsekiella* sp.; 5-6 *Encyonema* sp.; 7-8 *Navicula* sp. 9. *Discostella* sp. 10-11 *Aulacoseira* sp.



Palaeobiology

Reassessment of the taxonomic relationship in the intertidal benthic foraminiferal genus *Ammonia* from vast coastline of India, using combined morphological and molecular tools

This study was set out to add new insight into the genetic diversity and biogeographic distribution of *Ammonia* (Brunnich, 1772), a common intertidal benthic foraminifer. Splitting vs Lumping strategies have created confusion in its taxonomy. We use an integrated taxonomic approach using combined traditional morphological methods in tandem with molecular approaches to solve the taxonomic chaos in this genus. Morphological characteristics are measured from images taken using scanning electron microscope comprising variables considered important for identification (Figure 10). Genetic analysis based on partial

small subunit (SSU) ribosomal DNA sequences, and partial large subunit (LSU) ribosomal DNA revealed novel species of this genus which show preference for local endemism, which refute the long-standing notion of worldwide distribution of morpho-species in genus *Ammonia*.

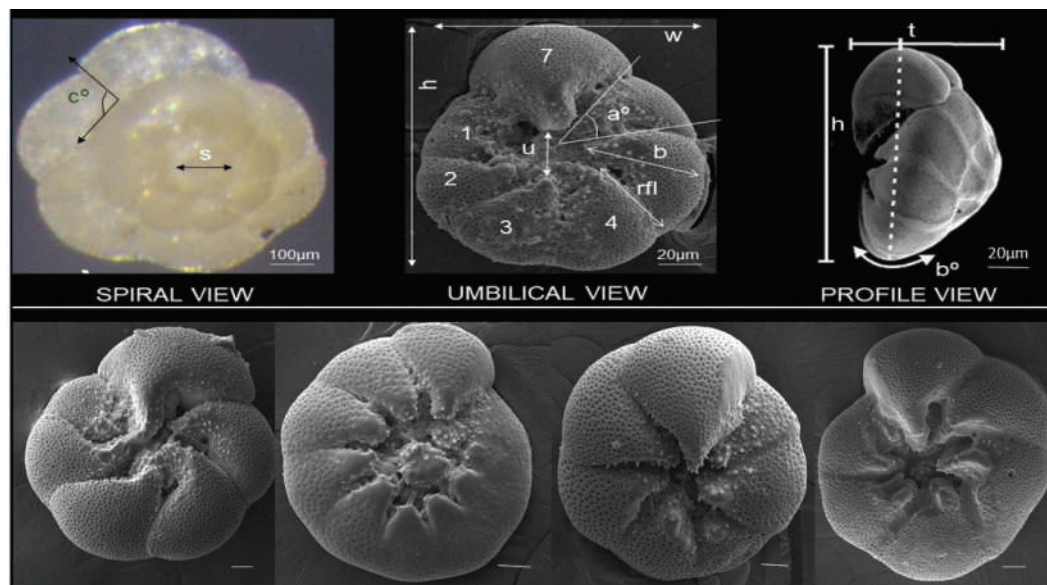


Figure 10

Morphological characteristics and different morpho-species of a common intertidal benthic foraminifera genus *Ammonia*. Scale bar: 20 µm

Bioenergy

Screening and selection of methanogenic archaea for biomethanation of organic fraction of municipal solid wastes

The methanogens isolated from hot springs were screened to select the most efficient strains by monitoring them for consistent methane yield for three subcultures. The most potent ones were then grown at 50°C to check their applications in thermophilic anaerobic digestion processes. The ones that survived and thrived at this temperature were further studied for their pH and salinity tolerance over a broad range and ability to utilize various substrates. These studies led to the three most potent and versatile strains of methanogens, one belonging to each physiological group, namely, *Methanothermobacter thermautotrophicus* (hydrogenotrophic), *Methanosarcina thermophila* (acetoclastic) and *Methanomethylovorans thermophila* (methylotrophic). Further studies on municipal solid waste were carried out to check the potential of these strains in industrial applications. The anaerobic digestion of the organic fraction of municipal solid waste was studied at different temperatures. The maximum TS reduction and substrate degradation were observed at 50°C, but no methane was produced at thermophilic temperatures, indicating the significance of bioaugmentation of selected strains. After using various combinations, it was observed that maximum methane production, substrate utilization and TS reduction were observed in the set containing all three methanogens. Our findings suggest the potential use of these strains for enhancing biomethane production from organic municipal solid waste.

Optimization of various parameters for anaerobic fungus *Orpinomyces* assisted biogas production from untreated rice straw

Effect of various parameters, namely rice straw particle size (in mm; 1, 5, 20 and 35), substrate concentration (in %; 3.75, 5, 6.25 and 7.5), initial AF inoculum (in %; 10, 15, 20 and 25), agitation (in rpm; 0, 50, 100, 150), carbon to nitrogen (C/N) ratio (15, 20, 25, 30, 35 and 40), and nitrogen sources (yeast extract, tryptone, peptone, urea, $(\text{NH}_4)_2\text{HPO}_4$, NaNO_3 , NH_4NO_3 , KNO_3 and NaNO_2) were evaluated on the biomethanation of rice straw augmented with anaerobic fungus *Orpinomyces*. The optimization results indicated that the higher methane and biogas yield could be obtained even using the larger-sized rice straw particles (shredded, c.a. 35 mm) at 5% substrate concentration, 20% initial fungal inoculum, 50 rpm agitation, at C/N ratio of 30 with tryptone as the most preferred nitrogen source. These findings suggested that the anaerobic fungus *Orpinomyces* has exceptional potential in recovering energy from different agricultural crop residues, including shredded rice straw particles in the form of methane, without needing energy-intensive, expensive, laborious, and pollution causing thermochemical pretreatment. This study has potential applications in generating cleaner energy while helping farmers get more revenue from their lignocellulosic produce.

SRB-lytic bacteriophage mediated inhibition of SRB growth and H₂S in contaminated water samples from oil fields: Prototype development

A bio-control method has been developed that is efficient, affordable, and ecologically friendly for inhibiting sulfate-reducing bacteria (SRB) that exist in oil reservoirs and have a negative impact on the quality of crude oil. A preliminary experiment was conducted to ascertain the activity of SRB-lytic bacteriophage on the native population of SRB. H₂S in SRB control (without bacteriophage) reached 0.085% after 16 days of incubation, while it was 0.043% in the test (with bacteriophage). A one-log reduction in SRB count was seen in the test compared to the control when the SRB count was determined using the RT-qPCR method. A prototype was developed to demonstrate the continuous process. The bacteriophage was used to treat 40 liters of water contaminated with SRB. 60–80% inhibition in H₂S was observed. After 14 days in SRB control (without bacteriophage), the H₂S reached 189.39 ppm, whereas, in the test (with bacteriophage), it was 67.64 ppm (Figure 11). SRB-lytic bacteriophages were harvested from the prototype (treatment reactor), and an experiment was set up to assess the efficacy of these bacteriophages. After 72 hours of incubation, 67.19% and 46.43% inhibition in H₂S was observed in 1:100 and 1:1000 bacteriophage dilution. This observation was significant in determining the efficacy of bacteriophage in a continuous system.



Figure 11

Prototype to demonstrate SRB lytic bacteriophage I inhibition of SRB and H₂S production in continuous mode

Assessing the adhesion potential of putative probiotic bacteria

Adhesion to intestinal epithelium is one of the most desirable traits of a probiotic. This ensures the colonization of mucosal surfaces, at least temporarily, which prevents pathogen binding and enables an effective interaction with immune system cells. Bacterial adhesion to intestinal surfaces could be driven initially by non-specific physical binding as hydrophobic interactions followed by specific cell wall components (Haddaji et al., 2015). Different structures and specific cell wall components of bacteria, such as fimbriae or pili, adhesins, mucus-binding proteins, fibronectin-binding proteins, or surface layer proteins, provide them an advantage for epithelial colonization; further, lipoteichoic acid or exo-polysaccharides produced by bacteria can contribute to adhesion to host epithelial cells (Pessione, 2012).

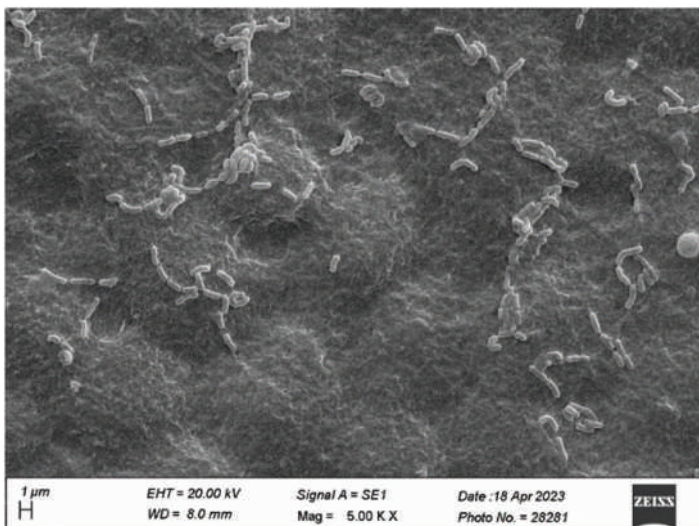


Figure 12

Scanning electron micrograph of adhered probiotic bacteria on HT-29 cell line

In the present investigation, the surface and adhesion properties of the putative probiotic bacteria were evaluated. The surface characteristics of the strains were analysed by measuring its adhesion to solvents (MATS test). The auto aggregation ability of these strains and its coaggregation with pathogens were studied. The ability of the probiotic strains to bind extracellular matrix components, such as mucin, fibrinogen and collagen was determined. The ability of the strains to adhere to HT-29 cell lines (colonic adenocarcinomas which are derived from human intestinal epithelium) was carried out in this study. The quantitative binding of putative probiotic bacteria was investigated on HT-29 cell lines by direct microscopic examination under scanning electron microscopy (Figure 12).

The hydrophobic properties of microbial surfaces are conducive to adhesion to abiotic and biotic surfaces and to penetration of host tissues. Higher hydrophobicity confers to the attachment of the bacterial cells to intestinal epithelium. It was observed that the probiotic bacteria have partitioned more in polar solvents with acidic groups as compared to nonpolar solvents indicating that the cell surface of probiotic bacteria is hydrophobic and has negatively charged groups. The adhesion of probiotic bacteria to this ECM is a prerequisite for colonization of the gut. In this study, the probiotic culture exhibited strong binding with mucin and collagen. There was ~45-51% coaggregation of probiotic bacteria with the pathogens. Haeri et al. (2012) defined bacterial strains to be poorly-adhesive as those with less than 20 bacterial cells adhered per 100 animal cells. On the other hand, moderately adhesive strains were defined as those with 21 to 50 bacteria adhered per 100 animal cells, and strongly adhesive strains as those with more than 51 bacteria adhered per 100 animal cells. Based on this, the cultures used in the present investigation were characterized as strongly adhesive. Even after extensive washing with PBS, a significant proportion of cells of bacterial strains remained attached to the monolayer, providing evidence that the adhesion was not limited to nonspecific physical entrapment. The high adhesion may be indicative of a good colonization ability of the putative probiotic bacteria.

Biohydrogen production from rice straw via dark fermentation route

Hydrogen is crucial as an alternative clean fuel in light of the depletion of energy resources and global warming since only water and heat are produced during combustion of hydrogen. Hydrogen of biological origin needs extensive exploration as a substitute for expensive and laborious thermochemical procedures. The termite gut bacteria that break down lignocellulose and produce biohydrogen have been investigated.

Two biohydrogen-producing bacteria which were obtained after co-culture experiment were identified by 16S rRNA gene sequencing. The isolates designated as CTS051-3 and XTS051-3 were identified as *Clostridium chromiireducens* and *Clostridium beijerinckii*/*Clostridium diolis* respectively.

The isolates were tested for their ability to utilize multiple complex substrates by growing them in media with complex substrates like CMC, avicel, xylan and lignocellulosic waste like rice straw. Daily per cent hydrogen and total gas was analysed. It was observed that both the isolates were able to utilize all supplemented multiple complex substrates with highest biohydrogen yield of 90 ml/ g TS and 98 ml/g TS on rice straw. Enzyme assay revealed the presence of respective lignocellulose-degrading enzymes.

Various cultural optimization and parameter optimization for hydrogen production of these two isolates was performed. The isolates have potential for continuous mode large-scale bioreactor application. This is one of the first studies to demonstrate termite gut isolates as biohydrogen producers using rice straw (lignocellulose substrate) at ambient temperature of 30°C.

Bioprospecting

The focus of research is on the isolation and synthesis of naturally occurring compounds, derivatives and their use in pharmaceuticals, nutraceuticals, agriculture and industries. We also try to understand the mechanistic approach of these compounds for disorders such as Alzheimer's disease, anemia, diabetes, cancer, and chikungunya virus.

Natural Product Chemistry

Fungi

Studies on alkali-tolerant fungi and their screening for alkaline protease activity

Most soil fungi grow in acid environments. Some of them grow in alkaline conditions. These are used in the development of biotechnological processes. Saprobic fungi have an enormous dispersal potential and an efficient enzymatic system that guarantees their biological role. They can degrade a great variety of carbon sources from plant tissues, and their decomposing activity is essential for the redistribution of nutrients in the soil. Several alkali-tolerant fungi found in a variety of soils have been isolated *in vitro* and screened for their alkaline protease activity.

Many of the fungal strains were analysed for their ability to produce alkaline protease enzymes at high pH levels. To determine their significance in industrial applications, several *in vitro* isolated fungi were analysed qualitatively.

The fungal genera like *Gliocladium*, *Purpureocillium*, *Synnemellisia* and *Curvularia* have been authenticated based on molecular analysis and have been found to possess promising alkaline protease production. This suggests that all these potential fungi can be useful for eco-friendly use for commercial production of alkaline protease and for their wide range of applications in different industries.

Quantitative assay for alkaline protease production

The fungal isolates showing maximum alkaline protease producing activity in qualitative assay were selected for quantitative assay using submerged fermentation. For this, a media-Czapek Dox Medium, pH 10.5 containing casein as substrate was used. Five agar blocks of 6 mm diameter were cut with the help of sterile cork borer from seven days old APDA culture plates and inoculated in 250 ml conical flasks containing 100 ml media, and flasks were incubated at 25°C for nine days under shaking condition with 150 rpm. On 7th day of incubation, enzyme activity was measured by protease assay. Upon completion of incubation, fermented broths were filtered through pre-weighed Whatman filter paper no. 42 and filtrate were subjected for centrifugation at 13000 rpm for 10 minutes, and the supernatant was directly used as crude enzyme extract for the quantification of enzyme production. Biomass was subjected to drying in a hot air oven; and the dry weight of biomass was measured.

Lichen

Compounds from lichens

Extracts of *Parmotrema reticulatum*, *Heterodermia diademata*, *H. hypocaesia*, and *Stereocaulon foliolosum* contain 10-110 µg/mg of phenolic compounds. The extracts had a range of 19-240 µg/mg of polysaccharides; and 10-230 µg/mg of protein content. The TLC and HPLC analysis of these species showed the presence of atranorin and salazinic acid as major compounds. The secondary compounds atranorin (β-orcinol depside) and salazinic acid (β-orcinol depsidone) were isolated and purified. The HR-MS analysis revealed that the molecular weight and molecular formula of atranorin was 374 and C₁₉H₁₈O₈ (HRMS calculated for [M+Na]⁺+ C₁₉H₁₈O₈Na⁺, m/z 397.0899) and those of salazinic acid was 388 and C₁₈H₁₂O₁₀ (HRMS calculated for [M+Na]⁺+ C₁₈H₁₂O₁₀Na⁺, m/z 411.0328), which matched with the available standard data.

These lichen species and their compounds Atranorin and Salazinic acid from the high-altitude western Himalaya showed moderate to strong antioxidative potential in terms of DPPH free radical scavenging, ABTS radical scavenging, and FRAP.

Furthermore, moderate to significant antibacterial activity of selected lichen species and their isolated compounds were observed against five bacterial strains, namely, *B. subtilis* (MTCC 121), *E. coli* (MTCC 739), *P. aeruginosa* (MTCC 2453), *R. planticola* (MTCC 530), and *S. aureus* (MTCC 2940) with IC₅₀ ranging from 7.8 to 125 µg/mL.

The cytotoxic activity of the extract of these five lichen species was tested against MCF-7 (a breast cancer cell line). Lichen extracts in varying concentrations (in µg/mL) were plotted against cell viability (in percentage) of MCF-7 cells, representing decreasing cell viability in a concentration-dependent manner. *H. diademata* and *S. foliolosum* showed the highest inhibition against MCF-cell lines with IC₅₀ values ranging from 0.1 to 0.2 mg/mL.

The pathophysiological correlation between cell viability and oxidative stress creates opportunities for the use of beneficial compounds referred for protective and even therapeutic purposes. Due to the correlation between oxidative stress and the development of cancer, important biopharmaceutical therapy approaches can also be revealed.

Atranorin exhibited higher cytotoxic potential against MCF-7 than salazinic acid. Based on the binding affinities shown by the docking studies, Atranorin is a potent inhibitor of mTOR and PR, making it an effective anti-breast cancer drug. Molecular docking experiments were carried out to determine the binding orientation of Atranorin and Salazinic acid to mTOR and PR to estimate the stable binding conformation and binding affinity of the lichen compounds with proteins. The results indicated that lichen metabolites could be good natural phytochemicals with antioxidative, antimicrobial and cytotoxicity against the MCF-7 cancer cell line.

Medicinal Chemistry

Cisplatin alters genes involved in intracellular neuronal copper transport

Copper is a vital nutrient necessary for growth and biological functions. Copper functions as a cofactor for several enzymes. Disturbances in intracellular copper metabolism may lead to alterations in copper levels which may be toxic to cells. Copper dyshomeostasis is linked to numerous neurological disorders, including Wilson's disease, Menke's disease, and Alzheimer's disease. Even though these disorders have distinct pathological mechanisms, disturbances in copper metabolism are a common factor in their progression. Various copper transport proteins maintain intracellular copper homeostasis, including CTR1, ATOX1, ATP7A, ATP7B, and other metallothionines. Cisplatin, a well-known anti-cancer drug, also uses copper-interacting

proteins to transport in the cell. Several studies show that Cisplatin enters the cells via copper transporter hCTR1, can interact with other copper transport proteins, and the efflux of Cisplatin also happens via ATP7A and ATP7B. As Cisplatin can interact with various copper transport proteins, we hypothesize that Cisplatin can lead to alterations in intracellular copper levels.

First, we performed confocal studies to check if Cisplatin can alter mitochondrial copper levels. Here, we used a fluorescent copper probe OBEP-CS1 that shows a turn-off fluorescence after binding with copper ions. This probe is specific to mitochondrial copper ions. The red fluorescence corresponds to the fluorescence of the unbound probe OBEP-CS1. A decrease in fluorescence in copper-treated cells compared to that of untreated cells indicates an increase in mitochondrial copper levels. On the other hand, increased red fluorescence in Cisplatin treated cells signifies a decrease in mitochondrial copper levels.

Further, to investigate the effect of Cisplatin on the expression of various copper transport proteins, we performed RT-PCR studies. In gene expression studies, we observed downregulation of proteins like ATOX1, CCS, ATP7A, ATP7B, MT1A and MT2A, whereas expression of hCTR1 and COX17 was upregulated after copper treatment. COX17 is a copper chaperone that transports copper to the mitochondria. The upregulation of COX17 might be why we saw increased mitochondrial copper levels during our confocal studies. CTR1 is another protein that is involved in intracellular copper uptake. Down-regulation of CCS is generally observed during the copper excess condition in the cytoplasm due to the downregulation of protein XIAP that regulates the activity of CCS. Cisplatin treated cells showed down-regulation of COX17 and CCS, corresponding to low copper levels in the mitochondria and high copper levels in the cytoplasm. These cells show upregulation of proteins involved in copper efflux ATP7B and genes involved in cellular oxidative stress, which are MT2A and COMMD1.

Confocal studies indicated decreased mitochondrial copper levels in the presence of Cisplatin, which differs from copper treated cells. From gene expression studies, we found that Cisplatin can alter expression of copper transport proteins. Thus, the data suggest that intracellular copper metabolism was altered in the presence of Cisplatin.

Encapsulated dihydrorugosaflavonoid- β -cyclodextrin complex

The prepared Inclusion complex of dihydrorugosaflavonoid (DHR) with 2-hydroxypropyl- β -cyclodextrin (HP- β -CD) by a freeze-drying method was characterized and confirmed by FT-IR, $^1\text{H-NMR}$, X-RD, and SEM technique. The thermogravimetric analysis was conducted by DSC and TGA, confirming the Inclusion complex's formation. A phase solubility study was carried out to find the stability constant of the complex. The results showed the formation of the DHR/HP- β -CD inclusion complex with the stoichiometry ratio of 1:1 (A_L type) as an enthalpy-driven process. DHR exhibits poor solubility, which hampers its potential therapeutic

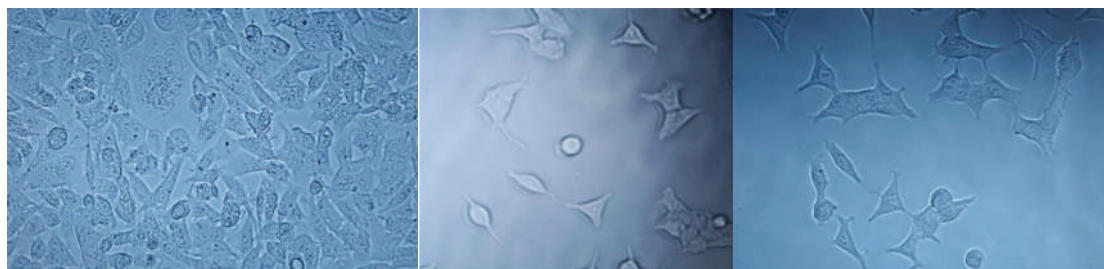


Figure 13 Images of MCF7 cell lines: a) control without test sample, b) DHR at 30 μM , c) DHR-HP- β -CD complex at 2.5 μM

exploitation. Compared with DHR, the solubility of DHR/HP- β -CD complex was significantly enhanced 32-fold after 40 minutes. The anticancer (IC_{50}) activity of DHR against breast cancer cell lines was obtained at 30 μ M, but its effectiveness increased by making inclusion complex at 2.5 μ M (Figure 13). The acute toxicity study on Swiss-albino mice showed no significant toxicity symptoms at 100mg/kg after oral administration of pure DHR and DHR/HP- β -CD inclusion complex. The computation binding of DHR with HP- β -CD was evaluated with the ligand DHR and has shown interactions with the hydroxy group of inner core of HP- β -CD, which might be the reason for its enhanced solubility. The docking score of -5.6 Kcal/mol after interaction of DHR with HP- β -CD. The changes observed from the DSC curves, such as size reduction, enlargement, change, and/or disappearance in the peak melting temperature of the DHR molecule, are significant indications of loss of the crystalline structure, which proved the formation of the inclusion complex. In the dissolution study, the DHR/HP- β -CD complex exhibited much faster dissolution than the pure DHR. This enhanced dissolution is expected to translate to an improved bioavailability of the DHR.

Antiproliferative activity of epoxy-phenanthridinone-triazole conjugates on MCF-7 cells

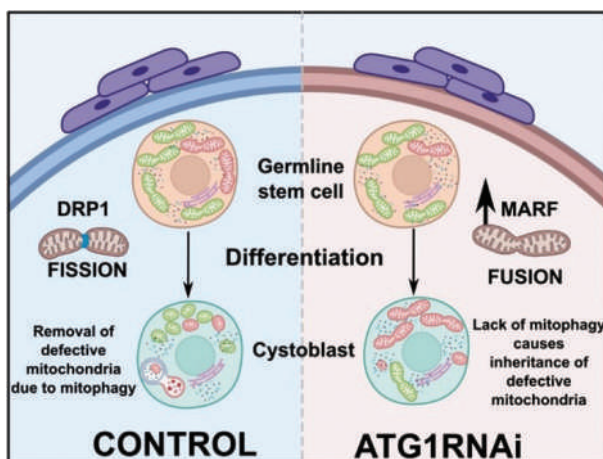
The epoxy-phenanthridinone-triazole conjugates prepared have shown antimycobacterial potential against *Mycobacterial tuberculosis*. These compounds have ROS-generating ability, which was confirmed by luminol assay, H_2O_2 in the presence of Ampiflu reagent, and horse radish peroxidase and glutathione assay. All compounds have shown increased ROS value, which has been monitored by fluorescence and luminescence. Several ROS-generating drugs have been repurposed for the treatment of cancer. Therefore, we checked the antiproliferative activity of epoxy-Phenanthridinone-triazole conjugates against MCF-7 cells. They have shown inhibitory potential towards MCF-7 cells at 1-5 μ g/ml.

Developmental Biology

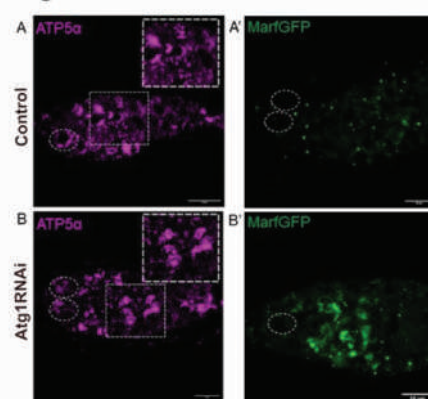
We use model organisms to study the cellular and signaling mechanisms governing developmental processes including germline stem cell maintenance, cardiac regeneration, glial morphogenesis and inter-organ signaling. Through our studies, we also aim to understand the pathogenic mechanisms underlying disorders including cardiac hypertrophy, Parkinson's disease and motor neuron degeneration.

Atg1 modulates mitochondrial dynamics to promote germline stem cell maintenance in *Drosophila*

In multicellular organisms, mitochondria are important for generating energy in the form of ATP and are transmitted to the next generation via the egg during oogenesis. Damaged mitochondria are removed by the conserved process of mitophagy which is crucial for maintaining cell health. Mitophagy is indispensable in germline stem cells (GSCs) for generating healthy sperms and eggs in *Drosophila melanogaster*. However, it is unclear if mitophagy is controlled by Autophagy-related (Atg) gene-1 (Atg1) and if it is necessary to maintain GSCs and their differentiation through gametogenesis. We use *Drosophila* female GSCs as a model to uncover the relationship between mitophagy, stem cell maintenance and differentiation. We interfered with Atg1 function in germ cells using Atg1RNAi (Atg1KD) and monitored removal of mitochondria through mitophagy. The total number of mitochondria in Atg1KD cells was increased, and surprisingly, they appeared fused (elongated) in the differentiated germ cells (cyst cells). Fragmented and elongated mitochondrial state is



Atg1KD germ cells show fused mitochondrial morphology



Ayachit and Shrivage., 2023

Figure 14 *Atg1KD* germ cells show fused mitochondrial morphology due to increased Marf levels. Control (A-A') and *Atg1KD* (B-B') germaria immunostained with anti-ATP5a (magenta) to visualise the mitochondria and with anti-GFP (green) to observe GFP tagged Marf protein. Dotted circles mark GSCs. Inset in right corner in A and B correspond to higher magnification of germarium marked with dotted rectangle in A and B showing mitochondrial morphology. Scale bar 10 μ M

controlled by Drp1 and Marf respectively. Marf levels were higher in Atg1KD cells suggesting that Atg1 regulates Marf levels in differentiated cells (Figure 14). However, there was no change in Drp1 levels suggesting that the mitochondrial fusion phenotype in Atg1KD cells is primarily due to increased Marf expression. Mitochondrial fusion observed in Atg1KD was rescued by overexpressing Drp1 or depleting Marf via RNAi, confirming a genetic interaction between them. Double knockdown of Atg1 and Marf showed significant loss of GSCs, their differentiated progeny and vitellogenic stages (eggs) in ovaries from flies as young as 10 days. Thus, indicating collaborative action of Marf and Atg1 are crucial during oogenesis. Our data uncovered a previously unknown interaction between Atg1 and Marf that is important for controlling mitophagy in GSCs and developing eggs during oogenesis.

GPCR signaling and regulation of glial morphogenesis

Glia are non-neuronal cells in the nervous system which controls various aspects of neuronal development, function and homeostasis. Defects in glial morphology can lead to functional deficits in the brain. Further, in neurodegenerative diseases such as ALS, altered glial morphology in astrocytes leading to astrogliosis regulates progression of the disease.

Glial cells are diverse in both, form and function. The *Drosophila* nervous system has different types of glia with many molecular and functional similarities to those in mammals. An important role of glia is in the formation of the blood-brain-barrier (BBB) which protects neurons and synapses from toxic insults. In *Drosophila*, the BBB is composed of large subperineurial glia (SPG) that tile with each other to ensheath the entire brain. The presence of pleated septate junctions between adjacent cells ensures impermeability of the barrier, regulating movement of molecules and maintaining ion homeostasis. To understand the mechanism that co-ordinates tiling for optimal alignment between adjacent cells, we are studying GPCR signaling mediated by G-protein $G\alpha_{12/13}$ which activates RhoGEF2 leading to changes in the actin cytoskeleton. This pathway is associated with cell shape change in early blastoderm embryos and in longitudinal glia in the embryonic CNS. The ligand Folded gastrulation (Fog) is known to activate $G\alpha_{12/13}$ signaling; however, its receptor, in the context of the nervous system is still unknown.

We have sought to identify potential G-protein coupled receptors (GPCRs) that co-ordinate cell expansion and tiling during blood-brain-barrier formation by down-regulating expression of select receptors using RNAi and examining the animals for changes in SPG organization. Interestingly, some of these animals showed

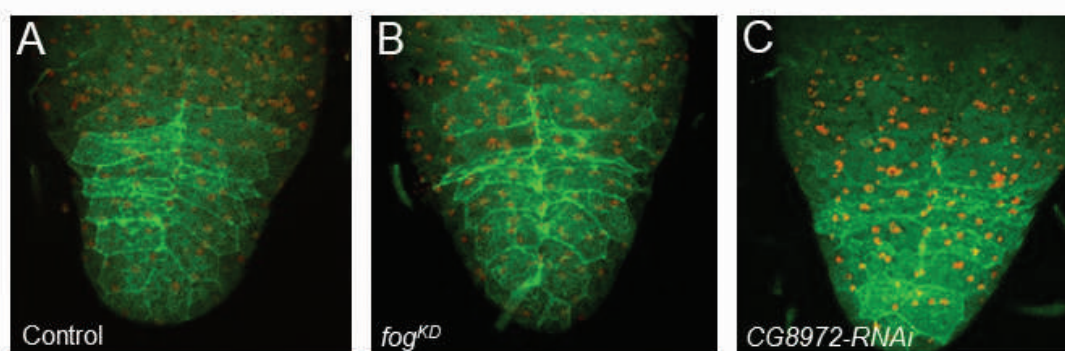


Figure 15 Screen to examine effect of knockdown of select GPCRs on glial morphology. Representative images of third instar larval brain of control (A) fog knock down (fogKD) (B) and CG8972 knock down (C) Cells in green are ventral subperineurial glia of the nerve cord

phenotypes similar to the knockdown of *fog*. Genetic studies are in progress to determine the mechanism underlying these effects. We have additionally generated reagents that will assist in evaluating the molecular and cellular factors that regulate SPG morphology and formation of an intact blood-brain-barrier (Figure 15).

Ccn2a-FGFR1-SHH signaling promotes intervertebral disc homeostasis and regeneration in adult zebrafish

The intervertebral disc (IVD), a fibrocartilaginous tissue between adjacent vertebrae, is present in all vertebrates. In mammals, including humans, IVD consists of centrally placed large vacuolated notochordal cell (NC) populated nucleus pulposus (NP), which is encapsulated by annulus fibrosus (AF), a multilayered angularly arranged lamellar collagenous structure consisting of fibroblasts. Further, AF is subdivided into two zones; outer annulus fibrosus (OAF), made up of small, tightly packed cells, and inner annulus fibrosus (IAF), made up of elongated cells (Figure 16).

IVD degeneration (IVDD) is considered a major reason for back, neck, and appendage pain, putting a considerable socio-economic burden on the clinical system. However, the molecular and cellular mechanisms involved in IVD homeostasis and degeneration are poorly understood. Our study shows that zebrafish IVDs possess distinct and non-overlapping cell proliferation and death zones. We find that in zebrafish, *cellular communication network factor 2a* (*ccn2a*) is expressed in notochord and IVDs.

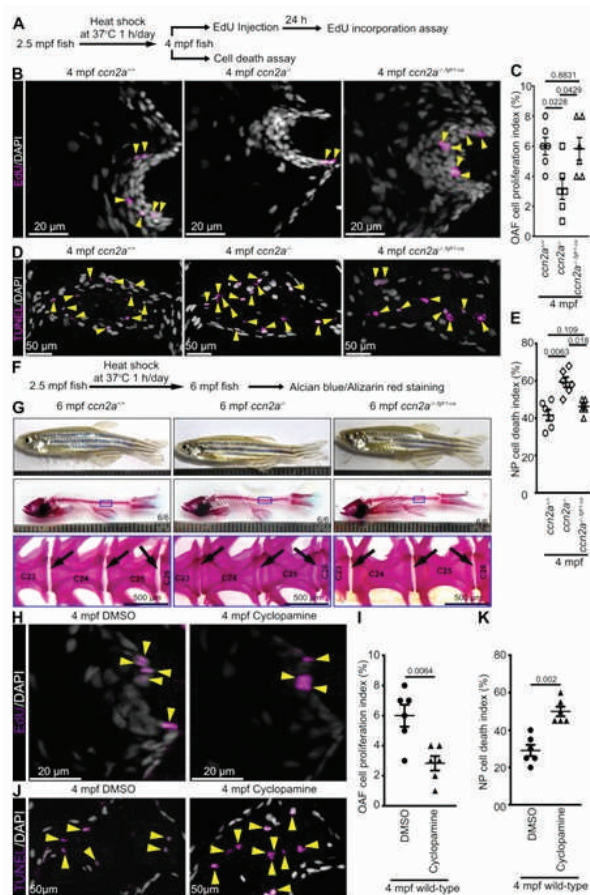


Figure 16 Ectopic expression of a constitutively active form of Fgfr1 can restore cellular phenotype in adult *ccn2a*^{-/-} IVDs through SHH signaling. (A) Schematic depiction of experimental procedures. (B) MIPs of confocal images of sagittal IVD sections stained for EdU (magenta; proliferating cells) and nuclei (white). Arrowheads indicate EdU⁺ cells in the OAF. (C) Quantification of proliferating OAF cell (n=6). (D) MIPs of confocal images of sagittal IVD sections stained for TUNEL (magenta; dead cells) and nuclei (white). Arrowheads indicate TUNEL⁺ cells in the NP. (E) Quantification of NP cell death (n=6). (F) Schematic depiction of experimental procedures. (G) Bright-field lateral views of live and AB/AR stained zebrafish. Black arrows indicate intervertebral spaces. mm; millimeter. (H) MIPs of confocal images of sagittal IVD sections stained for EdU (magenta; proliferating cells) and stained with DAPI (white; nuclei). Arrowheads indicate EdU⁺ cells in the OAF. (I) Quantification of proliferating OAF cell (n=6). (J) MIPs of confocal images of sagittal IVD sections stained for TUNEL (magenta; dead cells) and nuclei (white). Arrowheads indicate TUNEL⁺ cells in the NP. (K) Quantification of NP cell death (n=6).

In C, E, I, and K, data are mean \pm s.e.m. and each sample represents one animal. Digits on the images in G indicate the number of fish that showed the presented phenotype out of how many fish. MIP, maximum intensity projection. 'C' on images in G represents centrum/vertebrae.

Although IVD development appears normal in *ccn2a* mutants, the adult mutant IVDs exhibit decreased cell proliferation and increased cell death leading to IVD degeneration.

Moreover, *Ccn2a* overexpression promotes regeneration through accelerating cell proliferation and suppressing cell death in wild-type aged IVDs. Mechanistically, *Ccn2a* maintains IVD homeostasis and promotes IVD regeneration by enhancing outer annulus fibrosus cell proliferation and suppressing nucleus pulposus cell death by inducing FGFR1-SHH signaling. These findings reveal that *Ccn2a* plays a central role in IVD homeostasis and regeneration, which could be exploited for therapeutic intervention in degenerated human discs.

Genetics and Plant Breeding

ARI is engaged in improving the productivity and profitability of crops on an ecological and economically sustainable basis. The institute is one of the leading centres for improving crops such as wheat, soybean and grapes under the All India Coordinated Research Projects funded by the Indian Council of Agricultural Research.

Biotechnology

Advances in genomics and transcriptomics have provided a wealth of information about crop biology. Development of functional markers using this information is ongoing which may help in breeding next generation crop varieties.

Pyramiding of rust resistance genes into high grain quality wheat lines developed through marker assisted selection

The project aims to deliver newer versions of well adapted high yielding varieties as well as new improved genotypes combining superior grain quality and rust resistance with best possible agronomic performance. In previous seasons, recipients lines with improved quality parameters (MACS 2496 + *Gpc-B1+Lr24* and NI 5439 + *Gpc-B1+Lr24*) were crossed with the donor for leaf rust resistance HD2967 (*Lr19-Sr25+Lr34*). During the season 2022-23, plants with 3 genes were advanced to F₅ stage. About 78 homozygous lines with improved rust resistance and morphological traits were selected which will be further tested for yield components. Progeny of intercrosses carried out to achieve all 4 targeted genes (*Gpc-B1, Lr34, Lr24* and *Lr19*) were advanced to the F₃ stage, and about 250 spikes were selected based on disease reaction and plant morphology. Wheat lines carrying high degrees of rust resistance will serve as a valuable genetic resource in wheat improvement program.

Alternative dwarfing genes for improvement of early vigor in semi-dwarf wheat

Alternative dwarfing genes *Rht14* and *Rht18* provide semi-dwarf stature while retaining long coleoptile and better seedling establishment traits, thereby helping in emergence of seedlings under stubble-retained and dry conditions. Such wheat cultivars will be less affected by left-over crop residues and limited moisture conditions making them ideal candidates for conservation agriculture. Advanced backcross breeding lines developed through marker-assisted introgression of *Rht14* and *Rht18* in Indian wheat varieties were sown in the field for evaluation of agronomic traits. About 90 homozygous lines were selected for yield trials. Selected lines will be a valuable eco-friendly resource to combat stubble-burning in rice fields, thereby reducing environmental pollution. To identify candidate genes for alternative dwarfing genes, fine mapping and RNAseq analysis was carried out to identify potential candidate genes underlying *Rht14* and *Rht18* loci. New KASP SNP markers were developed for efficient selection of dwarfing genes in the segregating progenies.

Breeding for high-yielding elite soybean cultivars with climate/ disease resilience and end-use quality traits by multi-parent hybridization and genomic-assisted selection

We have submitted 192 distinct soybean accessions for GBS-ddRAD sequencing to increase SNP markers' usefulness and support advancements in soybean genomic-assisted breeding (GAB). Additionally, field evaluations for yield, agronomic, and biochemical traits will be conducted in *Kharif* 2023 at two locations (Hol, 18.5204 N, 73.8567 E, MSL 560m, and Soangaon, 17.6444 N, 73.9910 E, MSL 647m) under full irrigation and rainfed conditions to identify marker-trait associations. The most diverse accessions will be utilized as the founder line for multi-parent advanced generation inter-cross (MAGIC) population development.

Wheat Improvement program

ICAR-AICRP and MACS-ARI Wheat Improvement program

Wheat research at ARI aims to develop high-yielding, disease-resistant, and end-use quality wheat (*T. aestivum*, *T. durum*, and *T. dicoccum*) varieties for India in the general and peninsular zone in collaboration with the ICAR-AICRP wheat program co-ordinated through IIWBR Karnal. Production of breeder seed and disseminating the latest technology of wheat production are important objectives for the benefit of farmers. The following progress and activities are undergoing institutional support and collaborative projects with ICAR New Delhi, ICAR-IIWBR Karnal, CIMMYT Mexico, and DBT New Delhi and DST Govt. of India.

Improvement Achievement

Notification and release of wheat varieties

Two MACS wheat varieties, MACS 6768 (MACS SAKAS) (Figure 17) and MACS 4100 (MACS JEJURI) (Figure 18), were released and were officially notified with Gazette number S.O. 1056(E) dated March 6, 2023, for timely sown irrigated conditions under the Central Zone (Madhya Pradesh, Chhattisgarh, Gujarat, parts of Rajasthan, and Jhansi Division of Uttar Pradesh) and Peninsular Zone (Maharashtra and Karnataka) of India, respectively.



Figure 17 New bread wheat variety MACS SAKAS (MACS 6768)

A new bread wheat variety MACS 6768 (MACS SAKAS)

- Notified in 2023 for timely sown irrigated condition of Central Zone of India (Madhya Pradesh, Chhattisgarh, Gujarat, parts of Rajasthan, and Jhansi Division of Uttar Pradesh).
- Biofortified wheat variety has better nutritional quality (Protein 12%, zinc content 45.1 ppm and iron content 41.2 ppm).
- It possesses good chapati quality having with high Chapati score of 8.3.
- Resistant to black and brown rust disease.
- Having Amber colour grain with 44g, 1000-grain weight and hectoliter weight 82.1 kg/hl.
- Average yield of variety is 56.6 q/ha with potential yield of 92.4 q/ha.



Figure 18 New durum wheat variety MACS JEJURI (MACS 4100)

A new durum wheat variety MACS 4100 (MACSJEJURI)

- Notified in 2023 for timely sown irrigated condition of Peninsular Zone of India (Maharashtra and Karnataka).
- It has shown resistance to stem and leaf rust under artificial conditions.
- It has amber-colored bold grain with 43g, 1000-grain weight with good protein content (9.9%).
- Better nutritional quality (zinc 36.0 ppm and iron 33.6 ppm) with good milling quality (Test weight 80.9 kg/hl), sedimentation value (40.5 ml) and yellow pigment (7.1 ppm) and highest overall acceptability 6.6 (cooking quality of pasta product).
- Average yield of variety is 45.08 q/ha with potential yield of 61.8 q/ha.

Technology recommendation Foliar application of Cycocel (CCC) @ 600 ml in 400 liters of water per hectare at 50 DAS is recommended to reduce lodging and improving the productivity of dicoccum wheat in the Peninsular Zone.

ICAR-AICRP Wheat

Breeding trials Eight breeding trials were conducted. Total of 172 entries from different parts of India were being planted and evaluated.

Through analysis and selection criteria, the previous year trials were concluded in the current year. The promising entries found for irrigated timely sown condition were UAS3021, NWS2222, MACS6811, UAS3020, WH1306, NIAW4183, AKAW5314, NIAW4153, MACS6809, AKAW5100#, PWU15, MP1386, HI8841(d), PBW891. The promising entries found for irrigated late sown condition are IR-LS MACS6814, NIAW4114, AKAW5104, UAS3022, HI1674, DBW395, HI1672, HI1673, MP3557, NIAW4120, UAS3023, GW538, HI1675, MP1388, MACS6805, WH1310, GW542, DBW394, LOK79, UAS481(d), DDW61(d).

AVT trial results for MACS 6768: On overall basis, proposed entry MACS 6768 showed yield gain of 11.0%, 6%, 3.9%, 1.8% over check varieties HI 1636, GW513, HI 1544 and GW 322, respectively, whereas 4.1% over qualifying entry MP 3535. MACS 6768 has recorded the highest yield potential of 92.4 q/ha (in NIVT) with mean yield 56.6 q/ha. Frequency of appearing in first non-significant group for MACS 6768 was 15/38 times as compared to checks GW322 (15/38) and HI 1544 (10/38).

AVT trials results for MACS 4100: MACS 4100 is a high yielding durum wheat genotype with an average yield of 45.8 q/ha in comparison with durum wheat checks MACS 3949 (43.5 q/ha), UAS 428 (42.7 q/ha) and DDW 48 (47.7 q/ha). It showed yield potential of 61.8 q/ha and wider yield stability across the zone by appearing 12 out of 25 times in first top non-significant group. MACS 4100 was significantly superior in yield over check MACS 3949 by 14.3% in NIVT. In AVT I, proposed variety was superior in yield by 5.7, 10.7 and 7.6% over checks MACS 3949, UAS 428 & DDW 48, respectively. While in AVT II, it showed higher yield over checks UAS 428 and DDW 48 by 5.7 and 1.0%, respectively.

National coordinated trials: Four and thirteen wheat entries from MACS-ARI are being evaluated in the AVT and NIVT respectively. Among them, two were in restricted irrigation, six were in irrigated high fertility (four

bread wheat and two durum wheat), three bread wheat entries were late sown, and two dicoccum entries were in an irrigated special trial. Promotion of 35 new wheat entries developed at ARI to the national program on IPPSN is based on three years of yield and disease data from station trials, and promising entries from these entries will enter the national level multilocation trial for the next three years.

Pathological trials Total of 3362 entries evaluated for different diseases including, leaf rust, stem rust, leaf blight and other minor diseases. Through analysis and selection criteria the previous year trials were concluded with resistant and susceptible entries.

Pathological results for MACS 6768: MACS 6768 exhibited seedling resistance (all stage resistance) to all the 21 stem rust and 23 leaf rust pathotypes. The gene postulation SRT data shows Sr31+2+ Lr26 + R+Yr9+. It has shown resistance to stem and leaf rust under both natural and artificial screening conditions. Leaf rust severity under artificial condition showed ACI ranged from 5.7 to 12.1 with average ACI 8.1, while stem rust severity showed ACI ranging from 3 to 11.3 with average ACI 6.0.

Pathological results for MACS4100: MACS 4100 shown resistance to eight races for stem rust and eighteen races for leaf rust under artificial screening conditions. Leaf rust severity under artificial condition showed ACI ranged from 5.7 to 12.1 with average ACI 7.9, while stem rust severity showed ACI ranging from 6.5 to 16.8 with average ACI 13.

Agronomy trial evaluation and findings Experiment on various dates of sowing under timely conditions showed significantly higher grain yield (41.03 q/ha) recorded by GW 322, followed by test entry HI 8826 (40.06 q/ha) and MACS 3949 (39.75 q/ha). Similarly, various sowing dates under the late sown irrigated trial indicated significantly higher grain yield (48.37 q/ha) by HD 2932, followed by test entry DBW 320 (43.31 q/ha) and HI 1633 (41.92 q/ha), respectively. Under herbicide evaluation, pre-emergence applications of pendimethalin @ 1250 g a.i./ha + metribuzin @ 280 g/ha, resulted in a minimum weed count (8.33) and weed dry weight (5.33 g/sq.m.) at 90 DAS over weed count (39.33) and weed dry weight (32.13 g/sq.m.) at 90 DAS, respectively, under weedy check condition. One spray of nano urea @ 4 ml/lit at tillering stage with application of 75% recommended nitrogen recorded maximum grain yield (65.26 q/ha) which was 24.28% more than absolute control. Evaluation of RCT in wheat found that the combined use of soybean and wheat residue @ 3 t/ha each produced 5.32% higher grain yield than control treatment (no residue). Foliar potash application @ 4% resulted in significantly higher grain yield 32.84 q/ha which was 18.45% higher than the control treatment. However, three irrigations recorded higher yield of 35.42 q/ha compared to the control. Application of NPK solubilizing microbial (Rhizosphere) consortium indicates maximum wheat grain yield (55.77 q/ha) when 100% NPK + seed treatment with Bio NPK @ 2.5 ml/kg was used compared to control.

ARI station wheat research and activities

Development, selection and advancement of breeding lines For the development of breeding lines hybridization programme we generate 120-160 parental cross combinations and they will be screened for hybrid vigour and true F1 behaviour. The breeding materials of 787 cross combinations representing as lines/bulk from different segregating generations of F₂ to F₆ were screened and selected based on traits and objectives.

Station trials for yield We have conducted 16 station trials for yield evaluation. Total of 610 entries developed from institutional research, material selected from international nurseries and collaborative projects were being evaluated for yield performance. These entries were evaluated against various standard checks and disease screening. From these trials we have promoted 35 entries to IPPSN trial. The similar number of trials and entries were planted in the current year. All the breeding material were screened and evaluated for leaf rust, stem rust and leaf blight. The artificial inoculation of rust spores was injected and sprayed 5 to 7 times to maintain appropriate disease intensity.

Wheat breeder seed program Distribution of 208 q of wheat breeder seed for the 2022-23 wheat-cropping season to seed agencies (Mahabeej, NSC, KSSC), seed industries, farmers producing organizations (FPOs), and farmers. The seed will reach an approximate area of 2-2.5 lakh ha in Peninsular India (Maharashtra and Karnataka). Material for the nucleus seed and breeder seed production programs was planted at Hol, Songaon farm, in farmers' fields. The estimated total breeder seed is expected to be around 250q for the current year (Figure 19).



Figure 19 Joint inspection of Wheat Breeder Seed at Songaon farm

Wheat contract breeder seed program

The center is engaged in a contract breeder seed production program every year on farmer fields for improved wheat varieties to fulfill the demand for quality breeder seed from Mahabeej, the NSC, FPOs, farmers, etc. This year, a contract was made for fulfilling the demand of breeder seed of variety MACS 6222 on the farmer field of Shri. Umesh Dnyaneshar Holkar, Hol, on a 4.5 acres area, and 56.8 quintals of unprocessed seed of this variety have been received at the Hol farm (Figure 20).



Figure 20 Wheat contract breeder seed production program on farmers field

Minikit trials (MKTs) A total of eight wheat minikit trials of the newly released bread wheat variety MACS 6768 (MACS SAKAS) were distributed among farmers in the Central Zone of India for the popularization of the variety over Central India comprising Madhya Pradesh, Gujarat, Chhattisgarh and Rajasthan.

Germplasm characterization and trait discovery in wheat using genomics approaches and its integration for improving climate resilience, productivity and nutritional quality (DBT-ICAR-NBPGR-BT/Ag/Network/Wheat/2019-20)

3148 diverse germplasm accessions were evaluated in the first year and the core set of 500 and additional 600 new germplasms were evaluated in the second and third year. The pooled analysis of two years evaluation data revealed some of the accessions with high adaptability and stable genotypes at our location. These genotypes will be potential source genotypes for our wheat improvement program. The traits like plant height, days to flowering, days to heading, days to maturity, thousand grain weight and canopy temperature (maturity) were found to be high heritable. The accession with the desirable traits for drought tolerance mechanisms like short duration, CT-grain filling, early ground cover, thousand kernel weight, biomass, harvest index, CT-and stable yield performance were selected for further evaluation and also used in the crossing block to derive new breeding lines.

Accelerating genetic gains in maize and wheat for improved livelihood (CIMMYT-ICAR)

The analysis concluded from previous year field evaluation of 120 entries and selected 7 best high yielding entries from AGG project (SABWGPYT_ TPE3_ Trial 7 & 8) which are promoted to advanced station yield trials

and also utilised in the crossing program. Fifteen entries from the CIMMYT selections from nurseries and yield trials are promoted to advanced station trials and five out of them are being used in the crossing program. This year we have planted 180 entries for field evaluation.

Dissection of diversity and complex mechanism of *Bipolaris sorokiniana* infections in wheat using *ToxA-Tsn1* interaction

Ninety-six Isolates of *Bipolaris sorokiniana* were isolated on the potato dextrose agar media. The source used was infected leaf samples and infected grains received different locations of Uttar Pradesh, Bihar, Jharkhand, Madhya Pradesh, West Bengal, Haryana Maharashtra and Karnataka. During the isolation of the *Bipolaris sorokiniana*; four isolates were identified as *Bipolaris drechsleri* infections on wheat while 16 isolates were identified as *Exserohilum rostratum* infections on wheat. All the isolates are deposited in National Fungal Culture Collection of India (NFCCI) at ARI, Pune and accession number has been received. Ten representative isolates namely - KO-5803, RAJ 3972, Seed 28, HD 3091, RAJ 3705, HD 3094, Black Isolate, DD 1025, HI 1538, MP 1261 are selected based on the virulence pattern. The isolates are being sent for the De-novo whole genome sequencing. A hybrid sequencing approach will be followed in which the required sequencing depth will be achieved by Illumina paired end short sequencing, and gap filling will be done by Oxford Nanopore platform. Indigenous collection of the spring wheat germplasm (1000 nos.) was obtained from NBPGR, New Delhi. Genomic DNA has been isolated from 1000 indigenous wheat genotypes using modified CTAB method and DNA quantification is completed. Further screening of different combinations of genes *Sb1*, *Sb2*, *Sb3* and *Tsn1* genes is being carried out through KASP and SSR markers.

Soybean Improvement Program

Soybean research involves improvement through conventional breeding techniques and biotechnological tools, agronomic evaluation of soybean elite entries and development of soybean production technologies, technology transfer through frontline demonstrations and production of quality nucleus and breeder seed production and supply to the seed multiplying agencies, to aid the seed mission of Department of Agriculture and Cooperation, Government of India. This program is fully sponsored by The Indian Council of Agricultural Research, New Delhi since 1968 and being run as All India Coordinated Research Project on Soybean.

Soybean breeding program

a) Hybridization and evaluation of breeding material

During kharif 2022, twenty-three promising varieties and breeding lines were sown in crossing block for hybridization to incorporate the desired improved traits in prevailing soybean accessions. Earliness, high oil, high yield, null trypsin, null lipoxygenase, rust resistance, YMV resistance, charcoal rot resistance and vegetable and food grade type were the target traits. Crossing and hybridization were carried out and breeding material generation advancement is in progress.

b) Evaluation of MACS soybean varieties in All India Co-ordinated breeding trials

Soybean varieties MACS 1745 and MACS 1756 were tested in initial varietal trial for yield and overall performance across the 32 centers at all India level. These ranked 2nd and 12th with yield of 2705 and 2538 kg/ha, respectively. Similarly, MACS 1779 an early maturing (98 days) soybean variety was tested in soybean early IVT trials. It ranked 9th with yield of 2368 kg/ha in the year 2022.

c) Varietal release/ Registration of genetic stock at NBPGR, New Delhi/ Registration of varieties at PPV&FR authority

Recently released soybean varieties MACS 1407, MACS 1460 and MACS 1520 have been submitted to PPV&FR authority for registration. These have been recommended for DUS testing by the PPV&FR authority.

d) Evaluation of elite soybean entries

Breeding efforts led to the development of sixty-seven elite soybean breeding lines and were tested in four graded replicated trials. Of these, 7 lines gave significantly more yield than the highest yielding control (check) varieties KDS 753, DSb 34, JS 93-05, MACS 1188 and JS 95-60. Out of these, three lines MACS 1804, MACS 1847 and MACS 1834 gave seed yield of 2708, 3126 and 3210 kg/ha and showed 95, 98 and 92 days maturity, respectively. These entries will be proposed for initial varietal trial (IVT) of All India Coordinated Research Project for all India evaluation.

Agronomic evaluation and development of soybean production technologies

Effect of a novel bioformulation evaluated on soybean crop showed that treatment containing 75% RDF + Rhizobium + MDSR14 + 12c (2987 kg/ha) gave significantly higher seed yield of soybean over control (2383 kg/ha) and was closely followed by rest of the treatments. The crop applied with the formulation was significantly remunerative and recorded maximum benefit:cost ratio (2.93:1) over rest of the treatments. The treatment has recorded higher number of root nodulation (69 no.) and its dry weight (0.500 g).

A biostimulant (Gibberellin augments) applied at 3-4 and 8-9 nodal stage to soybean crop showed that 2.5 ml/l + GA (10 ppm) 1st spray followed by 5.0 ml/l 2nd spray was found promising in terms of seed yield (3430 kg/ha) over untreated control (3117 kg/ha), without showing any phyto-toxic effect on the crop growth.

Technology transfer/ outreach programme and its socio-economic impact

In order to demonstrate the impact of improved production technology over the traditional practice of soybean cultivation, fifteen frontline demonstrations comprising recently released soybean varieties were conducted. Improved practice was able to bring out 19% increase in soybean yield over farmers' traditional practice, mostly due to the sowing of improved soybean varieties MACS 1188, MACS 1281 and MACS 1460; and insect-pest management practices. An average yield under farmers practice was 23.83 q/ha while it was 28.33 q/ha with improved practice. The benefit due to adoption of improved practice of soybean cultivation at an additional cost of Rs. 2362 per hectare is a net return of Rs. 17,888 per hectare (Figures 21, 22).



Figure 21, 22 Frontline demonstrations and farmer-scientist interactions

Soybean breeder and nucleus seed production

A total of 220 quintals of breeder seed of soybean varieties, including MACS 1188, MACS 1281 and JS 335 has been supplied during kharif 2022 to public and private seed multiplying agencies and farmers as a source of pure seed. Similarly, 148 quintal soybean breeder seed production was undertaken, and will be supplied during the kharif 2023 season. Also, 24.50 quintals of nucleus seed of soybean varieties MACS 1188, MACS 1460, MACS 1520, MACS 1407, MACS 1281 and JS 335 has been produced. It can be the source of seed for breeder seed production in kharif 2023 (Figures 23, 24).



Figure 23, 24 Soybean breeder seed production programme

Soybean contract farming and collaborations for quality seed supply

Contract farming agreements were signed with four progressive farmers to produce quality soybean breeder seed production of recent varieties, to fulfill the breeder seed demand of the FPO, seed multiplying agencies, KVK's etc. About 102 quintal soybean breeder seed of the varieties MACS 1188, MACS 1460 and MACS 1281 was produced and procured.

Grape Improvement

ARI germplasm contains six *Vitis* species, 62 cultivars of grape, 6 wine varieties, 9 types of rootstocks maintained on own root system. Twenty cross combinations were attempted using ten female parents and three seedless male parents viz. Jumbo, SSN and Manik Chaman for developing table purpose seedless varieties with good quality attributes. 685 berries were harvested and given chilling treatment for obtaining good germination.

Isolation of stable seedless mutant of ARI 516

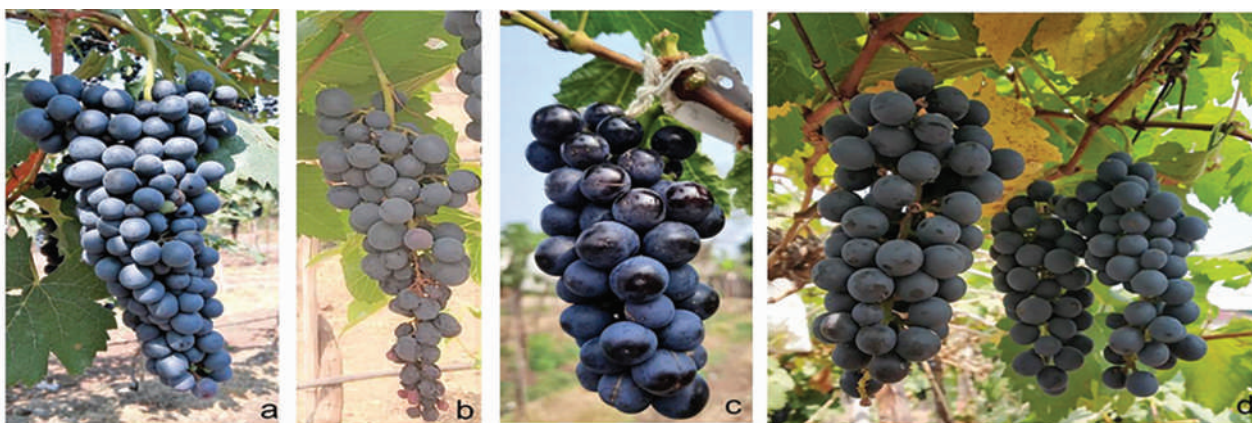
Seedlessness is a highly desirable agronomic trait in grapes as seedless variants are preferred for table grapes and raisin making. Multiplication of seedless mutant of grape variety ARI 516 and its molecular basis of seedlessness is being investigated. The cuttings of mother plant of seedless mutant having 5-6 buds were used for multiplication. A total of thirty cuttings of seedless mutants of ARI 516 are planted in the field. Another 26 cuttings are freshly planted in the current season. Two plants out of total surviving M_1V_2 plants in the field produced seedless berries which confirmed its stability for seedlessness.

Microscopic investigation of ovary and pollen development of seedless mutant

Ovary development was observed by microtome sectioning, which showed four normal ovules with germinative cells in both ARI 516 as well as a seedless mutant. The overall size of ovules in the mutant type was smaller than ARI 516. Assessment of male gamete functionality revealed that seedless mutant ARI 516 produces infertile pollen.

Morphological and biochemical analysis of berries

The seedless mutant showed reduced berry length, width, and 100-berry weight compared to ARI 516. In the biochemical study, parameters like total soluble solids (TSS), Titratable acidity (TA) showed no significant difference between mutant and ARI 516 berries. However, maximum gain in berry dimensions and weight were observed in the treatment of GA3 and the combination of GA3+6BA. It showed that the seedless mutant is responsive to GA3 and 6BA, while ARI 516 remained non-responsive to the exogenous application of GA3 and 6BA. Exogenous application of GA3 may be practiced to maximize berry size in the cultivation practices (Figure 25).



a. Bunch of ARI 516, b. Seedless mutant, c. Seedless mutant with GA, d. seedless mutant with GA+GBA

Figure 25 a. Bunch of ARI 516, b. Seedless mutant of ARI 516, c. Seedless mutant after application of growth hormone, d. seedless mutant after application of combination of growth hormones GA and Benzylaminopurin

Nanobioscience

Rapid dot-blot assay for aflatoxin B1A (AFB1) detection to ensure food safety

Aflatoxin B1 is a secondary metabolite produced by fungi and a major mycotoxin contaminant of food and animal feed. Consumption of aflatoxin B1 is harmful and may lead to hepatotoxicity and carcinogenicity. However, its detection is limited due to time consuming chromatographic methods like HPLC.

In the present investigation, a rapid, visual, user-friendly dot-blot assay was developed by conjugation of peptides with gold nanoparticles (AuNPs) as a detection agent. We used bioinformatic tools for rational design of a specific short peptide displaying good solubility and high affinity to AFB1 by molecular docking. Indirect ELISA showed a low K_d value (323 nM) suggesting the high binding of peptide with AFB1. Conjugation of gold nanoparticles with streptavidin–biotin interaction was employed to develop a dot-blot assay for AFB1 detection having a limit of detection of 0.39 $\mu\text{g}/\text{kg}$. The cross-reactivity with other mycotoxins was negligible. Detection of AFB1 was comparable by dot-blot assay (78–91%) and HPLC (65–87%).

The aflatoxin B1 dot-blot assay was validated using HPLC method for 146 samples and achieved high correlation with $R^2 = 0.87$. The assay displayed high accuracy (91%), sensitivity (71%) and specificity (96.5%). Therefore, a portable, easy-to-use dot-blot assay for aflatoxin B1 detection has potential for monitoring AFB1 contamination.

A pH-tuned chitosan-PLGA nanocarrier for fluconazole delivery reduces toxicity and improves efficacy against resistant *Candida*

Human fungal infections by *Candida* sp. cause high mortalities among the immunocompromised and immunosuppressed patients. *Candida auris* displays a high resistance to existing azole drugs, used for disease control. Drug nanocarriers like chitosan PLGA nanoparticles show improved drug efficacy and reduced toxicity. Fluconazole (FLZ) is a broad-spectrum antifungal used to control *Candida* infections and *Candida auris* displays resistance to FLZ. In this study we synthesized C-PLGA nanoparticles (110 nm) and loaded it with FLZ, achieving ~8-wt% drug loading. Drug release by the C-PLGA-FLZ nanoformulation (83%) was slow and sustained (5d), pH-tuned manner at pH 4, while release at pH 7 was low (34%). The localization of fluorescent-tagged C-PLGA-NPs was visualized on the *Candida* cell wall/ membrane by confocal microscopy. The nanoformulation resulted in ~1.9-fold reduced efflux of R6G dye as compared to drug treatment in *Candida albicans* and resistant *C. auris*.

Nanoformulation showed enhanced antifungal activity 16- and 64-fold ($p < 0.0001$ against *C. albicans* and *C. auris*, respectively, as compared to FLZ. Highly antifungal activity of nanoformulation was observed *in-vivo* against *C. albicans* and *C. auris* with negligible toxicity. Thus, PLGA NPs-mediated fluconazole delivery can contribute to increased drug efficacy and to reduce the problem of fungal resistance.

Development of membrane for application in organ on a chip

Membranes are barriers connecting dissimilar environments, thus, hold an essential place in the human body. Therefore, studying the membranes is critical for understanding the body's functions concerning cells/tissue/organs and its surroundings. In vitro cell culture (2D and 3D) can be used to assess the membrane properties like compartmentalization and transport of ions, gases, and signalling molecules. We have developed a firm yet elastic membrane which allows the growth of cells over its surface. The membrane, a composite of PDMS (elastomer) and cellulose acetate (biopolymer), is characterized morphologically, physically, chemically, and biologically.

We have established the fabricated membrane containing one-part PDMS, eight parts toluene, and two parts cellulose acetate to be an ideal membrane for application in organ-on-a-chip. The presence of cellulose acetate eliminates the need to modify the surface of PDMS for cell adherence and growth, while PDMS provides the required elasticity. Furthermore, the standardized ratio provides a surface roughness that aids in higher surface area for cell growth. Thus, the membrane possesses properties like tunable elasticity, biocompatibility, tensile strength, selective permeability to gases and impermeability to liquids, along with the ability of cell growth over the surface. The membrane could further be incorporated to emulate the lung-alveolar interface in vitro. The membranes, with modifications (bulk and surface), can be used for applications like on-chip models, wound healing, etc (Figure 26).

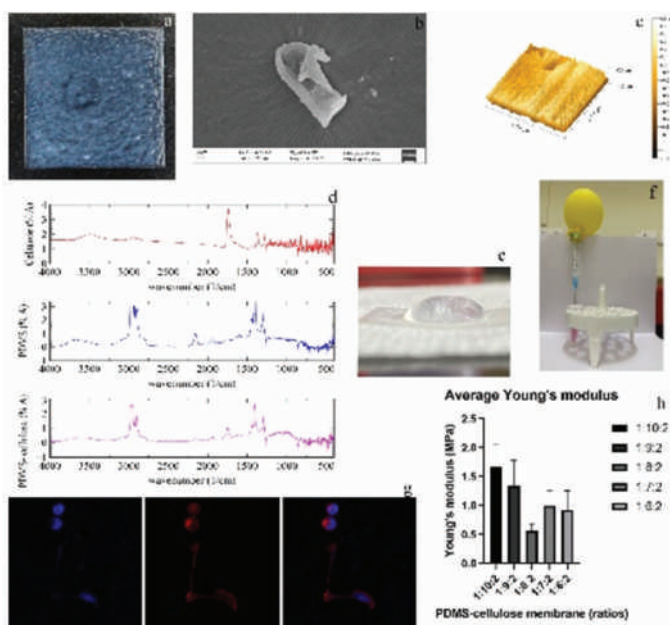


Figure 26

a, b and c represent the visual, SEM and AFM image of the membrane surface respectively; d represents the FTIR spectra of PDMS, cellulose and the composite; e and f represent the setup for liquid and gas-permeability assays respectively; g represents the images of NIH 3T3 cells as seen under the confocal microscope; h represents a graph of the Young's modulus of the membranes

Interactions among Hepatitis E Virus RNA, miR-140 and hnRNP K

Hepatitis E virus (HEV) is a positive-sense single-stranded RNA virus that is a common cause of acute viral hepatitis worldwide. In the present study, we identified that highly conserved intact miR-140 binding site (MBS) and host factor hsa-miR-140-3p are the critical requirements for HEV replication. MBS might form a secondary RNA structure that allows the recruitment of hnRNP K, which is a key protein of the HEV replication complex. In the process of HEV replication, MBS can serve as a binding platform for hnRNP K only in the presence of hsa-miR-140-3p. In addition, we also identified the novel interaction of hnRNP K and miR-140 endogenously as well as during HEV replication. The present study highlights the importance of human host factors, miR-140, and hnRNP K, in the HEV life cycle (Figure 27).

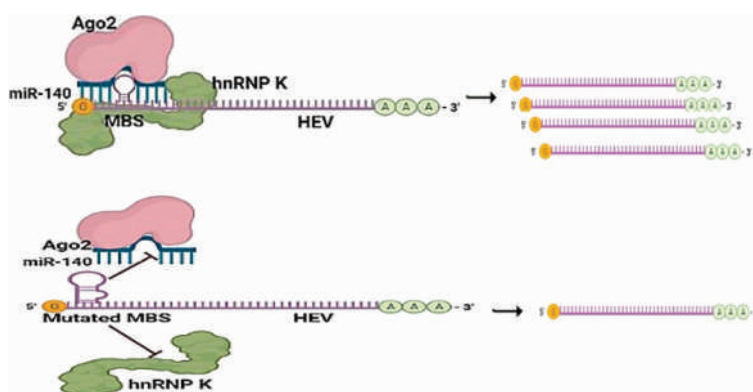


Figure 27

miR-140 and intact MBS are required for the interaction of hnRNP K to the HEV genome, and this interaction affects HEV replication. Upper panel: miR-140 is an important host factor required for HEV replication, and it serves as a platform for the recruitment of hnRNP K and Ago2 in the MBS region. These interactions are required for successful HEV replication. Lower panel: Mutation at miR-140 binding site, inhibits interactions of HEV RNA with Ago2 and hnRNP K and also inhibits HEV replication.

Photofunctionalized dental implants: a treatment option for diabetics

Good bone-to-implant contact (BIC) is required for the successful integration and functioning of a dental implant. The surface of the implant is the most crucial because it is in contact with the bone of the host. Research proves that modification of the implant surface improves osseointegration. Various strategies for implant surface modification include etching with acid, blasting through grit and/or sand, biomimetic coating, anodizing, coating with bioactive molecules, using inorganic materials, etc. Certain systemic conditions such as diabetes mellitus, osteoporosis, etc., affect the quality and quantity of the bones and therefore retard the process of osseointegration of dental implants. Since UV photofunctionalization can be a chair-side protocol for surface modification of dental implants, we standardised the process with three commercially available implants viz., Group 1—laser-etched implant surface (Laser Lok, BioHorizons, Birmingham, AL, USA); Group 2—titanium-zirconium alloy surface (Roxolid, Straumann Implants AG, Basel, Switzerland); Group 3—air-abraded, acid-etched surface (SLA dental implants, Straumann Implants AG, Basel, Switzerland). The UV photofunctionalization was carried out in a specially designed device for 60 and 90 minutes. The X-ray photoelectron spectroscopy (XPS) data was used to analyse the implant surface chemical composition, which revealed the formation of Ti^{4+} conversion to Ti^{3+} , and a reduction in the carbon content of the implants. The bioactivity of MG-63 cells (osteoblasts) was assessed in media containing elevated glucose concentrations to mimic a diabetes environment. Specifically in Group 3 implants, the cell adhesion was the best. Cell proliferation and mineralization (calcium deposition) were demonstrated to be better on the photofunctionalized implant surfaces. Photofunctionalization increased the hydrophilicity of the surface, promoting osseointegration and proving to be beneficial to the diabetics.

Targeted silencing of the MCL-1 gene using multi-layered dendrimer-based nanoconstructs achieves efficient tumor regression in xenografted mice models

The setback in the practical clinical use of RNA interference (RNAi)-based cancer treatment stems from the lack of targeted small interfering RNA (siRNA) delivery. Here, we show that luteinizing hormone-releasing

hormone (LHRH) analog-tethered multi-layered polyamidoamine (PAMAM) nanoconstructs silence the anti-apoptotic MCL-1 gene in LHRH receptor overexpressing human breast (MCF-7) and prostate cancer (LNCaP) cells with 70.91% and 74.10% efficiency, respectively (Figure 28). These results were confirmed by RT-PCR. The Acridine orange/ Ethidium bromide (AO/EB) dual staining revealed that the silencing of MCL-1 induced apoptosis in both the cell lines. *In vivo* tumor regression studies performed using MCF-7 and LNCaP xenografted severe combined immunodeficiency (SCID) mice demonstrated highly improved tumor regression in groups treated with targeted nanoconstructs complexed with MCL-1 siRNA (T + siMCL-1) compared to the other treatment groups. The quantitative RT-PCR results of tumor tissues demonstrated significant MCL-1 gene silencing, i.e., 73.76% and 92.63% in breast and prostate tumors, respectively, after T + siMCL-1 treatment. Reduction in MCL-1 protein expression as assessed by immunohistochemistry further confirmed these results. Furthermore, the caspase 3/7 assay demonstrated apoptosis in the MCL-1 silenced tissues. The study strongly suggests that targeted delivery of siRNAs using multi-layered dendrimer nanostructures could be an effective therapy for LHRH overexpressing cancers.

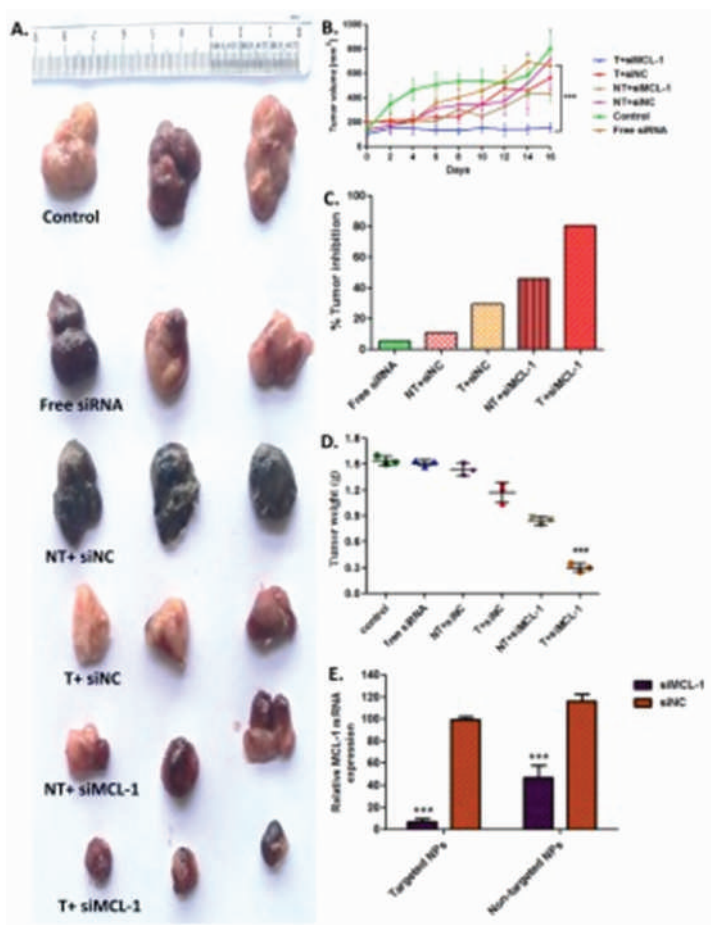


Figure 28

LNCaP cells xenografted tumors. (A) Images of excised tumors from different treatment groups, (B) *In vivo* average tumor volume of the treated groups. Day 0 corresponds to 3 weeks after inoculation of cells when the tumor volume was approximately 150 mm³ (n = 5 tumors) compared to the control group. (C) Percent tumor inhibition in all the six treatment groups. (D) Average tumor weight, excised from different treatment groups at the end of the study period. (E) The expression level of MCL-1 in excised tumor tissues was quantified by real-time PCR. Data represented as mean \pm SEM, ***p < 0.001.

Nucleolin aptamer conjugated MSNPs-PLR-PEG multifunctional nanoconstructs for targeted co-delivery of anticancer drug and siRNA to counter drug resistance in TNBC

The emergence of drug resistance in cancer cells is among the major challenges for treating cancer. In the last few years, the co-delivery of drug and siRNA has shown promising results against drug-resistant cancers. In the present study, we developed mesoporous silica-based multifunctional nanocarrier for co-delivery against drug resistant triple-negative breast cancer (TNBC) cells. We synthesized the nanocarrier by modifying

mesoporous silica nanoparticles with poly-L-arginine, polyethylene glycol and AS1411 aptamer to impart siRNA binding ability, biocompatibility, and cancer cell specificity, respectively. We optimized the loading of doxorubicin (DOX) within the developed nanocarrier to avoid interference with siRNA binding. We ascertained the target specificity by performing a receptor blockade assay during cellular uptake studies. The cytotoxic efficacy of DOX and siRNA co-delivered using the developed nanocarrier was assessed using DOX-resistant

MDA-MB-231 TNBC cells. The nanocarrier exhibited >10-fold and 40-fold reduction in the IC₅₀ values of DOX due to co-delivery with BCL-xL and BCL-2 siRNA, respectively. The results were further validated using a 3-D *in vitro* cell culture system. This study demonstrates that the targeted co-delivery of drug and siRNA has a strong potential to overcome drug resistance in TNBC cells (Figure 29).

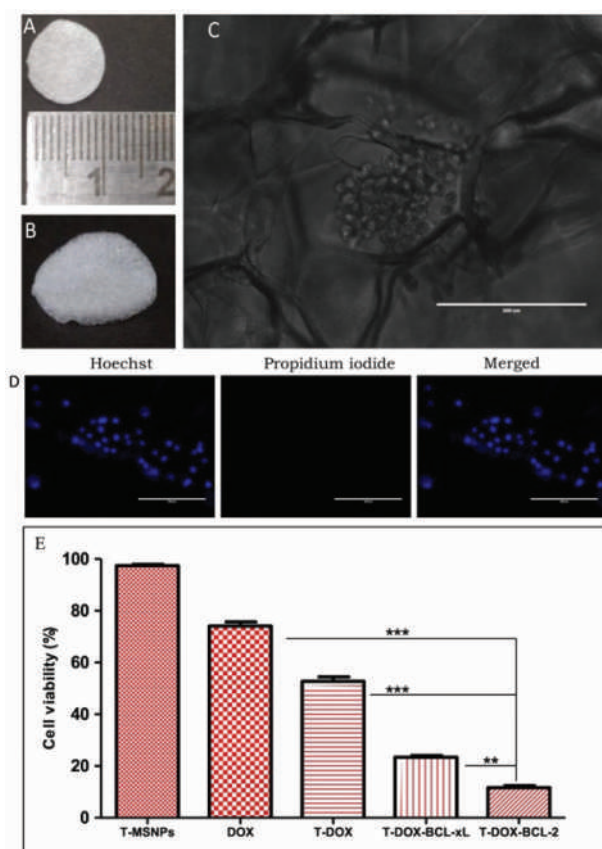


Figure 29

(A) Top and, (B) lateral view of the scaffold. (C) DOX-resistant MDA MB-231 aggregate under an inverted microscope (20 \times), and (D) live/dead staining of cells grown on scaffolds, (E) Cytotoxicity assessment on cells grown in 3D scaffold. Cytotoxicity evaluation after 48 h treatment to assess the effect of DOX and BCL-xL/BCL-2 siRNA co-delivered via T-MSNPs (N = 3, $p < 0.01, 0.001$).

Tenofvir-tethered gold nanoparticles as a novel multifunctional long-acting anti-HIV therapy to overcome deficient drug delivery

The adoption of Antiretroviral Therapy (ART) substantially extends the life expectancy and quality of HIV-infected patients. Yet, eliminating the latent reservoirs of HIV to achieve a cure remains an unmet need. The advent of nanomedicine has revolutionized the treatment of HIV/AIDS. The present study explores a unique combination of Tenofvir (TNF) with gold nanoparticles (AuNPs) as a potential therapeutic approach to overcome several limitations of the current ART. TNF-tethered AuNPs were successfully synthesized. Cell viability, genotoxicity, haemolysis, and histopathological studies confirmed the complete safety of the preparation. Most importantly, its anti-HIV1 reverse transcriptase activity was ~15 folds higher than the native TNF. In addition, it exhibited potent anti-HIV1 protease activity, a much sought-after target in anti-HIV1 therapeutics. Finally, the *in vivo* biodistribution studies validated that the AuNPs could reach many tissues/organs, serving as a secure nest for HIV and overcoming the problem of deficient drug delivery to HIV reservoirs. The study shows that the combination of TNF and AuNPs exhibits multifunctional activity, viz. anti-HIV1 and anti-HIV1 protease. These findings highlight the prospects of developing AuNP-TNF as a novel next-generation platform to treat HIV/AIDS (Figure 30).

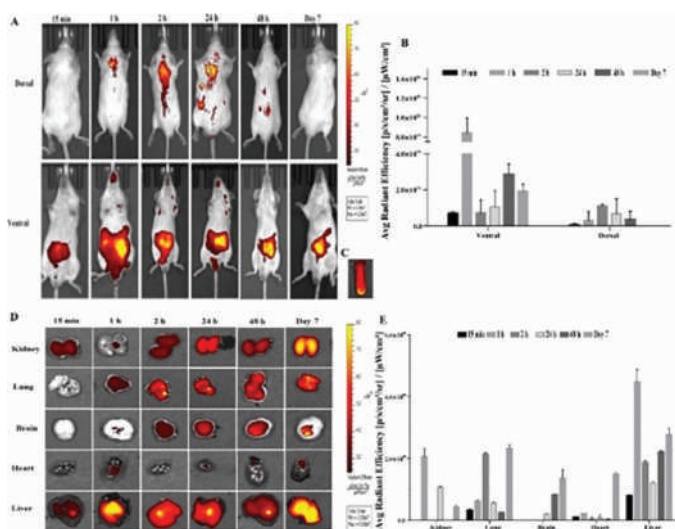


Figure 30
 (A) Real-time whole-body images of the healthy male BALB/c mice, corresponding semiquantitative data of NIR fluorescence signal at prescheduled time point post-injection of Cy5.5-AuNPs, (B) Average radiant efficiency [p/s/cm2/sr]/[μW/cm2] of IVIS® imaged mice. Data were obtained from the Region of Interest (ROI) of the fluorescent area in each mouse, (C) NIR fluorescence image of the Cy5.5-AuNPs stock in a tube, (D) images of dissected organs of healthy BALB/c mice post-injection of Cy5.5-AuNPs, (E) Average Radiant Efficiency [p/s/cm2/sr]/[μW/cm2] of Cy5.5-AuNPs from isolated organs at different time point (Mean±SD, n=3).

Aptamer tethered bio-responsive mesoporous silica nanoparticles for efficient targeted delivery of paclitaxel to treat ovarian cancer cells

Ovarian cancer is the leading cause of cancer deaths in female patients. The current therapeutics in ovarian cancer are limited and inefficient in curing the disease. To tackle this, we have synthesized tetrasulfide derivative of silica doped, biodegradable, glutathione-responsive targeted mesoporous silica nanoparticles modified with heterobifunctional polyethylene glycol as a linker and mucin-1 aptamer for triggered paclitaxel delivery to the ovarian cancer cells. Degradable mesoporous silica nanoparticles were synthesized by a modified sol-gel method with tetraethyl orthosilicate and Bis (triethoxysilylpropyl) tetrasulfide. The degradable mesoporous silica nanoparticles had good paclitaxel encapsulation efficiency and glutathione-responsive paclitaxel release ability. The glutathione utilization assay and visual destruction observed in transmission electron microscopy images confirmed the degradation of the mesoporous silica nanoparticles in the tumor cell environment. The targeted degradable mesoporous silica nanoparticles were efficiently taken up by ovarian cancer cell lines OVACAR-3 and PA-1 (Figure 31). Significant toxicity on OVACAR-3 (IC50 25.66 nM) and PA-1 (IC50 42.93 nM) cell lines was observed when treated with paclitaxel-loaded targeted

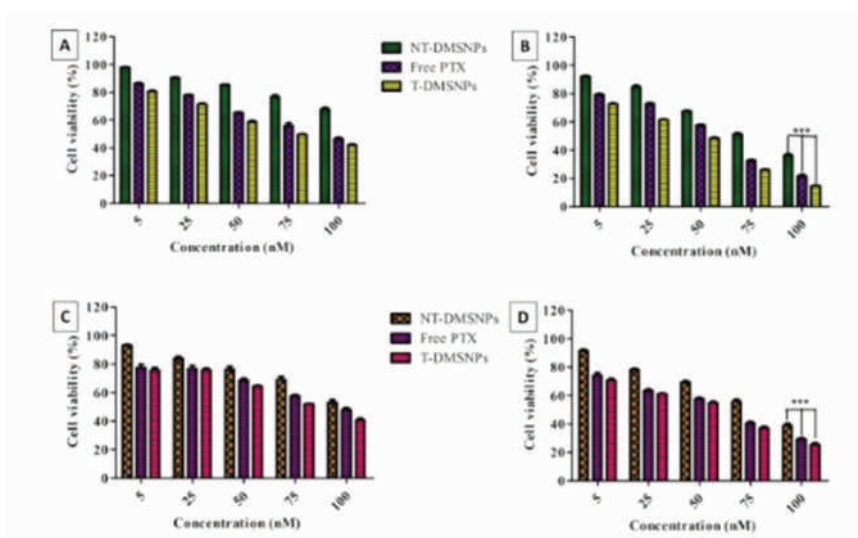


Figure 31
 Cell viability assay of OVACAR-3 cell line (A&B) and PA-1 cells (C&D) for 24 (A&C) and 48 h (B&D). Data represented as mean±SD

degradable mesoporous silica nanoparticles. Results of this study demonstrated that mucin1 targeted, glutathione-responsive mesoporous silica nanoparticles loaded with paclitaxel had a significant antitumor effect on ovarian cancer cells. All these findings demonstrated that the developed nano-formulation could be suitable for ovarian cancer treatment.

In vivo imaging of prostate tumor-targeted folic acid conjugated quantum dots

Cancer is a major threat to human health; thus, early detection is imperative for successful management. Rapid diagnosis can be achieved by imaging primary (subcutaneous) tumors using fluorophores conjugated with tumor markers. Here, the application of biocompatible, quantum efficient, monodisperse, and photostable polymer-coated quantum dots (PQDs) is demonstrated for targeted prostate tumor imaging in living SCID mice. Briefly, PQDs (blue) are conjugated to folic acid (FA-PQDs) using DCC-NHS chemistry. Initially, in vitro targeted imaging via FA-PQDs is evaluated in LNCaP cells. The confocal microscopic evaluation demonstrates the uptake of FA-PQDs. To understand the dispersion of PQDs in vivo, the biodistribution of PQDs is assessed at different time intervals (1-180 minutes) using whole-body fluorescence imaging and computed tomography (CT) scan (Figure 32). PQDs are seen to accumulate in organs like the liver, kidneys, spleen, lungs, and urinary bladder within 60 minutes, however, PQDs are not observed at 180 minutes indicating renal clearance. Further, to target the prostate tumor (~200 mm³) in mice, FA-PQDs are injected intravenously, and whole-body fluorescence imaging along with a CT scan is recorded. FA-PQDs are seen at the tumor site as compared to PQDs. The results confirm that the FA-PQDs function as excellent nanoprobe for targeted tumor imaging in vivo.

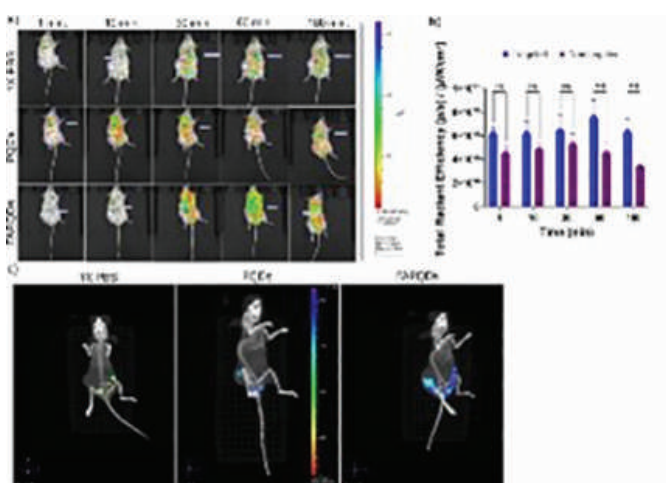


Figure 32

(a) whole-body fluorescence tumor imaging of control, non-targeted and targeted groups of SCID mice at different time intervals. (b) Graph showing the significance of tumor fluorescence intensity of targeted group with control and non-targeted groups (2-Way ANOVA-multiple comparison Dunnet's test). (c) CT scan image of control, non-targeted and targeted groups at 60 min

Hyaluronic acid functionalized liposomes embedded in biodegradable beads for duo drugs delivery to oxaliplatin-resistant colon cancer

Oxaliplatin (OHP) resistance is a major hurdle in the chemotherapeutic treatment of colorectal cancer (CRC). The present study aimed to formulate Eudragit S-100 (ES-100) coated alginate beads bearing drugs loaded targeted liposomes for simultaneous delivery of OHP and curcumin (CUR) to exert a synergistic therapeutic effect on OHP-resistant HT-29 cell line. The liposomes were prepared by the thin-film hydration method and optimized for various formulation parameters using a Box-Behnken design (BBD) with the aid of Design-Expert® software. Hyaluronic acid (HA) was conjugated on the liposomal surface using carbodiimide chemistry

to target CD44 receptors, which are overexpressed on the CRC cells. HA coupled drugs bearing liposomes (OC-L-HA) were then characterized for various attributes, viz. shape, surface morphology, size, zeta potential, PDI, entrapment efficiency, and drug loading, as well as *in vitro* cell-based studies. OC-L-HA were entrapped in the alginate beads and examined for their *in vitro* potential and *in vivo* performances. MTT assay demonstrated that OC-L-HA exhibited 2.76- and 2.58-fold higher cytotoxicity than targeted CUR liposomes and targeted OHP liposomes, respectively (Figure 33). The outcomes of the studies revealed that these surface-modified liposomes entrapped in Eudragit S100 coated beads could be an effective strategy for the treatment of CRC.

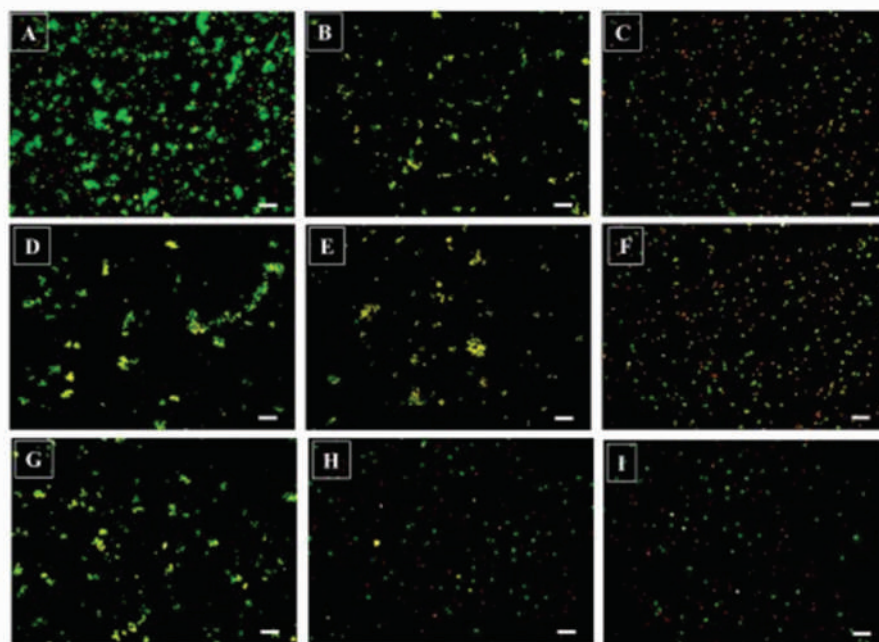


Figure 33

AO/EB staining of HT-29r cells treated with different treatment groups- OHP, OHP-L, OHP-L-HA (A, B, C); CUR, CUR-L, CUR-L-HA (D, E, F); OHP + CUR, OCL, OC-L-HA (G, H, I) respectively.

Annexure

Repositories

Agharkar Herbarium at MACS (AHMA)

Five hundred new specimens were added to the AHMA collection. AHMA also holds a rich collection of medicinally important plants. Around 1000 old specimens from Dr VD Vartak's collection were sorted and re-pasted to maintain them. The present number of specimens in AHMA is 34500. Seven researchers from different parts of India visited and consulted AHMA. The diatom collection holds around 4167 samples covering the present day to Pleistocene period. The present culture collection holds 74 strains of *Gomphonema* and 25 strains of *Stauronies*.

Ajrekar Mycological Herbarium

Ajrekar Mycological Herbarium holds 10515 exsiccate specimens including 57 specimens received from different centers in India for deposit and accession during the period of report.

Animal Facility

Animal Facility at ARI is registered with Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), Ministry of Environment and Forests, Government of India, New Delhi. The Registration No. of the Facility is 101/GO/RRcBiBt/S/99/CPCSEA. The Facility has licenses for a) research and breeding of small animals, b) breeding of small laboratory animals (rat and mice) for trading and c) research for commercial purposes.

The Facility has well organized infrastructure. We conducted a) routine genetic and biochemical monitoring of laboratory animals using microsatellite SSLP and biochemical markers, b) two Institute Animal Ethics Committee (IAEC) meetings and IAEC gave approval for total 38 proposals, c) upgraded the facility by developing preclinical pharmacological and toxicological laboratories and also added in-vivo live imaging instrument in the lab, d) performed six proposals on contract basis and five intra- and extra-mural projects, e) published seven international articles based on the animal work conducted in the facility, f) provided quality and healthy animals by pursuing 4Rs (Replace, Reduce, Refine, Rehabilitate), g) provided training for technical staff, students and scientists of different groups of the Institute and also to students from outside the Institute in ethical handling of laboratory animals, h) generated revenue for the Institute by selling of the animals and performing projects on contract basis, and i) developed animal models of various diseases to test various drugs and biologically active molecules.

Crude Drug Repository

It is a repository of genuine/ authenticated crude drug specimens by voucher depositions of field/ market samples of crude drugs.

Fossil Repository

Fossil repository hosts over 8000 fossil type specimens of various animal and plant groups. Over 5000 megafossils include phylum mollusca, brachiopoda, echinodermata, annelida, chordata, bryozoa, and various trace fossils, intertrappean fish, plant fossils as well as recent traces, collected from various localities of peninsular India. Over 2500 microfossils, including foraminifera, pollens and spores are also part of the collection. Revision of taxonomic status of certain specimens considered as trace fossils from the Paleogene of Kachchh and deposited as type specimens is completed.

MACS Collection of Microorganisms (MCM)

Under this project, specialized cultures of microorganisms used in various processes are being maintained in active form and supplied to researchers on demand. The specialized cultures include standard reference cultures, cultures used in metal-microbe interactions and industrial waste treatment, extremophiles such as halophilic, thermophilic and mesophilic methanogenic archaea, and alkaliphilic cultures.

National Fungal Culture Collection of India (NFCCI-WDCM 932)

As a part of the conservation of fungal diversity, live, pure and authenticated cultures of interesting fungi received from various organizations in India were deposited and accessioned. The total accession of NFCCI comes to 5490. The fungal germplasm is being maintained in culture collection by following standard long-term preservation methods, like freeze drying, distilled water, glycerol and liquid nitrogen. A total 268 fungi were accessioned during period of report and 165 authentic fungal strains were supplied to various academia, research institution, and industry.

Library and Information Centre

The Library and Information Centre is the hub of learning and research activities. It has played an essential role in providing information and various services to its users. The library is enriched with a valuable archive of the Founder-Director Prof. SP Agharkar. This archive includes books, back volumes, periodicals, and reference works primarily in German. ARI library has print, online journals, and databases accessible within the campus through campus LAN. It is also a part of a CSIR-DST consortium known as the National Knowledge Resource Consortium (NKRC). Grammarly, a software that aids writing skills was acquired. The library has migrated totally to KOHA, an open-source software. SMART-DMS is an active repository of information related to the institute, including research papers, patents, monographs, PhD theses, etc., which are uploaded regularly. Hindi books are purchased to promote the Hindi language. Email intimation about the new arrival of information resources is given to the users. The Library and Information Centre maintains the institute's website and social media sites (Facebook, Twitter, and Instagram).

The current holdings of the library are:

Particulars	Total	Particulars	Total
Books / Bound Volumes	30093	Maps and Atlases	569
Reference Books	1138	Microfilms / Fisches	636
PhD Theses	393	Annual Report	10
Msc / MPhil Thesis	97	Journals	55
ARI Reprints/ Articles	3772	Digital collection/Documents	3222

Services Rendered/ Offered

Crude Drug Authentication Service

The authentication service is rendered to pharmaceuticals, researchers, students on request. One hundred and thirty-three authentication reports were generated for the academic institutes/ industries.

Fungal Identification Service of NFCCI

Fungal cultures (288), and other samples received from academic, research institutions, and industry were authenticated/identified. As such, 102 centers including academic and research institutions and private centers in India benefited from various services of NFCCI.

Technical Services

These included the supply of bacterial cultures, identification of bacteria by 16S rRNA gene sequencing, and BIOLOG system, bacterial characterization, validation and technical audit of compressed biogas plant, biomethane potential analysis, total viable count and analysis of soil microbial biomass. Evaluation of a biostimulant on soybean crop was done during kharif 2022.

Intellectual Property

Patents Granted

Separation of serum by paper based micro-fluidics and estimation of different forms of iron using camera phone. Kulkarni PP, Bodas DS, Joshi BN. Indian Patent No. 413193

Polymer coated fluorescent semiconductor nanocrystals. Shailaja Agrawal, Kishore Paknikar, Dhananjay Bodas. Indian Patent No. 396220

Patents Applied/ Filed

A liquid microbial consortium for biohydrogen generation and process thereof, Prashant K. Dhakephalkar, Sumit Singh Dagar, Soham D. Pore, Sai S. Hivarkar, Shashishekhar Pandit, Kaustubh Pathak, Vikram Lanjekar, Pranav Kshirsagar. India & PCT, 202121030605, 11.6.2022

A process for preparation of polymer coated fluorescent semiconductor nanocrystals under mathematically derived 15 process parameters. Sulaxna Pandey, Dhananjay Bodas. Patent of Addition TEMP/E-1/41123/2022-MUM

Protection of Plant Varieties and Farmers Rights Authority

Grape variety MACS 516, Acknowledgement No. REG/2022/0082, 26.5.2022. Status: Recommended for DUS test (distinctiveness, uniformity, stability)

Soybean varieties MACS 1407, Acknowledgement No. REG/2022/0078, 26.5.2022; MACS 1460, Acknowledgement No. REG/2022/0080, 26.5.2022; MACS 1520, Acknowledgement No. REG/2022/0079, 26.5.2022. Status: Recommended for DUS test (distinctiveness, uniformity, stability)

Memorandum of Understanding/ Agreements

MoU

National Research Development Corporation, New Delhi, 4 November 2022

Bioenergy Institute of Engineering and Ocean Technology, ONGC, 22 October 2022

Agreements

Bioenergy Verdure, The Green Square Agribiotech, Biome Technologies, Nasik, 29 June 2022;

National Biodiversity Authority, Chennai, 30 September 2022; GPS Renewables Pvt. Ltd. Bengaluru, 19 May 2022; 18 November 2022

Genetics & Plant Breeding Farmers, August-September 2022

Publications (Books/ Book Chapters/ Bulletins/ Research Papers/ Booklets)

Books

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Bulletins

- 1) सोयाबीन उत्पादन की उन्नत तकनीक; 2) सोयाबीन के प्रमुख रोग और समेकित रोग प्रबंधन; 3) सोयाबीन के प्रमुख किट और समेकित किट प्रबंधन; 4) गहू लागवडीचे सुधारित तंत्रज्ञान; 5) डायकोकम गहू उत्पादन तंत्रज्ञान; 6) दर्जेदार गहू बियाणे उत्पादन तंत्रज्ञान; 7) Improved technologies of wheat production (Hindi, Marathi); 8) ARI 516 grape variety (English, Marathi, Hindi)

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- Vigneshwaran, A, Wadmare N and Karthick B. 2022. A new species of *Hippodonta* Lange-Bertalot, Metzeltin & Witkowski (Bacillariophyceae, Naviculales) from the Western Ghats, India. *Phytotaxa*, 558 (2): 219-228. (Impact Factor =1.050)
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Wijayawardene NN, Phillips AJL, Pereira DS, Dai DQ, Aptroot A, Monteiro JS, Druzhinina IS, Cai F, Fan X, Selbmann L, Coleine C, Castañeda-Ruiz RF, Kukwa M, Flakus A, Fiuza PO, Kirk PM, K. C. Rajeshkumar, et al. (2022) Forecasting the number of species of asexually reproducing fungi (Ascomycota and Basidiomycota). Fungal Diversity. <https://doi.org/10.1007/s13225-022-00500-5>

Yadav S, Verma SK, Singh R, Singh VK, Chaurasia B, Singh PN and Kumar S. 2022. *Neokamalomyces indicus* gen. nov., sp. nov. (Mycosphaerellaceae)-a Septoria-like genus from India. Phytotaxa, 571(2):141-168. (Impact Factor = 1.050)

Yogeshwaran M, Radhakrishnan C, Dwivedi A, Kocielek JP and Karthick B. 2022. *Humidophila manipurensis* sp. nov. and the first record of *Humidophila bigibba* (Hustedt) Lowe, Kocielek, Johansen, Van de Vijver, Lange-Bertalot et Kopalovi from Northeast India. Fottea, 22(2):162-170. (Impact Factor =2.429)

Visits abroad

Navathe S. International Maize and Wheat Improvement Center (CIMMYT), Texcoco, Mexico, 14 August-22 December 2022

Patra C. Nagaoka University of Technology, Nagaoka, Japan, 6 May-7 June 2022

Ratnaparkhi A. EMBO Molecular and Developmental Biology Workshop on Drosophila, Kolymbari, Crete, Greece, 19-25 June 2022

Participation in Conferences/ Workshops/ Meetings, etc.

Biodiversity – Plant & Diatoms

Vijayan S and Datar MN. Poor in Species, Rich in Endemics: A Study of Vertical Cliffs from the Northern Western Ghats, India.

Shigwan B and Datar MN. Informal community conservation against formal protected area network in conserving diversity: insights from forests of the northern Western Ghats, India.

XXXII Annual conference of Indian Association for Angiosperm Taxonomy and National Symposium, Dharwad, November 2022

Pansare S, Datar M, Kulkarni P. *In vitro* regeneration of *Crinum* species for conservation, optimization and establishment of bulb culture. National Conference, Emerging Trends in Plant Sciences Research with Special Emphasis on Medicinal Plants, SPPU, Pune, 14-16 March 2023

Sukhramani G. 31st IAAT conference

Maurya S and Sukhramani G. Virtual Conference, GAP-Asia: Genomes of Animals & Plants, 20 April 2022

XXVIII Indian Colloquium on Microplaeontology and Stratigraphy, SPPU, Pune

Pardhi S, Kokila T and Karthick B. Diatoms (Bacillariophyta) of the World's Higher Aquatic Environment, Ladhakh, Himalayas

Radhakrishnan C and Karthick B. Aerophilic diatoms as ecological indicators in Eastern Himalaya hotspot, India

Biodiversity – Fungi & Lichens

- Gaikwad S, Sutar R, Mapari S, Khare R, Behera B. 2022. Antimicrobial Potential of Lichen Compounds; Evaluation of Antioxidant Activity of Lichen Metabolites from Western Himalaya. International Conference on Multidisciplinary Approaches in Lichenology, Indian Lichenological Society and CSIR-NBRI, Lucknow, 28-30 September 2022
- Singh PN. Lead lecture, Platinum Jubilee Conference, Plant and Soil Health Management: Issues and Innovations, University of Mysore, Mysuru, 2-4 February 2023; Glimpses of Fungi: Classification, Taxonomic Studies & Their Potential Significance, Rajiv Gandhi University. Itanagar
- Singh SK. Keynote address, UGC DRS SAP II and National Seminar, Biodiversity and Biomolecules (NSBB 2022), Vidyasagar University, Midnapore, 21-22 December 2022
- Mapari S, Gaikwad S, Sutar R, Khare R, Behera B. Anticancer potential of selected Himalayan macrolichen derived secondary compounds. International Conference on Multidisciplinary Approaches in Lichenology, Indian Lichenological Society and CSIR-NBRI, Lucknow, 28-30 September 2022. Ajay Singh Award for the Best Poster presentation to Sachin Mapari
- Mapari S, Gaikwad S, Sutar R, Khare R, Behera B. Investigation on antimicrobial activities exhibited by lichen extracts and their metabolites; Studies on selected macro-lichens and their bioactive constituents for its use as pharmaceutical supplements. National Conference, Emerging Trends in Plant Science Research with Special Emphasis on Medicinal Plants and Workshop on Medicinal Plants, SPPU, Pune, 14-16 March 2023

Biodiversity - Palaeobiology

- Kaushik T. 108th Indian Science Congress, RTM Nagpur University, Nagpur, 3–7 January 2023; Environmental Geosciences and Sustainable Development (online), School of Environmental and Earth Sciences, Kaviyatri Bahinabai Chaudhari North Maharashtra University, Jalgaon, 20 March 2023; IISER-Pune, 25 August 2022; Fossil Day Celebrations, Palaeontological Society of India-Pune Chapter and IISER, Pune, 15 October 2022; Series of lectures in the Skill Development Program. Department of Geology, Fergusson College, Pune, 6–9 December 2022
- Rajguru M, Thirumalai M, Kaushik T. 2022. Combined morphological and ribosomal DNA based molecular taxonomy of extant benthic foraminifera from India. XXVIII Indian Colloquium of Micropaleontology and Stratigraphy. Department of Environmental Science, SPPU, Pune, 4–6 May 2022
- Rajguru M, Anilkumar N, Mohan R and Kaushik T. 2022. Environmental sequencing offers reasonable assessments of picoeukaryotes diversity and distribution across the meridional transect of the Indian sector of the Southern Ocean; Exploration of cryptic genetic diversity in *N. pachyderma* from the Indian sector of the Southern Ocean using integrative taxonomic approaches. 10th SCAR Open Science Conference, NCPOR, Goa, 1–10 August 2022

Bioenergy

- Dagar SS. Biological pretreatment using anaerobic microbes (online). College of Agricultural Engineering & Technology, CCS HAU, Hisar; Lignocellulose degradation and biofuel production. SPPU, Pune; Discovering anaerobic fungi: From non-beings to the worthy ones. National Seminar, Recent Trends in Biology, SPPU
- Kshirsagar P. Chromatography: An analytical Technique. Sinhgad College of Science, Pune, 1 December 2022

Developmental Biology

Indian Zebrafish Investigators Meeting, IISER, Pune, 21-23 September 2022

Ayachit M. Autophagy-related-gene 1 regulates mitochondrial dynamics during *Drosophila* oogenesis. Mitochondria and Metabolism Meeting, IISER, Pune, 13-15 February 2023

Rayrikar AY. Ccn2a-FGFR1-SHH signaling is necessary for intervertebral disc homeostasis and regeneration in adult zebrafish. 2nd prize

Joshi B. Celsr1b is essential for neuronal development in zebrafish

Chakraborty G. Evaluation of the toxicological effects of Tributyl Phosphate and its metabolites in zebrafish embryogenesis

Londhe R. Hydra cultivation and regeneration. Lecture and demonstration, BSc Biotechnology, Nowrosjee Wadia College, Pune, 7 May 2022; Sinhgad College of Science, Pune, 19 May 2022

Patra C. National Conference, Unravelling Applications of Alternative Experimental Models in Biological Research 2022, Bishop Heber College, Tiruchirappalli; 9th International Congress, Society for Ethnopharmacology 2022, JSS Academy of Higher Education and Research, Mysuru, Karnataka; Zebrafish in regenerative Biology. Mumbai-Pune Networking Workshop, Alibaug, 11-12 March 2023; Zebrafish a model organism in Regenerative Biology 2023, TIFR Mumbai; Faculty Development Program 2022, School of Pharmaceutical Science & Technology, JIS University, Kolkata; Ccn2a in heart regeneration, Nagaoka University of Technology, Nagaoka, Japan

Ratnaparkhi A. Mahabaleshwar Seminars: Mitochondria and Metabolism, 13-15 February 2023, IISER, Pune; Mumbai-Pune Networking Workshop, Alibaug, 11-12 March 2023; Seminars - Ruia College, Mumbai, 20 July 2022; Sophia College, Mumbai, 22 July 2022; TIFR, Mumbai, 21 July 2022; Conference, 19-21 December 2022, Kasturba Medical College, Manipal; No-Garland Neuroscience Meeting, IISER, Pune, 2-5 February 2023; SERB Karyashala Molecular Biology Workshop for under-represented Groups in Academia, IISER, Pune, 25-31 January 2023; Workshop, Zebrafish in Biomedical Research, ARI, Pune, 20-24 March 2023

Shravage B. Mitochondria and Metabolism meeting, IISER, Pune 13-15 February 2023; Mini-Symposium, Latest in Autophagy and Lysosome Biology, CSIR-IGIB, 12 January 2023; India Investigator Network Online Talk Series, 6 April 2022–30 March 2023; Workshop, Zebrafish in Biomedical Research, ARI, Pune and IISER, Pune, 20-24 March 2023; Autophagy and germline stem cells, Sophia College Retreat, Kune Mission, Khandala, 29-30 July 2022; Science Museum Webinar, ISBD for Schools and Colleges of the North-Eastern, 7 July 2022

Indian Zebrafish Investigators Meeting, IISER, Pune, 21-23 September 2022

Bhakta S. Deciphering the role of Fhod3 and Tmod1 in heart development.

Punde A. Ccn2a induces heart regeneration by inducing macrophage infiltration in adult zebrafish

Wagh G. Integrin $\alpha 8$ is required for epicardial cell movement in zebrafish (*Danio rerio*)

Katagade V. GPCR signalling, mitochondrial dynamics and glial morphogenesis. Mahabaleshwar Seminars: Mitochondria and Metabolism, IISER, Pune, 13-15 February 2023

Genetics & Plant Breeding

Baviskar V. 108th Indian Science Congress 2023, RTM Nagpur University, Nagpur, 3-7 January 2023; Workshop, Agri-preneurship Development in Seed Sector for Sustainability of Agriculture and Rural Economy, ICAR-IWBR, Karnal, 1-10 February 2023

- Jaybhay SA. Annual Group Meeting of AICRP on Soybean, SOPA, Indore, 17-18 May 2022
- Jaybhay SA, Idhol BD. Soybean Germplasm Day, UAS, Bengaluru, 23 April 2022
- Jaybhay SA, Suresha PG. Review meeting for soybean research programme 2022 (online), IISR, Indore, 3 August 2022; International Conference on Legume Genomics and Genetics (online) 2022, ICRISAT, Hyderabad, 8 November 2022; Meeting, Soybean rust resistance breeding, UAS, Dharwad, 18 January 2023; Meeting (online) on breeder seed of soybean and groundnut, ICAR IISR, Mau, 16 February 2023; Quinquennial Review Team (QRT) Meeting, AICRP Soybean, UAS, Dharwad, 23 February 2023
- Oak M. Nutritional security: Research and recommendations. AFARM, Pune, 17 October 2022
- Tetali S. Meeting, Rajya Draksha Bagaitdar Sangh, Pune, 20 July 2022; Online Meeting AICRP-F, 11 May 2022; Grape Growers Conference 2022, Maharashtra Rajya Draksha Bagaitdar Sangh (MRDBS), Pune, 28-30 August 2022; Meeting, MRDBS, NIASM, Baramati, 10 November 2022; Farmers Mela, Phaltan, 10 November 2022
- Yashavanthakumar KJ, Baviskar V. 61st All India Wheat and Barley Research Workers' Meet, RVSKVV, Gwalior, 29-31 August 2022; Training, BISA-CIMMYT, Ludhiana, 3-4 November 2022
- Yashavanthakumar KJ, Navathe S. Training, BISA-CIMMYT & ICAR-NBPGR, 28-31 March 2023; Monitoring Team, ICAR-IIWBR Zonal monitoring of Peninsular Zone, 11-14 February 2023
- International Conference on Current Trends and Future Prospects of Plant Biology & 14th Plant Sciences Colloquium, University of Hyderabad, 23-25 February 2023
- Chavan S, Tetali S, Patil R. 2023. Characterization of seedlessness in interspecific grape hybrid ARI 516
- Methe P, Oak M. HMW-glutenin subunit mutants and end-use quality of wheat. 1st prize
- Kawade S, Oak M. Effect of nitrogen and sulfur application on wheat yield and quality
- Venkatesan S, Vikhe P, Patil R, Oak M, Tamhankar S. EMS-induced mutations in Gibberellin biosynthetic pathway for wheat improvement and their detection by TILLING.

Nanobioscience

- Gajbhiye V. Triptorelin-conjugated PAMAM dendrimers efficiently down regulate MCL-1 gene in vitro and in vivo for the treatment of breast and prostate cancer. 21st International Symposium of Controlled Release Society Indian Chapter, NMIMS Campus, Mumbai, 25.2.2023. Second best poster award
- Ghormade V. Applications of biopolymeric nanoparticles for RNAi and biopesticide delivery for sustainable agriculture. International e-conference on Biopolymers, Asian Polymer Association and Indian Chitin Chitosan Society, New Delhi, 14-16 July 2022; Multiplexed lateral flow assay for rapid detection of mycotoxins to ensure food safety. National Conference on Fungal Diversity for sustainable future (Hybrid Mode) and 48th Annual Meeting of Mycological Society of India, Bilaspur, 28-30 November 2022
- Gokul Patil, Rutuja Pawar and Vandana Ghormade. 2022. An effective chitosan hydrogel composite containing silica nanoparticles and aluminium chloride for rapid hemorrhage control. International e-conference on Biopolymers, New Delhi, 14-16 July 2022. Best Poster Award
- Rajwade JM. Nanotechnologies in point-of-care diagnostics. Abeda Inamdar College, 20 August 2022; Nanobiotechnology with reference to use of metals and their formulations. AISSMS' College of Pharmacy, Pune, 28 December 2022; Rapid diagnostics for viral diseases. Online Refresher Program, SPPU, Pune, 28 January 2023; Rapid methods for diagnosing viral diseases. DY Patil Arts, Commerce and Science College, Pimpri, Pune, 25 February 2023

Awards/ Appreciation/ Appointments on academic and professional bodies

Jaybhay SA. Adarsh Krishi Sevak Krishi Shastradnya Award of the Krushi Sevak Agricultural Magazine, for contribution to Agricultural Extension and Technology Transfer and Research, Raver, Jalgaon, 5 February 2023

Methe P. DST AWSAR award 2023 for PhD Scholars for the story नरम गेहूँ, स्वादिष्ट बिस्कुट: स्वस्थ भारत

Oak MD, Jaybhay SA, Philips V and Taware SP. ICAR Certificate of Appreciation for development of three soybean varieties and one soybean agronomic technology, 52nd Annual Group Meeting of AICRP on Soybean, Indore, 17-18 May 2022

Rahalkar M. Member, Technical Expert Committee, Energy Bioscience, Environmental & Forest Biotechnology, DBT, 2022-2025; Nav Durga Award of the Loksatta-Indian Express Group, 10 October 2022

Ratnaparkhi A. EMBO Travel Grant to attend Molecular and Developmental Biology Workshop on Drosophila, Kolymbari, Crete, Greece, 19-25 June 2022

Singh PN. Second prize, National Competition of Fungal Photography 2022, Association of Fungal Biologists and SIES College of Arts, Science and Commerce, Mumbai, 2 October 2022

Singh SK. Session Chairman, National Conference, Emerging Trends in Plant Science Research with Special Emphasis on Medicinal Plants, SPPU, Pune, 14-16 March 2023

Tetali S. RAC member, Maharashtra Rajya Draksh Bagaitdar Sangh

Yashavanthakumar KJ. Zonal co-ordinator, Peninsular Zone, ICAR-IIWBR, Karnal

PhD degree award

Student, Subject	Thesis	Guide, Co-Guide
Ashtekar ND, Botany	Studies on taxonomic complexities of Indian <i>Penicillium</i> species following polyphasic taxonomic concept	Rajeshkumar KC
Avchar R, Biotechnology	Exploration of diversity, taxonomy, phylogeny and biotechnological potential of thermotolerant and thermophilic yeasts from diverse habitats	Baghela A
Chavan AM, Botany	Study of the diverse semi-dwarfing genes in durum wheat	Tamhankar SA
Jamalpure S, Microbiology	Development of point of care diagnostics for detection of viral pathogens affecting shrimp and prawns	Rajwade JM
Kapse NG, Microbiology	Influence of microbial metabolism and reservoir properties on enhanced oil recovery: Insights from simulated laboratory studies	Dhakephalkar PK
Khatri K, Microbiology	Exploration of diverse methanotrophs for taxonomic novelty and biotechnological potential	Rahalkar MC
Kulkarni N, Biotechnology	Studies on surface functionalized Lanthanum Strontium Manganese Oxide nanoparticles mediated hyperthermia for the treatment of breast cancer	Jadhav SH
Pandey S, Biotechnology	Synthesis of multicolour quantum efficient fluorescent nanocrystals using microreactor for the application in bioimaging	Bodas DS
Rahi S, Biotechnology	Rapid detection of mycotoxins for ensuring food safety	Ghormade V
Rana S, Biotechnology	Studies on <i>Fusarium</i> spp. for Beauvericin Production and its applications	Singh SK

Student, Subject	Thesis	Guide, Co-Guide
Rayrikar A, Zoology	Role of connective tissue growth factor in vertebrate development using Zebrafish (<i>Danio rerio</i>) as a model organism	Patra C
Tiwari S, Biotechnology	Diversity, Taxonomy, Phylogeny and Biotechnological potential of Yeasts associated with wood-feeding termites of the Western Ghats	Behera BC

Supervision of PhD students

Guide, Co-Guide	Student, Subject	Thesis
Biodiversity – Plants & Diatoms		
Datar MN	Bokil S, Botany	Systematic studies on the subtribe <i>Ischaeminae</i> J. Presl (<i>Andropogoneae</i> - <i>Poaceae</i>) in India
	Smrithy V, Botany	Study of cliff dwelling vascular chasmophytes from Northern Western Ghats with special emphasis to desiccation tolerant species
	Shigwan B, Botany	Forests of Northern Western Ghats: Diversity, composition and effect of disturbance on tree vegetation
Karthick B	Thacker M, Botany	Diatoms as indicators of environmental and climatic change in the <i>Myristica</i> swamps of the Western Ghats
	Cheran R, Environmental Science	Aerophilic diatoms of Eastern Himalayas: Diversity and distribution across environmental gradients
	Neha Wadmare, Botany	Systematics and biogeography of the genus <i>Stauroneis</i> Ehrenberg (<i>Bacillariophyceae</i>) from the Indian Subcontinent
	Pardhi S, Botany	Diversity and distribution of the genus <i>Gomphonema</i> Ehrenberg in Western Ghats, India
Choudhary RK	Nayak P, Botany	An integrated morpho-molecular approach to analyse diatom assemblages for ecological assessment in Mula-Mutha River Basin
	Vigneshwaran A, Botany	Diatom diversity across the streams and rivers of the Western Ghats and its application in water quality monitoring
	Kadu M, Botany	Phytochemical standardization and pharmacological studies on selected <i>Haplanthodes</i> species
	Sukhramani G, Botany	Taxonomy, phylogeny, and historical biogeography of <i>Smilax</i> L. in India
	Sarawgi A, Botany	Systematic studies on the genus <i>Canscora</i> Lam. (<i>Gentianaceae</i>) in India
Biodiversity – Fungi & Lichens		
Rajeshkumar KC	Sruthi OP, Botany	Molecular systematics and reappraisal of lignicolous Ascomycota from the Western Ghats of India
	Ansil PA, Botany	Polyphasic taxonomy of lichen family <i>Graphidaceae</i> from the Western Ghats, India
	Jaybhay SA, Botany	Molecular characterization of phosphate solubilizing fungi and assessment of their effect on growth and yield of soybean
Singh PN, Singh SK	Pawar K, Microbiology	Studies on alkaliphilic fungi for alkaline protease production and its applications
	Maurya DK, Microbiology	Studies on diversity of endophytic actinomycetes from medicinal plants and their bioactivities

Guide, Co-Guide	Student, Subject	Thesis
Singh SK	Suthar M, Botany	Studies on melanin producing fungi and evaluation of its bioactive potential
	Kumawat S, Botany	Studies on secondary metabolites from selected Ophiocardycipitaceous and other entomogenous fungi from Western Ghats, India and evaluations of their bioactivities
	Lagashetti A, Biotechnology	Studies on fungal pigments and their application in dyeing textile fabrics
Behera BC	Gaikwad S, Botany	Studies on selected macro-lichens and their bioactive constituents for its use as pharmaceutical supplements
	Ruchira Sutar, Botany	Studies on antimicrobial, antioxidative, cardiovascular-protective and cytoprotective potential of selected macrolichens and their secondary compounds
	Mapari S, Botany	Studies on cytoprotective and anticancer potential of lichen compounds from selected Himalayan macro-lichens
	Sengar D, Biotechnology	Studies on reversal of drug resistance in ovarian cancer using nanoparticle-nucleotide complexes
Bioenergy		
Dagar SS	Deore K, Microbiology	Thermophilic methanogenic archaea from hot springs and oil reservoirs, and their application
	Gaikwad S, Microbiology	Bacteriophages for inhibition of sulfate reducing bacteria associated with oil reservoir souring
	Hivarkar S, Microbiology	Investigating diversity of thermophilic anaerobic bacteria from hot spring environments for utilization of agricultural biomass
	Bhujbal P, Microbiology	Development of a sustainable bioprocess for second-generation ethanol production using anaerobic microbes
Dhakephalkar PK	Deshpande P, Microbiology	Enhanced biomethanation of untreated rice straw using anaerobic fibrolytic fungi
	Yadav K, Microbiology	Studies on methanogens at extreme eco-physiological conditions: Implications for life on Mars
	Deshmukh K, Microbiology	Biohydrogen production from rice straw via dark fermentation route
	Pisu V, Microbiology	Deciphering the potential of anaerobic gut bacteria as next generation probiotics for improved health
Bioprospecting		
Kulkarni PP	Suryavanshi KR, Biotechnology	Understanding the role of metal ions in neurodegeneration and inflammation in Alzheimer's disease
	Shete PA, Biotechnology	Studies on inflammation associated with iron dyshomeostasis and its prevention
Srivastava PS	Gulawani SS, Biotechnology	A study of mechanism of action of natural products-based molecules in gynecological cancers
Developmental Biology		
Patra C	Joshi B, Biotechnology	Role of <i>celsr1</i> in morphogenesis using zebrafish as a model organism
	Wagh G, Biotechnology	Elucidation of the role of selected secreted molecules in zebrafish development

Guide, Co-Guide	Student, Subject	Thesis
	Punde A, Biotechnology	Role of matricellular protein in vascularization
Shravage B	Murmu N, Biotechnology	Determine the role of autophagy in germline stem cell ageing in <i>Drosophila</i>
	Nilangekar K, Biotechnology	Determine the role of autophagy in germline stem cell niche in <i>Drosophila</i>
	Selarka K, Biotechnology	Autophagy regulators in the female germline stem cell (GSC)-niche
	Kulkarni M, Biotechnology	Mitophagy regulators in the female germline stem cells in <i>Drosophila</i>
Genetics & Plant Breeding		
Oak MD	Methe PS, Biotechnology	Development of wheat genotype with good biscuit-making properties using marker-assisted selection and mutation breeding
	Kawade SS, Biochemistry	Gluten protein dynamics and wheat end-use quality
	Pawar PB, Biotechnology	Physiology and genetics of drought tolerance in diverse germplasm of spring wheat (<i>Triticum aestivum</i> L.)
Patil RM	Sonali M, Biotechnology	Agronomic, physiological and transcriptomic response of soybean to drought stress at reproductive stage
	Vikhe P, Biotechnology	Genetic studies on gibberellin-responsive dwarfing loci Rht14 and Rht18 and their deployment in wheat improvement
	Venkatesan S, Biotechnology	EMS-induced mutations for wheat improvement and their detection by TILLING
	Chavan S, Biotechnology	Investigation of genetic basis of seedlessness in grapes and its impact on biochemical composition in berries
	Ayachit M, Biotechnology	Role of Atg1 in mitochondrial dynamics during <i>Drosophila</i> development
Tetali SP	Bagwan JH, Botany	Elucidation of physiological mechanisms contributing to the resilience of wheat under restricted moisture
	Idhol BD, Botany	Genetic diversity, stability, heterosis and combining ability studies in vegetable soybean (<i>Glycine max</i> (L.) Merrill)
	Phalake SV, Botany	Evaluation of promising ARI grape hybrids and varieties for end-use and standardization of cultivation practices for hybrid ARI 516
Nanobioscience		
Rajwade JM	Padhye A, Biotechnology	Evaluation of zinc oxide nanoparticles in delaying the development of diabetic nephropathy
	Khairnar B, Biotechnology	Designing and synthesis of novel therapeutic beta sheet breaker peptides for Alzheimer's disease
	Madiwal V, Microbiology	Nanoscale surface modification of dental material for preventing implant related failures
	Kulkarni S, Microbiology	Oligonucleotide modified nanoparticles as probes for determining antibiotic resistance associated with point mutations in ESKAPE pathogens
Bodas DS	Suryavanshi P, Biotechnology	Development of ovarian cancer -co T cells perfused scaffold with emphasis on immunotherapy

Guide, Co-Guide	Student, Subject	Thesis
	Sathe T, Biotechnology	Design and development of polymer-lipid membrane for application in organ-on-a-chip
Ghormade V	Deepali, Biotechnology	Gene silencing in <i>Spodoptera litura</i> through nanocarrier delivered dsRNA
	Maheshwari G, Biotechnology	Aptamer based detection of downy and powdery mildew of grapes
	Singh S, Biotechnology	Nano-mediated detection of powdery mildew fungal pathogen in tomato
Gajbhiye V	Salve R, Biotechnology	Targeted co-delivery of siRNA for effective therapeutic outcome against metastatic ovarian cancer
	Shaikh A, Biotechnology	Oncogene repair using splice switching oligonucleotides-nanoparticle complex for the treatment of triple-negative breast cancer
	Patra S, Biotechnology	Development of Chikungunya virus antigen-loaded nanoparticles as a candidate vaccine
Karpe YA	Salunke P, Biotechnology	Exploring non-pathogenic protozoa as a eukaryotic platform for protein expression
	Nangare R, Biotechnology	Development of miRNA - attenuated and mRNA-based candidate vaccines against Chikungunya virus
Rahalkar M	Mohite J, Microbiology	Utilizing the potential of methane-oxidizing bacteria for methane mitigation and valorization
	Manvi S, Biotechnology	In-depth studies on methanotrophs from Indian rice fields focusing on their applications in plant growth promotion and methane mitigation in rice agriculture

Mentorship

Mentor	Post-doctoral Fellow	Fellowship
Dagar SS	Sengupta KK	SERB-NPDF
Shravage B	Pendharkar G	DST-TARE-PDF

DST KARYA Programme

Department of Science & Technology, Government of Rajasthan has been executing KARYA (Knowledge Augmentation through Research in Young Aspirants) programme, which provides a unique opportunity for basic science undergraduate and post-graduate students from Rajasthan to work on short-term research problems for eight weeks at premier institutions across the Nation. DST GOR shortlists the students and provides a fellowship for eight weeks along with travel fare. ARI Scientists Dr Sanjay K Singh, Dr Jyutika M Rajwade and Dr Prasad P Kulkarni accepted three students during May-June 2022.

Supervision of BSc, MSc Students

Seventy-five BSc, MSc students were trained at ARI.

राजभाषा

हिन्दी पखवाड़ा, 14-29 सितंबर 2022

हिन्दी पुस्तक प्रदर्शनी, शोध छात्र-छात्राओं द्वारा स्वयं के शोध कार्य का प्रस्तुतीकरण, निबंध और व्यंगचित्र प्रतियोगिता, वक्तृत्व, शुद्धलेखन एवं अनुवाद प्रतियोगिता इत्यादि का आयोजन हुआ।



निबंध लेखन प्रतियोगिता



वक्तृत्व प्रतियोगिता



शुद्धलेखन प्रतियोगिता



मुख्य अतिथि डॉ. हिमांशु शेखर,
वैज्ञानिक-जी, डीआरडीओ



प्रमाणपत्र प्राप्त करते प्रतिभागी



हिन्दी कार्यशालाओं का आयोजन



डॉ. रितेश कुमार चौधरी, वैज्ञानिक-ई,
एआरआई, 27 सितंबर 2022



श्री. राजेंद्र प्रसाद वर्मा, सहायक निदेशक, हिन्दी शिक्षण योजना, पुणे,
8 दिसम्बर 2022



डॉ. मंदार दातार, वैज्ञानिक-डी, एआरआई, 17 मार्च 2023

द्वितीय अखिल भारतीय राजभाषा सम्मेलन, सूरत, 14-15 सितंबर 2022

संस्थान के 5 अधिकारी/वैज्ञानिक सम्मिलित हुए।



भारत के माननीय गृह मंत्री श्री अमित शाह



संस्थान के वैज्ञानिक एवं अधिकारीगण

संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा निरीक्षण, 18 जनवरी 2023

संसदीय निरीक्षण में संस्थान का प्रदर्शन संतोषजनक रहा।



समिति के माननीय सदस्यगण



संस्थान के अधिकारीगण



संसदीय राजभाषा समिति के माननीय सदस्यगण एवं संस्थान के अधिकारीगण

Events/ Outreach/ Science Popularisation

National Technology Day, 11 May 2022

Online Lecture: Atmanirbhar Bharat through technology route

Dr Pradeep Kumar Srivastava

Executive Director

Technology Information Forecasting and Assessment Council, New Delhi

Indian Zebrafish Investigators Conference, September 2022

Fossil Festival, 10-11 October 2022

It was organized as a part of Earth Science Week (10-14 October 2022). One hundred and twenty students from the Chandrakant Darode Madhyamik Vidyalay, Shivaji Nagar, Pune (10.10.22) and Aditya English Medium School, Baner, Pune (11.10.22) visited the MACS-ARI Fossil Museum and Repository. A fossil flyer series was published on ARI social media platforms in Hindi, Marathi, and English.

Vigilance awareness week, 31 October-6 November 2022

विषय: भ्रष्टाचार मुक्त भारत – विकसित भारत

Theme: Corruption-free India for a developed Nation

Rashtriya Ekta Diwas, 31 October 2022

Integrity pledge and Rashtriya Ekta Diwas Pledge

Lecture, 4 November 2022

Preventive Vigilance, Dr Virendra Gajbhiye, Vigilance Officer, ARI

Founder's Day Function & Platinum Jubilee Celebration, 18 November 2022



Lectures were delivered by Dr V Premnath, Director, Venture Centre, Pune, Dr Shekhar Mande, Former Director-General, Council of Scientific and Industrial Research, and Dr Anil Kakodkar, President, MACS-ARI. Silver medals were presented to ARI staff Dr PK Dhakephalkar, Dr RJ Waghole, Dr BC Behera, Mr HN Mate, Mr BN Waghmare, for completing twenty-five years of service. An agreement was signed with GPS Renewables, Bengaluru for a project on biomethanation. A cultural programme was organized, wherein staff and students of ARI performed.

Constitution Day, 26 November 2022

Lecture, 25 November 2022

Democracy and the Constitution of India

Dr Shailendra Kharat

Assistant Professor, Department of Political Science

Dr Ambedkar Samajvidnyan Bhavan, Savitribai Phule Pune University, Pune

Taxonomy of Anamorphic Ascomycetes, 16-18 December 2022

Hands-on training was imparted to MSc, PhD students and Teachers of Rajiv Gandhi University, Arunachal Pradesh.

India International Science Festival, 21-24 January 2023



Agharkar Research Institute and Vijnana Bharati jointly organised an outreach activity for school students as a primer to the 8th India International Science Festival, Bhopal. The theme was 'Marching towards Amrit Kaal with Science Technology and Innovation'. Dr Shekhar Mande, National President, Vijnana Bharati, Dr Manasi Malgaonkar, Secretary, Western Maharashtra Chapter of Vijnana Bharati graced the occasion. ARI scientists Dr Sujata Tetali and Dr Mandar Datar spoke on "Agriculture Science" and "History of Tea and Coffee", respectively. Students of Chandrakant Darode High School interacted with the experts. Dr Virendra Gajbhiye, Dr Ritesh Choudhary, Dr Sudhir Navathe, Dr Soham Pore, Mr Pranav Kshirsagar, Mr M Kamal, Ms Monali Kadu, Ms Sakshi Prakash represented ARI at the IISF, Bhopal.

National Science Day



Open House at ARI, 28 February 2023



Exhibition at Giant Metrewave Radio Telescope, Khodad, 28 February-1 March 2023 Smt. Namrata Gaikwad, Dr Bharati Sharma, Dr PG Gamare, Dr Vikram Lanjekar, Dr Ashwini Misar, Smt. Rohini Londhe, Shri. Shrikant Khairnar, Shri. Vitthal Gite, and Smt. Rupali Bambe explained the science exhibits.



Excellent chapati wheat variety MACS 6478 was demonstrated in comparison to local/ private varieties Lok 1, Gold 23 and Ajit 102 to farmers at the farm of Shri. Shivaji Mahadev Sorte. The programme was held in collaboration with Maharashtra State Seed Corporation Ltd. (MAHABEEJ) and State Department of Agriculture, Maharashtra on 28 February 2023.

Awareness Programme

An interactive programme on River Biodiversity and Pollution was organized by the Biodiversity (Plants & Diatoms) Group for nearly 250 students of students of Standards 6th, 7th, and 8th at Kendriya Vidyalaya (DIAT), Girinagar, Pune, and Sundarbai Marathe Vidyalaya, Kharadi, Pune.

Workshop on Zebrafish in Biomedical Research, March 2023

Educational visits to ARI

MSc Zoology, Goa University, 17 January 2023; MSc Microbiology, DY Patil University, Pune, 15 March 2023; BSc and MSc Microbiology and Biotechnology, Ramnarain Ruia Autonomous College, Mumbai, 7 February 2023; Vivekanand College, Chembur, Mumbai, 20 February 2023; Shivaji University, Kolhapur, 23 March 2023

Popular Articles

ARI scientists contributed popular articles in regional language publications, delivered radio talks and television interviews. They have used the Institute's social media platforms like Facebook, Twitter, Instagram and YouTube for reaching out to the beneficiaries.

Institutional Research Projects

Sr. No	Project Code	Project title	Investigator(s)	Associated staff & students
Biodiversity & Palaeobiology				
Plants & Diatoms				
1	BD-07	Diatom herbarium and culture collection	Karthick B	Wadmare N
2	BOT-15	Digitizing AHMA	Datar MN	Bokil S
3	BOT-17	Repository of crude drugs, and authentication services	Choudhary RK Kulkarni PP	Gaikwad NS Kadu M
Fungi				
4	MYC-02	National Facility – Repositories and service (NFCCI, AMH, and Identification Service)	Singh SK, Singh PN, Rajeshkumar KC	Maurya D, Lad S

Sr. No	Project Code	Project title	Investigator(s)	Associated staff & students
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Palaeobiology

5	BD-03	Modernization of fossil repository	Kaushik T	Rana H (up to 30.4.2022)
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Developmental Biology

6	ZOO-18	Identification and functional analysis of novel regulators during heart development and regeneration	C Patra	Bojja S
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SPONSORED PROJECTS

No.	Code	Title	Sponsor	Investigators
1	ARI/SP/001	All India Co-ordinated Research Project on Soybean (01.04.1968 onwards)	ICAR-IISR, Indore	Mr. S.A. Jaybhay
2	ARI/SP/002	"All India Co-ordinated Fruit Improvement Project" (01.10.1970 to 25.07.2022)	ICAR-AICRP (Fruits), Bengaluru	Dr. Sujata Tetali
3	ARI/SP/003	All India Co-ordinated Wheat Improvement Project" (01.04.1972 onwards)	ICAR-IIWBR, Karnal	Dr. Yashavanthakumar K. J.
4	ARI/SP/033	Production of Soybean Breeder Seeds of Annual Oil Seed Crops" (02.02.1988 onwards)	ICAR, New Delhi	Mr. S.A. Jaybhay
5	ARI/SP/034	Front-line Demonstrations of Annual Oil Seed Soybean" (21.02.1989 onwards)	ICAR-IISR, Indore	Mr. S.A. Jaybhay
6	ARI/SP/043	Front-line Demonstrations in Wheat" (01.04.1993 onwards)	ICAR-IIWBR, Karnal	Dr. V.S. Baviskar
7	ARI/SP/096	Wheat Breeder Seed Scheme" (1995 Onwards)	ICAR, New Delhi	Dr. Yashavanthakumar K. J.
8	ARI/SP/268	"Conservation of Selected endemic species of orchids of northern western ghats through ex-situ multiplication and reintroduction in wild" (03.05.17 to 02.05.2020) (Extended upto 31.03.2023)	TATA Power Corporation, Mumbai	Dr. M.N. Datar & Dr. A.S. Upadhye
9	ARI/SP/281	"Pyramiding of Rust Resistance Genes into High Grain Quality Wheat Lines Developed Through Marker-assisted Selection" (19.03.2018 to 18.03.2021) (Extended upto 18.12.2022)	DBT, New Delhi	Dr. M.D. Oak
10	ARI/SP/289	"Microbial Production of Hydrogen from Rice Straw" (Upto 06.03.2020) (Extended upto 09.05.2022)	KPIT Technologies Ltd., Pune	Dr. P.K. Dhakephalkar

No.	Code	Title	Sponsor	Investigators
11	ARI/SP/292	"Mapping genes/QTL for resistance to spot blotch and stem rust in durum wheat" (26.03.2019 to 25.03.2022) (Extended upto 25.09.2022)	SERB, New Delhi	Dr. R.M. Patil
12	ARI/SP/293	"High resolution QTL mapping for iron (Fe), zinc (Zn), grain protein, and phytate content and their introgression in high yielding wheat cultivars" (25.03.2019 to 24.03.2022) (Extended upto 17.09.2022)	DBT, New Delhi	Dr. M.D. Oak
13	ARI/SP/294	"Development, evaluation and molecular characterization of a seedless mutant in Grapes variety ARI 516" (30.03.2019 to 29.03.2022) (Extended upto 29.11.2022)	SERB, New Delhi	Dr. Sujata Tetali
14	ARI/SP/296	"Strengthening of seed infrastructure facilities at soybean breeder seed production centers' under the component Creation of seed infrastructure facilities of sub-mission on seed and planting material (SMSP)" (29.03.2019 to 05.09.2022)	ICAR-Indian Institute of Seed Science, Kushmaur	Mr. S.A. Jaybhay
15	ARI/SP/297	"Crispr- Cas9 based genome-editing approach to explore functions of Actin Binding Proteins in zebrafish: Unravelling F-actin regulation underlying behaviour of cells, tissues and animals" (02.05.2019 to 01.05.2022) (Extended upto 01.05.2023)	DBT, New Delhi	Dr. Chinmoy Patra
16	ARI/SP/298	"Exploration of cryptic genetic diversity in extant planktic foraminiferal morphospecies from the Southern Indian Ocean" (21.08.2019 to 20.08.2022) (Extended upto 31.03.2023)	National Centre for Polar and Ocean Research, Goa	Dr. Tushar Kaushik
17	ARI/SP/299	"Microchip for bacterial separation, DNA extraction and multiplexed detection using LAMP" (10.08.2019 to 09.08.2022)	ICMR, New Delhi	Dr. Dhananjay Bodas
18	ARI/SP/300	"Production, nano-delivery and validation of viral vaccine against nodavirus of fish" (24.09.2019 to 23.09.2022)	DBT, New Delhi	Dr. K.M. Paknikar Dr. J.M. Rajwade
19	ARI/SP/302	"Exploration of pro-regenerative secreted molecules and their mechanistic details in heart regeneration using zebrafish as a model organism" (01.10.2019 to 30.09.2024)	IndiaAlliance, DBT wellcome, Hyderabad	Dr. Chinmoy Patra
20	ARI/SP/303	"Understanding Enzymatic Mechanism of Fungal and Algal Growth on Paint Film" (15.11.2019 to 14.11.2020) (Extended upto 31.03.2023)	Asian Paints Limited, Navi Mumbai	Dr. S.K. Singh

No.	Code	Title	Sponsor	Investigators
21	ARI/SP/304	"Validating the performance of pharmaceutical aerosols by multi-scale simulations and analytical experiments" (11.11.2019 to 10.11.2022)	SERB, New Delhi	Dr. Bothiraja Chellampillai Dr. J.M. Rajwade
22	ARI/SP/305	"Augmentation of Cordycepin by Optimizing In vitro Culture Conditions of Caterpillar Fungi" (30.10.2019 to 29.10.2022) Extended upto 28.02.2023	SERB, New Delhi	Dr. Mahesh Yashwant Borde Dr. S.K. Singh
23	ARI/SP/306	"Exploring the role of Chemokine Receptor 3.1 (Cxcr3.1) in zebrafish heart regeneration using genetic and chemical tools" (31.12.2019 to 30.12.2021) (Extended upto 29.06.2022)	SERB, New Delhi	Dr. Himanshu
24	ARI/SP/307	"Revisiting the traditional biomethanation: Replacing cattle dung with fibrolytic anaerobic fungi and methanogenic archaea in light of multi-omics approaches" (09.01.2020 to 08.01.2022) (Extended upto 08.06.2022)	SERB, New Delhi	Dr. Kriti Sengupta
25	ARI/SP/309	"Understanding the regulation of Fog dependent GPCR signaling in the Drosophila CNS" (15.02.2020 to 14.02.2023) Extended upto 14.08.2023	SERB, New Delhi	Dr. Anuradha Ratnaparkhi
26	ARI/SP/310	"Characterisation of Genetic Resources: Germplasm Characterization and Trait Discovery in Wheat using Genomics Approaches and its Integration for Improving Climate Resilience, Productivity and Nutritional quality" "Sub Project-3:Evaluation of wheat germplasm for abiotic stresses" (29.02.2020 to 28.02.2025)	DBT, New Delhi	Dr. Yashavantha Kumar K.J
27	ARI/SP/313	"SRB-lytic Bacteriophage Mediated Inhibition of SRB Growth and/ or H2S Production at Pre-pilot scale : Prototype Development and Feasibility Assessment" (15.10.2020 to 14.10.2022) Extended upto 14.08.2023	OECT, New Delhi	Dr. P.K. Dhakephalkar
28	ARI/SP/314	"Studies on Selected Crinum species from Maharashtra for their Bioprospecting potential against Alzheimer's disease" (08.10.2020 to 07.10.2023)	RGSTC, Mumbai	Dr. P.P. Kulkarni
29	ARI/SP/315	"Evaluation of bioprospecting potential of naturally occurring flavonoids their derivatives and inclusion complexes with biodegradable macromolecules" (17.12.2020 to 16.12.2023) (Terminated on 28.02.2023)	DST, New Delhi	Dr. Garima Mishra

No.	Code	Title	Sponsor	Investigators
30	ARI/SP/316	"Unravelling the symbiosis of algal and fungal partners in lichen family Graphidaceae and Parmeliaceae from the Western Ghats through polyphasic taxonomic approach and ecological studies" (30.12.2020 to 29.12.2023)	SERB, New Delhi	Dr. Rajesh Kumar K.C.
31	ARI/SP/317	"Revisiting the taxonomy of the wild relatives of Sarsaparilla (Smilax L.) in India, developing super-barcodes, and understanding their diversification using phylogenomic tools" (30.12.2020 to 29.12.2023)	SERB, New Delhi	Dr. Ritesh Kumar Choudhary
32	ARI/SP/318	"Determine the mechanism of Autophagy-related gene-1 (Atg1) mediated regulation of mitochondrial dynamics during Drosophila oogenesis" (30.12.2020 to 29.12.2023)	SERB, New Delhi	Dr. B.V. Shravage
33	ARI/SP/319	"Fine mapping and marker-assisted breeding for alternative dwarfing genes Rht14 and Rht18 to develop semidwarf wheat genotype suitable for conservation agriculture" (01.01.2021 to 31.12.2023)	ICAR-National Agricultural Science Fund (NASF), New Delhi	Dr. R.M. Patil
34	ARI/SP/320	"Development of new approaches to live attenuated vaccine against Chikungunya virus" (31.12.2020 to 30.12.2023)	SERB, New Delhi	Dr. Yogesh Karpe
35	ARI/SP/321	"Analysis & characterization of probiotic properties of microbial cultures provided by HTBS" (01.02.2021 to 31.01.2024) "Heterologous gene expression and gene alterations for qualitative/ quantitative improvement of microbial enzyme catalysed biotransformation" (01.01.2023 to 31.12.2023)	Hi Tech BioSciences India Pvt. Ltd., Pune	Dr. P.K. Dhakephalkar
36	ARI/SP/322	"Exploring the role of mitophagy modulators in Parkinson's disease using Drosophila melanogaster" (21.01.2021 to 20.01.2023)	SERB, New Delhi	Dr. Jyotsna Asthana
37	ARI/SP/323	"Translation of proven rapid hemostatic dressing 'Hemo-halt gauze and gel' Prototypes from laboratory to a commercially viable product" (02.02.2021 to 01.02.2023)	DBT, New Delhi	Dr. Vandana Ghormade
38	ARI/SP/325	"Modulation of splicing via aptamer guided targeted nanoconstructs for oncogene RNA repair in triple-negative breast cancer" (25.08.2021 to 24.08.2024)	ICMR, New Delhi	Dr. Virendra Gajbhiye

No.	Code	Title	Sponsor	Investigators
39	ARI/SP/326	"Accelerating Genetic Gains in Maize and Wheat for Improved Livelihood (AGG)" (04.10.2021 to 03.10.2024)	Bill & Melinda Gates Foundation (BMGF) and the United Kingdom's Department for International Development (DFID)	Dr. YashavanthaKumar K.J Dr. Sudhir Navathe
40	ARI/SP/327	"Nano-mediated rapid detection and biocontrol of downy and powdery mildew of grapes and powdery mildew of tomatoes" (01.12.2021 to 30.11.2024)	DBT, New Delhi	Dr. Vandana Ghormade
41	ARI/SP/328	"Phylogeny, Diversification and Biogeography of Gomphonemoid Diatoms in the Western Ghats Biodiversity Hotspot, India: A model system for eukaryotic microbes" (20.12.2021 to 19.12.2024)	SERB, New Delhi	Dr. Karthick Balasubramanian
42	ARI/SP/329	"Development of functional GluN1/GluN2B-NMDAR antagonists for the treatment of Alzheimer's disease" (06.12.2021 to 05.12.2024)	SERB, New Delhi	Dr. Vinodkumar Ganpatrao Ugale Dr. P.P. Kulkarni
43	ARI/SP/330	"Methane Oxidation Potential and Associated Methanotrophic Bacterial Community of Tropical Moist Deciduous Forest and Grassland Soils of Terai Ecozone" (30.12.2021 to 29.12.2024)	SERB, New Delhi	Dr. Monali Rahalkar
44	ARI/SP/331	"Reassessment of the taxonomic relationship in the genus Ammonia (Foraminifera) using a combined morphological, ecological, and molecular systematic approaches from around India's coastline" (21.01.2022 to 20.01.2025)	SERB, New Delhi	Dr. Tushar Kaushik
45	ARI/SP/332	"Dissection of diversity and complex mechanism of Bipolaris sorokiniana infections in wheat using ToxA-Tsn1 interaction" (28.01.2022 to 27.01.2025)	SERB, New Delhi	Dr. R.M. Patil Dr. YashavanthaKumar K.J Dr. Sudhir Navathe
46	ARI/SP/333	"Anticancer activity of bioactive compounds from medicinal mushrooms of Western Ghats of Maharashtra" (13.12.2021 to 12.12.2024)	SERB, New Delhi	Dr. Hiralal Bhaskar Sonawane Dr. B.C. Behera
47	ARI/SP/334	"Assessment of potential of multifunctional microbial metabolites in developing 'smart' bandages for treatment of superficial wounds" (13.12.2021 to 12.12.2024)	SERB, New Delhi	Dr. Girish Bhikanrao Pendharkar Dr. J.M. Rajwade
48	ARI/SP/335	"Development of inhalation nanoformulation for bimodal delivery of antifungal cell wall and cell membrane inhibitors against Aspergillus lung infections for reduced systemic toxicity and effective treatment" (02.03.2022 to 01.03.2025)	ICMR, New Delhi	Dr. Vandana Ghormade

No.	Code	Title	Sponsor	Investigators
49	ARI/SP/336	"Candidate Chikungunya virus vaccine To test efficacy of E2 protein-loaded PLGA-PEG nanoparticle as a candidate vaccine in adult and aged mouse model" (01.04.2022 to 31.03.2025)	DST, New Delhi	Dr. Yogesh Karpe
50	ARI/SP/337	"Demonstration of ARI process for biomethanation of rice straw at 25 L scale and process improvement for enhanced biomethanation at higher solid loading rates at 10000 L scale" (24.05.2022 to 23.05.2023)	GPS Renewables Private Limited, Bangalore	Dr. P.K. Dhakephalkar Dr. Sumit Singh Dagar
51	ARI/SP/338	"Bioprospecting of lichens for assessing the environmental impact level due to quarrying and mining and taxonomic studies of lichens outcrops of the north Western Ghats" (11.10.2022 to 10.10.2025)	DST, New Delhi	Dr. Gargee Pandit
52	ARI/SP/340	"Culturomics and metagenomics based detection of microbes associated with microbial induced corrosion in subsea pipelines and evaluating the potential of different mitigation strategies" (22.10.2022 to 21.04.2024)	IEOT, ONGC, Panvel	Dr. P.K. Dhakephalkar
53	ARI/SP/341	"Application of methanotrophs in rice agriculture for methane mitigation and plant growth promotion". (09.11.2022 to 08.11.2025)	SERB, New Delhi	Dr. Monali Rahalkar
54	ARI/SP/342	"Breeding for high yielding elite soybean cultivars with climate/disease resilience and end-use quality traits by multi-parent hybridization and genomic-assisted selection". (01.09.2022 to 31.08.2027)	Regional Center for Biotechnology, Haryana	Dr. Abhinandan Surgonda Patil
55	ARI/SP/343	"Phytochemical and pharmacological Investigations of some Selected Unexplored Endemic Species of Apiaceae Family of Northern Western Ghats". (17.10.2022 to 16.10.2025)	SERB, New Delhi	Dr. Manojkumar Maroti Jadhao Dr. Ritesh Kumar Choudhary
56	ARI/SP/344	"Sustainable Utilization of Medicinal Plants Resources in Maharashtra" (27.12.2022 to 26.04.2023)	RGSTC, Mumbai	Dr. P.P. Kulkarni
57	ARI/SP/345	"Mass spectrometry based identification and characterization of mycolic acid derived lipid biomarkers and their application for development of a lateral flow POC device for tuberculosis diagnosis" (15.12.2022 to 14.12.2023)	ICMR, New Delhi	Dr. Vandana Ghormade

No.	Code	Title	Sponsor	Investigators
58	ARI/SP/346	"Understanding synergistic toxicity of Copper, Manganese, and Iron and its implications for neurological disorders" (20.01.2023 to 19.01.2026)	SERB, New Delhi	Dr. P.P. Kulkarni
59	ARI/SP/347	"Isolation and biomass production of selected diatoms as a live feed for shrimp in hatcheries and commercial farms" (30.03.2023 to 29.03.2024)	Amazing Biotech Pvt. Ltd., Tamil Nadu	Dr. Karthick Balasubramanian
60	ARI/SP/348	"Therapeutic investigations and isolation of bioactives from Haplanthodes species, the wild relatives of Kalmegh" (24.03.2023 to 23.03.2026)	RGSTC, Mumbai	Dr. Ritesh Kumar Choudhary

Personnel (As on 31.3.2023)

Director

Dr. P.K. Dhakephalkar

Dr. M.N. Datar, Scientist 'D'

M.H. Mhetre, Laboratory Assistant 'D'

N.S. Gaikwad, Laboratory Assistant 'C'

S. A. Pardhi, Laboratory Assistant 'B'

Biodiversity & Paleobiology Group

Biodiversity - Fungi

Dr. S.K. Singh, Scientist 'F'

Dr. Rajesh Kumar K.C., Scientist 'E'

Dr. P.N. Singh, Scientist 'D'

S. B. Gaikwad, Technical Officer 'A'

D.K. Mourya, Laboratory Assistant 'D'

S.S. Lad, Laboratory Assistant 'D'

Bioenergy Group

Dr. S.S. Dagar, Scientist 'E'

P.R. Kshirsagar, Scientist 'D'

Dr. V.B. Lanjekar, Technical Officer 'B'

S.K.Tiwari, Attendant 'A'

Biodiversity - Lichens

Dr. B.C. Behera, Scientist 'E'

Dr. B.O. Sharma, Technical Officer 'C'

Bioprospecting Group

Dr. P.P. Kulkarni, Scientist 'F'

Dr. P. Srivastava, Scientist 'D'

Dr. R.J. Waghole, Technical Officer 'A'

Dr. A.V. Misar, Technical Officer 'A'

Biodiversity - Palaeobiology

Dr. T. Kaushik, Scientist 'D'

Dr. P.G. Gamre, Technical Officer 'B'

S. S. Deshmukh, Laboratory Assistant 'E'

Developmental Biology Group

Dr. A. Ratnaparkhi, Scientist 'F'

Dr. C. Patra, Scientist 'E'

Dr. B.V. Shrivage, Scientist 'E'

M. B. Daware, Technical Officer 'C'

Biodiversity - Plants and Diatoms

Dr. Karthick B, Scientist 'E'

Dr. R.K. Chaudhary, Scientist 'E'

R. J. Londhe, Technical Officer 'B'
A. A. Nikam, Laboratory Assistant 'B'

Genetics & Plant Breeding Group

Dr. M. D. Oak, Scientist 'E'
Dr. R. M. Patil, Scientist 'D'
Dr. S. P. Tetali, Scientist 'D'
S. A. Jaybhay, Scientist 'D'
Dr. A. M. Chavan, Scientist 'D'
Dr. Y. Kumar K.J., Scientist 'C'
Dr. V. S. Baviskar, Scientist 'C'
Dr. S.P. Nawathe, Scientist 'C'
Dr. Suresha P G., Scientist 'B'
V. M. Khade, Technical Officer 'C'
V. D. Surve, Technical Officer 'C'
J. H. Bagwan, Technical Officer 'B'
B. D. Idhol, Technical Officer 'B'
S. V. Phalake, Technical Officer 'A'
V. D. Gite, Technical Officer 'A'
B. N. Waghmare, Technical Officer 'A'
A. A. Deshpande, Technical Officer 'A'
S. S. Khairnar, Technical Assistant 'B'
J.S. Sarode, Laboratory Assistant 'D'
D. H. Salunkhe, Laboratory Assistant 'D'
D. N. Bankar, Laboratory Assistant 'C'
S. R. Kachhi, Attendant 'C'
S. V. Ghadge, Attendant 'C'
D. L. Kolte, Attendant 'B'
G. S. Rajguru, Attendant 'B'
T. B. Dhurve, Attendant 'B'

Nanobioscience Group

Dr. J.M. Rajwade, Scientist 'F'
Dr. D.S. Bodas, Scientist 'E'
Dr. V. Ghormade, Scientist 'E'
Dr. V. Gajbhiye, Scientist 'E'
Dr. M.C. Rahalkar, Scientist 'E'
Dr. Y. A. Karpe, Scientist 'D'
R.G. Bambe, Technical Officer 'A'

A. Dwivedi, Technical Assistant 'B'
S.S. Waghmare, Laboratory Assistant 'C'

Animal House

Dr. S.H. Jadhav, Scientist 'D'
V.M. Gosavi, Attendant 'B'

Director Office

Dr. G. K. Wagh, Technical Officer 'D'
J. V. Deshpande, Private Secretary
Dr. P.P. Apte, Laboratory Assistant 'C'
S.P. Balsane, Attendant 'B'

Administration

A. Rahman, Administrative Officer
C. D. Nagpure, Officer 'B'
A.G. Dhongade, Senior Private Secretary
M. B. Tiwari, Officer 'A'
T.V. Kurhade, Assistant 'B'
D.V. Gawade, Assistant 'B'
R.B. Dhobale, Assistant 'A'
S.S. Shah, Assistant 'A'
R.S. Shinde, Assistant 'A'
R.M. Dhandhore, Assistant 'D'
A.B. Kusalkar, Driver
G.H. Agawan, Driver

Finance & Accounts

D.K. Sharma, Finance and Accounts Officer
A.D. Joshi, Officer 'B'
M. C. Ranjane, Officer 'A'
M.V. Patake, Assistant 'B'
S.S. Chavan, Assistant 'A'
R.G. Birwadkar, Assistant 'A'
S. R. Murade, Assistant 'A'
K.R. Sathe, Attendant 'C'

Garden

K. H. Sable, Technical Officer 'B'
S. N. Gajbhar, Attendant 'D'

Purchase

S.A. Tembe, Officer 'B'
S.S. Kalekar, Assistant 'B'
P. D. Gagare, Assistant 'A'
A.V. Wable, Assistant. 'A'
A.T. Salvi, Attendant. 'C'

Store

H.N. Mate, Officer 'B'
S.A. Shaikh, Assistant. 'A'
P. S. Velankar, Assistant. 'A'
R.M. Salunke, Attendant 'D'

Engineering (Civil)

P.V. Sawant, Technical Officer 'B'
D.S. Shinde, Technician 'B'

Engineering (IT)

M. Kharade, Technical Officer 'C'
Nayankumara D, Technician 'B'

Library & Information Centre

R.P. Janrao, Assistant Library & Information Officer
S.A. Deshmukh, Senior Library Assistant
R.R. Kale, Library & Information Assistant

Appointment

Dr. Suresha P G., Scientist 'B'

Compassionate Appointment

S.K. Tiwari, Attendant 'A'

Promotion Scientific Staff

Dr.P.P. Kulkarni, Scientist 'F'

Dr. Y.A. Karpe, Scientist 'E'
Dr. Rajesh Kumar K.C., Scientist 'E'
Dr. C. Patra, Scientist 'E'
Dr. S.S. Dagar, Scientist 'E'
Dr. B.V. Shrivage, Scientist 'E'
Dr. A. M. Chavan, Scientist 'D'
Dr. T. Kaushik, Scientist 'D'

Administrative & NTM Staff

M.C. Ranjane, Officer 'A'
M.V. Patake, Assistant 'B'
T.V. Kurhade, Assistant 'B'
D.V. Gawade, Assistant 'B'
R.M. Dhandore, Attendant 'D'
S.V. Ghadge, Attendant 'C'
T.B. Dhurve, Attendant 'B'

MACP

Dr. P. Srivastava, Scientist 'D'

Superannuation

M.T. Gurav, Attendant 'D', 30.04.2022
V.G. Tallu, Officer 'A', 31.07.2022
A.S. Kelkar, Technical Officer 'C' 30.09.2022
P.V. Gosavi, SPO, 31.12.2022

Reservation & Concessions

Details of posts filled during 2022-23

Group	SC	ST	OBC	EWS	General	Total
A	-	1	-	-	-	1
B	-	-	-	-	-	-
C	1	-	-	-	-	1
Total	1	1	-	-	-	2

Project Staff (As on 31.3.2023)

Fellows

Dr. Vinod Ubale, SERB-TARE
 Dr. Girish Pendharkar, SERB-TARE
 Dr. Abhinandan Patil, RAMLINGASWAMI RE-ENTRY

DST-INSPIRE Faculty

Dr. Pratibha

Project Scientist

Dr. Soham Pore

DST Women Scientist Scheme

Dr. Gargee Pandit

Research Associate

Sponsored Project

Dr. Sneha Maheshwari
 Dr. Deepa Shetty

ARI Project

Dr. Neelam Kapse

Project Associate

Sponsored Project

Sai Hivarkar
 Yogeshwaran Murugesan
 Shravani Kulkarni
 Pravin Pawar

Senior Research Fellows

Sponsored Project

Suhasini Venkatesan
 Roshani Kumari Mishra

Junior Research Fellows

Sponsored Projects

Vrushali Katagade

Amey Rayrikar
 Minal Ayachit
 Sakshi Prakash
 Shweta Kalke
 Kamal Mayattu
 Sourabh Gaikwad

Sponsored Projects

Shubha Manvi
 Aazam Shaikh
 Vaishnavi Dixit
 Harikrishnanan K.
 Shivanjali Pansare
 Kartik Rangari

ARI Projects

Kunal Yadav
 Monali Kadu

Research Students

Sponsored Project

Shivangni Singh

ARI Project

Sarang Bokil

Project Assistant

ARI Project

Satish Bojja

Sponsored Projects

Gaurav Chakraborty
 Pravin Pawar
 Vaidehi Pisu
 Prajkta Maragale
 Lokesh Mane
 Siddhi Chandras

Project Technical Assistant

ARI Project

Dhanashree Bomle

Field Assistant / Field Operator

Sponsored Project

Anil Jadhav

Field Worker

Sponsored Project

Yogesh Nilakhe

Own Fellowship

CSIR Senior Research Fellows

Ganesh Wagh

Neha Wadmare

Payal Deshpande

Pravinkumar Methé

Nikhil Ashtekar

Komal Suryavanshi

Malika Suthar

Ansil PA

CSIR Junior Research Fellows

Mrunmayee Kulkarni

Shruthi O P

Pratyasha Nayak

UGC Senior Research Fellows

Kadambari Pawar

Ruchira Sutar

Padmaja Shete

Rajesh Salve

Pooja Suryavanshi

Tanmayee Sathe

Kalyani Deshmukh

UGC Junior Research Fellows

Rohini Nangare

Surajit Patra

Deepali Choudhary

Prajakta Bhujbal

Swapnaja Gulawani

Aditi Sarawgi

Karan Selarka

Vasudha Dwivedi

Swarnav Bhakta

Kajal Pardhi

Asavari Kulkarni

Tabbasum Nadaf

DBT Junior Research Fellows

Rajkumar Samantha

Niladari Haldar

Snehal Kulkarni

Ashwini Punde

Siddhi Chavan

Sachin Mapari

DST-INSPIRE Junior Research Fellows

Aishwarya Padhye

G. Maheswari

Devyani Sengar

Gitika Sukhramani

ICMR Senior Research Fellows

Kiran Nilangekar

SARTHI Junior Research Fellows

Bhushan Shigwan

Jyoti Mohite

MAHAJYOTI Junior Research Fellows

Shweta Kumavat

Temporary Staff

Snehal Shinde, Project Administrative Assistant

Tejashri Bhandare, Project Administrative Assistant

Rupali Gurav, Project Administrative Assistant

Sukanya Sharma, Hindi Translator cum Typist

Rajani Gadekar, Hindi Typist

Aditya Bhujang, Hindi Typist

Audit Report 2022-23

Maharashtra Association for the Cultivation of Science

Independent Auditors Report

We have audited the accompanying financial statements of Maharashtra Association for the Cultivation of Science, Pune which comprise the Balance Sheet as at March 31, 2023, the Statement of Income and Expenditure, for the year then ended, and a summary of the significant accounting policies and other explanatory information.

In our opinion and to the best of our information and according to the explanations given to us, subject to the "Emphasis of Matter" parain the report the aforesaid financial statements give the information required by The Maharashtra Public Trust Act, 1950 (earlier known as "The Bombay Trust Act, 1950") in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India: -

- i. In the case of Balance Sheet, of the state of affairs of the Trust as at March 31, 2023;
- ii. In the case of Income & Expenditure Account, of the Surplus for the year ended on that date.

Basis for Opinion

We conducted our audit in accordance with Standards on Auditing (SAs). Our responsibilities under those Standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the entity in accordance with the ethical requirements that are relevant to our audit of the financial statements, and we have fulfilled our other responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion and no serious irregularity observed.

Management's Responsibility for the Financial Statements

The Trust's Management is responsible for the matters with respect to the preparation of financial statements that give a true and fair view of the financial position, financial performance of the Trust and in accordance with the accounting principles generally accepted in India.

This responsibility also includes maintenance of adequate accounting records in accordance with the provisions of the Act for safeguarding the assets of the Trust and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial statements based on our audit. We have taken into account the provisions of the Act, the accounting and auditing standards and matters which are required to be included in the audit report under the provisions of the Act and the Rules made there under.

An audit involves performing procedures to obtain audit evidence about the amounts and the disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal financial control relevant to the Trust's preparation of the financial statements, including evaluating the appropriateness of the accounting policies used and the reasonableness of the accounting estimates made by the Trust's Management, as well as evaluating the overall presentation of the financial statements.

Emphasis of Matter

We draw your attention to following matter.

1. Effective from 01.04.2022, the Trust has changed its method of computing depreciation on its Fixed Assets from Straight Line method (SLM) to the Written Down Value method (WDV) as per the rates specified in Income Tax Act, 1961. Based on Statement of Financial Accounting Standards the Trust determined that the change in depreciation method from Straight Line Value method to a Written Down Value Method is a change in accounting estimate affected by a change in accounting principle. This change in method of depreciation has been made with effect from the current year i.e. financial year 2022-23. Due to this changes, profit for the year has been shown less to the extent of Rs 4,408/-.

Subject to above, we report that:

1. We have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our Audit.
2. In our opinion, proper books of accounts as required by law have been kept by the institute so far as it appears from our examination of those books.
3. The Balance Sheet and Income and Expenditure Account dealt with by the report are in agreement with the books of accounts.

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

Nikhil Gugale
Partner
UDIN: 23177609BGTGQY658

Place: Pune
Date: 28/06/2023

**REPORT OF AN AUDITOR RELATING OF ACCOUNTS AUDITED
UNDER SUB SECTION(2) OF SECTION 33 & 34 AND RULE 19 OF
THE MAHARASHTRA PUBLIC TRUST ACT**

Name of the Public Trust: MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE
For year ending 31st March, 2023

Sr. No.	Particulars	Remarks
A	Whether accounts are maintained regularly and in accordance with the provisions of the Act and the rules.	YES
B	Whether receipts and disbursements are properly and correctly shown in the accounts.	YES
C	Whether the cash balance and vouchers in the custody of the manager or trustee on the date of audit were in agreement with the accounts.	YES
D	Whether all books, deeds, accounts, vouchers or other documents records required by the auditor were produced before him.	YES
E	Whether a register of movable and immovable properties is properly maintained, the changes therein are communicated from time to time to the regional office and the defects and inaccuracies mentioned in the previous audit report have been duly complied within.	YES
F	Whether the manager or trustee or any other person required by the auditor to appear before him did so and furnished the necessary information required by him.	YES
G	Whether any property or funds of the Trust were applied for any object or purpose other than the object or purpose of the Trust	NO
H	Whether tenders were invited for repairs or construction involving expenditure exceeding Rs. 5000/-	YES
I	Whether any money of the public trust has been invested contrary to the provisions Section 35	NO
J	Alienation, if any of the immovable property contrary to the provisions of Section 36 which have come to the notice of the auditor.	NO
K	All cases of irregular, illegal or improper expenditure or failure or omission to recover monies or other property belonging to the public trust or of loss or waste of money or other property thereof and whether such expenditure, failure, omission loss or waste was caused in consequence of breach of trust or misapplication or any other misconduct on the part of the trustees or any other person while in the management of the trust.	NO
L	Whether the minutes books of the proceedings of the meeting is maintained.	YES
M	Whether any of the trustees has any interest in the investment of the trust.	NO
N	Whether the irregularities pointed out by the auditors in the accounts of the previous year have been duly complied with by the trustees during the period of audit.	YES
O	Any special matter which the auditor may think fit or necessary to bring to the notice of the Deputy or Assistant Charity Commissioner	NO

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

Place: Pune
Date: 28/06/2023

Nikhil Gugale
Partner
UDIN: 23177609BGTGQZ4858

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE - 411 004.

BALANCE SHEET AS ON 31.03.2023

Amount - Rs.

FUNDS AND LIABILITIES	SCH.	CURRENT YEAR	PREVIOUS YEAR
CAPITAL ACCOUNTS	A	1,07,61,721	1,07,61,721
CURRENT LIABILITIES	B	30,62,319	34,48,427
INCOME & EXP.A/C (Sub Schedule 4)		1,91,62,006	1,83,12,950
TOTAL		3,29,86,046	3,25,23,098

PROPERTY AND ASSETS	SCH.	CURRENT YEAR	
FIXED ASSETS	C	91,93,858	92,03,662
INVESTMENTS	D	1,86,44,346	1,84,50,001
DEPOSITS & ADVANCES	E	32,34,290	35,42,874
CASH & BANK BALANCES	F	19,13,552	13,26,561
TOTAL		3,29,86,046	3,25,23,098

The above Balance Sheet to the best of our knowledge and belief contains a true account of the Funds, Liabilities and of the Property and Assets of the Association.

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

HON. F.& A.O.
M.A.C.S.

HON. Treasurer
M.A.C.S.

HON. Secretary
M.A.C.S.

Nikhil Gugale
Partner
UDIN: 23177609BGTGQY658

Place: Pune
Date: 28/06/2023

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE - 411 004

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED ON 31.03.2023

Amount - Rs.

EXPENDITURE	CURRENT YEAR	PREVIOUS YEAR	INCOME	CURRENT YEAR	PREVIOUS YEAR
Depreciation : Immovable Properties (By way of provision or adjustment)	8,157	2,965	Interest (Realised) On S.B. A/c	16,075	59,052
			On Investments	8,73,131	8,51,684
			On HDFC S.B. A/c	44,264	15,768
Establishment Expenses (As per Schedule H)	2,01,555	2,05,665	Income from other Sources (As per Schedule L)	2,16,000	4,51,492
Audit fees	-	-	Income tax refund received (Interest)	2,708	4,675
Depreciation : Furniture & Dead Stock	1,646	44,306			
Expenditure on the object of The Trust (As per Schedule I)	91,764	75,891			
Surplus carried over to Balance sheet	8,49,056	10,53,845			
TOTAL	11,52,178	13,82,671	TOTAL	11,52,178	13,82,671

We hereby certify that the above income and Expenditure Account is correct to the best of our knowledge and belief.

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

HON. F.& A.O.
M.A.C.S.

HON. Treasurer
M.A.C.S.

HON. Secretary
M.A.C.S.

Nikhil Gugale
Partner
UDIN: 23177609BGTGQY658

Place: Pune

Date: 28/06/2023

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE - 411 004

STATEMENT OF RECEIPTS & PAYMENTS FOR THE YEAR ENDED ON 31.03.2023

Amount - Rs.

RECEIPTS	SCH.	CURRENT YEAR	PREVIOUS YEAR	PAYMENTS	SCH.	CURRENT YEAR	PREVIOUS YEAR
Opening Balances	F	13,26,561	5,77,817	Establishment Expenses	H	2,00,230	2,05,370
Interest Received				Expenditure on Object of Trust	K	91,764	58,978
On Savings Bank A/c		60,339	74,820	Audit Fees & Creditors		-	85,915
Interest on Investments		5,79,260	7,93,338	Income tax refund paid share of ARI & Scheme		-	14,31,798
Encashment of Fixed Deposit		-	31,00,000	Legal Fees		-	-
Income tax refund received with interest		2,708	4,675	Professional fees		-	-
Donation Received				Fixed Deposit with Banks		-	31,00,000
Nisarg Sevak Sanstha		10,000	-	Indirect Receipt & Payment	J	6,04,933	6,67,35,000
Income from Other Sources	G	2,06,000	1,86,500	Closing Balances	F	19,13,552	13,26,561
Indirect Receipt & Payment	J	6,25,611	6,82,06,472				
TOTAL		28,10,479	7,29,43,622	TOTAL		28,10,479	7,29,43,622

We hereby certify that the aforesaid statement to be true and correct to the best of our knowledge and belief.

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

HON. F.& A.O.
M.A.C.S.

HON. Treasurer
M.A.C.S.

HON. Secretary
M.A.C.S.

Nikhil Gugale
Partner
UDIN: 23177609BGTGQY658

Place: Pune
Date: 28/06/2023

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE-411 004

Schedule "A" : Capital Account

Amount - Rs.

PARTICULARS	SUB-SCH	CURRENT YEAR	PREVIOUS YEAR
TRUST FUND OR CORPUS	1	1,03,77,874	1,03,77,874
OTHER EARMARKED FUNDS	2	3,83,847	3,83,847
TOTAL(RS.)		1,07,61,721	1,07,61,721

Schedule "B" : Current Liabilities

Amount - Rs.

PARTICULARS	SUB-SCH	CURRENT YEAR	PREVIOUS YEAR
OTHER LIABILITIES	3	30,62,319	34,48,427
TOTAL(RS.)		30,62,319	34,48,427

Schedule "C" : Fixed Assets

Amount - Rs.

PARTICULARS	SUB-SCH	CURRENT YEAR	PREVIOUS YEAR
LAND AND BUILDING	5	91,91,377	91,99,535
PLANT AND MACHINERY	5	2,481	4,127
TOTAL(RS.)		91,93,858	92,03,662

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE-411 004

Schedules to and forming part of Balance Sheet as on 31.03.2023

Schedule "D" : Investments

Amount - Rs.

Sr. No.	Name of the Company	PARTICULARS	Date of Investment	Date of Maturity	CURRENT YEAR	PREVIOUS YEAR
SHARES						
1	Central Potteries Ltd. Nagpur	Share of Rs. 25 each Certificate No.1343 bearing Sr. No. 29114 to 29126 13 ordinary Certificate No. 551 bearing Sr. No. 3717 to 3756 40 ordinary	21.01.1949 10.06.1940		Nil	1325
2	HINDUSTAN MOTORS LTD.	Shares of Rs. 10 each 50 ordinary Share certificate No.33932 bearing Sr. No. 4632651-4632700	-	-	500	500
FIXED DEPOSITS						
1	BANK OF MAHARASHTRA	60088467793 60088467534	30.12.2020 30.12.2020	31.12.2023 31.12.2023	3,00,000 3,00,000	3,00,000 3,00,000
2	INDIAN BANK	6019228988 6019228671 6056528884	03.03.2021 03.03.2021 31.07.2021	29.02.2024 29.02.2024 28.07.2024	10,32,625 10,32,625 2,00,000	10,32,625 10,32,625 2,00,000
4	BANK OF INDIA	50345110007246	24.11.2022	24.11.2024	21,51,778	19,56,108
5	HDFC	50300352429665 50300600778898 50300600781152 50300600779810 50300405767617 50300405767962 50300417029245 50300437838952 50300417031045	11.07.2022 04.03.2022 04.03.2022 04.03.2022 25.02.2022 25.02.2022 09.04.2022 13.06.2022 09.04.2022	12.07.2023 05.03.2024 05.03.2024 05.03.2024 26.02.2024 26.02.2024 10.04.2024 14.06.2024 10.04.2024	71,47,178 10,00,000 17,00,000 4,00,000 5,00,000 10,00,000 2,00,000 5,69,640 1,10,000	71,47,178 10,00,000 17,00,000 4,00,000 5,00,000 10,00,000 2,00,000 5,69,640 1,10,000
6	IDFC	10053500553	24.11.2022	07.04.2024	10,00,000	10,00,000
GRAND TOTAL					1,86,44,346	1,84,50,001

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE - 411 004

Schedule to and forming part of Balance Sheet as on 31.03.2023

Schedule "E" : Deposits & Advances

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
<u>DEPOSITS :</u>				
Telephone Deposit	10,000		10,000	
Deposit with Court	15,000	25,000	15,000	25,000
<u>ADVANCES :</u>				
Income Tax Deducted at Source	30,96,876	30,96,876	34,92,055	34,92,055
<u>Interest accrued on Investments</u>				
(Subject to confirmation from bank & other agencies)				
As per last Balance Sheet	25,819		2,41,055	
Less Realised during the year	25,819		4,15,558	
	-		(1,74,503)	
Accrued Interest during the year	1,12,414	1,12,414	2,00,322	25,819
TOTAL Rs.		32,34,290		35,42,874

Schedule "F" : Cash & Bank Balances

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
	OPENING BALANCE	CLOSING BALANCE	OPENING BALANCE	CLOSING BALANCE
<u>CASH IN HAND</u>	7,727	2,218	4,798	7,727
<u>BANK :-</u>				
With Bank of Maharashtra Erandwana Branch in Savings A/c No.9709	1,51,907	1,54,103	2,71,624	1,51,907
With Union Bank of India, F.C.Road Branch in S.B.A/c 48941261091951	3,98,182	4,10,495	3,00,850	3,98,182
With HDFC SAVING BK A/C NO.50100304122670	7,68,745	13,46,736	545	7,68,745
TOTAL (RS.)	13,26,561	19,13,552	5,77,817	13,26,561

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE - 411 004

Schedules to and forming part of Statement of Receipts & Payments and
Income & Expenditure account for the year ended on 31.03.2023

Schedule "G" : Income From Other Sources

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
	INCOME & EXP. ACCOUNT	RECEIPT & PAYMENT ACCOUNT	INCOME & EXP. ACCOUNT	RECEIPT & PAYMENT ACCOUNT
Fee for Home Gardening course	-	2,04,000		1,86,000
Claim received against loss due to flood	-	-		
Life Membership Fees		2,000	-	500
TOTAL (RS.)	-	2,06,000	-	1,86,500

Schedule "H" : Establishment Expenses

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
	INCOME & EXP. ACCOUNT	RECEIPT & PAYMENT ACCOUNT	INCOME & EXP. ACCOUNT	RECEIPT & PAYMENT ACCOUNT
Honorarium to Staff	1,92,894	1,92,894	1,79,046	1,79,046
Meeting Expenses	7,115	7,115	6,431	6,431
Shares written off	1,325	-	-	-
Printing & Stationery	92	92	295	-
Professional Fees	-	-	10,000	10,000
Advertisement charges	-	-	9,450	9,450
Bank charges	129	129	443	443
TOTAL (RS.)	2,01,555	2,00,230	2,05,665	2,05,370

Schedule "I": Expenditure on the Object of the Trust

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Expenditure out of Earmarked Donations		
Home Garden Course Expenses	91,764	75,891
TOTAL (RS.)	91,764	75,891

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE - 411 004

Schedules to and forming part of Receipts & Payments for the year ended on 31.03.2023

Schedule "J": Indirect Receipts & Payments

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
	RECEIPTS	PAYMENTS	RECEIPTS	PAYMENTS
ARI Account	-	-	6,55,00,000	6,55,00,000
Schemes Account	5,39,000	5,39,000	12,00,000	12,00,000
Advance to staff	60,000	60,000	22,087	35,000
Loans and advances	26,611	5,933	13,54,094	-
Current Liabilities	-	-	1,30,291	-
TOTAL (RS.)	6,25,611	6,04,933	6,82,06,472	6,67,35,000

Schedule "K": Expenditure on the Object of the Trust

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Expenditure out of Earmarked Donations		
Home Garden Expenses	91,764	53,978
A. D. Agate Award Expenses	-	2,500
Donation Expenses Prof. P.V.Sukhatme	-	2,500
TOTAL (RS.)	91,764	58,978

Schedule "L": Income From Other Sources

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Fee for Home Gardening Course	2,04,000	1,80,000
Donation	10,000	2,70,992
Life Membership Fees	2,000	500
TOTAL (RS.)	2,16,000	4,51,492

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE - 411 004

Schedules to and forming part of Balance Sheet as on 31.03.2023

Sub Schedule "1" Trust Fund or Corpus

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Trust/Corpus Fund	1,03,77,874	1,03,77,874
TOTAL(RS.)	1,03,77,874	1,03,77,874

Sub Schedule "2" Other Earmarked Funds

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Reserve Fund (Created vide resolution No. 16 dated 12.4.1984)	36,926	36,926
Museum Fund (As per Last Balance Sheet)	888	888
Prof. S.P. Agharkar Fund (As per Last Balance Sheet)	14,000	14,000
Prof. S.P. Agharkar Birth Centenary Fund (As per last Balance Sheet)	3,32,033	3,32,033
TOTAL (RS.)	3,83,847	3,83,847

Sub Schedule "3" Other Liabilities

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
TDS Payable	30,62,319	34,48,427
TOTAL (RS.)	30,62,319	34,48,427

Sub Schedule "4" Income & Expenditure Account

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
Opening Balance	1,83,12,950		1,73,19,105	
Surplus carried over to Balance sheet	8,49,056		9,93,845	
		1,91,62,006		1,83,12,950
TOTAL (RS.)		1,91,62,006		1,83,12,950

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE - 411 004

Schedule to and forming part of Balance Sheet as on 31.03.2023

Sub Schedule "5" : Immovable Properties

Amount - Rs.

Sr No	Assets	Gross block as at 01/04/22	Rate of Dep	Rate of Addition > 6 months	Addition < 6 months	Deletions during the year	Total WDV	Depreciation for current year	Net block as at 31/03/23	Net block as at 31/03/22
1	Land	91,18,520	0%	-	-	-	91,18,520	-	91,18,520	91,18,520
2	Building	81,015	10%	-	-	-	81,015	8,157	72,857	81,015
3	Plant and Machinery									
	Equipments	12	0%	-	-	-	12	-	12	12
	Publications	4,115	40%	-	-	-	4,115	1,646	2,469	4,115
	Total	92,03,662		-	-	-	92,03,662	9,803	91,93,858	92,03,662

Agharkar Research Institute of Maharashtra Association for the Cultivation of Science

Independent Auditor's Report

To,
The Director,

AGHARKAR RESEARCH INSTITUTE OF MAHARASHTRA ASSOCIATION FOR CULTIVATION OF SCIENCE

Opinion

We have audited the accompanying financial statements of Agharkar Research Institute of Maharashtra association for the Cultivation of Science, situated at Gopal Ganesh Agharkar Road, Pune which comprise the Balance Sheet as at March 31, 2023, the Statement of Income and Expenditure, for the year then ended, and a summary of the significant accounting policies and other explanatory information.

In our opinion and to the best of our information and according to the explanations given to us, subject to the "Emphasis of Matter" para in the report, the aforesaid financial statements give the information required by The Maharashtra Public Trust Act, 1950 (earlier known as "The Bombay Trust Act, 1950") in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India:-

- i. In the case of Balance Sheet, of the state of affairs of the Trust as at March 31, 2023;
- ii. In the case of Income & Expenditure Account, of the Surplus for the year ended on that date.

Basis for opinion

We conducted our audit in accordance with Standards on Auditing (SAs). Our responsibilities under those Standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the entity in accordance with the ethical requirements that are relevant to our audit of the financial statements, and we have fulfilled our other responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion and no serious irregularity observed.

Management's Responsibility for the Financial Statements

The Institute's Management is responsible for the matters with respect to the preparation of financial statements that give a true and fair view of the financial position, financial performance of the Trust and in accordance with the accounting principles generally accepted in India.

This responsibility also includes maintenance of adequate accounting records in accordance with the provisions of the Act for safeguarding the assets of the Trust and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial statements based on our audit. We have taken into account the provisions of the Act, the accounting and auditing standards and matters which are required to be included in the audit report under the provisions of the Act and the Rules made there under.

An audit involves performing procedures to obtain audit evidence about the amounts and the disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal financial control relevant to the Trust's preparation of the financial statements that give a true and fair view in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on whether the Trust has in place an adequate internal financial controls system over financial reporting and the operating effectiveness of such controls. An audit also includes evaluating the appropriateness of the accounting policies used and the reasonableness of the accounting estimates made by the Trust's Management, as well as evaluating the overall presentation of the financial statements.

Emphasis of Matter

We draw your attention to following matters.

1. Effective from 01.04.2022, the Trust has changed its method of computing depreciation on its Fixed Assets from Straight Line method (SLM) to the Written Down Value method (WDV) as per the rates specified in Income Tax Act, 1961. Based on Statement of Financial Accounting Standards the Trust determined that the change in depreciation method from Straight Line Value method to a Written Down Value Method is a change in accounting estimate affected by a change in accounting principle. This change in method of depreciation has been made with effect from the current year i.e. financial year 2022-23. Due to this changes, expenditure for the year has been shown less to the extent of Rs 1,90,66,650/-.
2. The Institute has not Earmarked investments to the extent of its Earmarked Fund.
3. Long outstanding balances are appearing under current liabilities, and no confirmations from parties were available for our verification.
4. Old unreconciled balances are appearing under Current Assets, Loans & Advances, and no confirmations from parties were available for our verification.
 - a) We have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our Audit.
 - b) In our opinion, proper books of accounts as required by law have been kept by the institute so far as it appears from our examination of those books.
 - c) The Balance Sheet, Income and Expenditure Account and the Receipts and Payments Account dealt with by the report are in agreement with the books of accounts.
 - d) In our opinion, the Balance sheet & Income & Expenditure Account dealt with by this report, are in compliance with the accounting standards prescribed by the Institute of Chartered Accountants of India except the Accounting Standards - 1 "Disclosure of Accounting Policies", Accounting Standards - 5 "Net Profit or Loss for the year, Prior Period items and changes in Accounting Policies".
 - e) There is no separate Reserves and Surplus account maintained by the institute. The balance of Income & Expenditure i.e Surplus/Deficit is transferred to Corpus/Capital Fund Schedule.

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

Place: Pune
Date: 28/06/2023

Nikhil Gugale
Partner
UDIN: 23177609BGTGRA6252

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Balance Sheet as on 31.03.2023

Amount - Rs.

PARTICULARS	SCH	CURRENT YEAR	PREVIOUS YEAR
CORPUS/CAPITAL FUND AND LIABILITIES:			
CAPITAL FUND	1	23,08,79,524	18,18,07,131
RESERVES AND SURPLUS	2	-	-
EARMARKED/ENDOWMENT FUNDS	3	18,95,83,890	19,21,22,480
SECURED LOANS AND BORROWINGS	4	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABILITIES	6	-	-
CURRENT LIABILITIES AND PROVISIONS	7	18,15,70,617	22,18,84,903
TOTAL		60,20,34,031	59,58,14,514
ASSETS:			
FIXED ASSETS	8	35,16,94,645	21,84,05,138
INVESTMENTS-FROM EARMARKED/ENDOWMENT FUNDS	9	10,04,50,831	9,68,42,831
INVESTMENTS-OTHERS	10	-	-
CURRENT ASSETS, LOANS, ADVANCES ETC.	11	14,98,88,555	28,05,66,545
MISCELLANEOUS EXPENDITURES (to the extent not written off or adjusted)			
TOTAL		60,20,34,031	59,58,14,514
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

The above Balance Sheet to the best of our knowledge & belief contains a True Account of the Funds and Liabilities of the Property and Assets of the Agharkar Research Institute.

Note : Previous year's figures are regrouped wherever necessary

(D.K. SHARMA)FINANCE & ACCOUNTS OFFICER
MACS-ARI

Place: Pune

Date: 28/06/2023

(P.K. DHAKEPHALKAR)DIRECTOR
MACS-ARI

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

Nikhil Gugale

Partner

UDIN: 23177609BGTGRA6252

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Income & Expenditure Account for the Year ended 31.03.2023

Amount - Rs.

PARTICULARS	SCH	CURRENT YEAR	PREVIOUS YEAR
Income			
Income from Sales/Services	12	15,80,060	17,99,327
Grants/Subsidies	13	24,69,45,050	21,18,76,200
Fees/Subscriptions	14	-	1,82,940
Income from Investments(Income on Invest. From earmarked/endowment Funds transferred to Funds)	15	-	-
Income from Royalty, Publications etc.	16	45,600	60,296
Interest Earned	17	39,24,254	15,20,119
Other Income	18	60,000	1,85,847
Increase/(decrease) in stock of Laboratory consumables	19	81,995	5,59,342
Donation Received in kind (Equipment)			-
Total (A)		25,26,36,959	21,61,84,070
Expenditure			
Establishment Expenses	20	17,84,26,513	15,86,62,953
Other Administrative Expenses etc.	21	6,92,28,137	4,45,59,517
Expenditure on Grants, Subsidies etc.	22	-	-
Interest	23	-	-
Depreciation (Net Total at the year-end- corresponding to schedule 8)	8	4,64,29,284	2,53,79,600
Total (B)		29,40,83,934	22,86,02,070
Balance being excess of Expenditure over Income (A-B)		(4,14,46,975)	(1,24,18,000)
CORPUS/CAPITAL FUND		(4,14,46,975)	(1,24,18,000)
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

Note: We hereby certify that the above Income & Expenditure account is correct to the best of our knowledge and belief.

Note: Previous year's figures are regrouped wherever necessary

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

(D.K. SHARMA)
FINANCE & ACCOUNTS OFFICER
MACS-ARI
Place: Pune
Date: 28/06/2023

(P.K. DHAKEPHALKAR)
DIRECTOR
MACS-ARI

Nikhil Gugale
Partner
UDIN: 23177609BGTGRA6252

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules Forming Part of Balance Sheet as at 31.03.2023

Schedule 1: Corpus/Capital Fund

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
Corpus Fund	-		-	
Capital Fund				
Balance as the beginning of the year	8,78,63,221		6,21,55,441	
Add : Contributions towards Corpus/ Capital Fund (Schedule D)	18,04,40,589		3,81,25,780	
Add/ (Deduct) : Balance of Net Income/ (Expenditure)	(4,14,46,975)	22,68,56,835	(1,24,18,000)	8,78,63,221
Capital Grant				
Balance as the beginning of the year	9,39,43,910		2,64,44,682	
Add: Capital Grant during the year	9,00,00,000		10,50,00,000	
Add: Interest Earned F.Y 2022-23 (Cap)	17,79,054		12,59,686	
Less: Interest Paid F.Y 2021-21 (Cap)	12,59,686		6,34,678	
Less: Expenditure during the year	18,04,40,589		3,81,25,780	
		40,22,689		9,39,43,910
Balance at the end of the year		23,08,79,524		18,18,07,131

Schedule 2: Reserves & Surplus

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
1. Capital Reserve:-				
As per last Account	-		-	
Addition during the year	-		-	
Less: Transfer to Establishment expenses	-	-	-	-
2. Revaluation Reserve:-				
As per last Account	-		-	
Addition during the year	-		-	
Less: Deductions during the year	-	-	-	-
3. Special Reserve : A.R.I. Reserve Fund:-				
As per last Account	-		-	
Addition during the year	-		-	
Add: Interest accrued	-		-	
Less: Deductions during the year	-	-	-	-
4. General Reserve:-				
As per last Account	-		-	
Addition during the year	-		-	
Less: Deductions during the year	-	-	-	-
Total (Rs.)				

MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE: PUNE - 411 004

Schedules Forming Part of Balance Sheet as at 31.03.2023

Schedule 3 : Earmarked/Endowment Funds

Amount - Rs.

PARTICULARS	FUND-WISE BREAK UP				TOTALS	
	Lab. Res. Fund (Tech. Dev. Fund)	Dr. A. B. Joshi	Dr. A. D. Agate	Welfare fund	Current Year	Previous Year
a> Opening balance of the funds	13,27,94,234	7,43,125	2,060	1,26,939	13,36,66,358	11,80,48,743
b> Additions to the funds:	-	-	-	-	-	-
i) Donations/grants	-	-	-	-	-	-
ii) Income from investments made on account of funds.	48,13,438	12,752	-	-	48,26,190	89,97,329
iii) Culture Identification Charges	-	-	-	-	-	-
iv) Overhead Charges from Scheme	24,19,695	-	-	-	24,19,695	25,42,546
v) Interest received on Funds from various projects	-	-	-	-	-	-
vi) Other Misc.	70,14,787	-	-	-	70,14,787	40,77,739
TOTAL (a+b)	14,70,42,154	7,55,877	2,060	1,26,939	14,79,27,030	13,36,66,357
c>Utilisation/Expenditure towards objectives of funds	-	-	-	-	-	-
I> Capital Expenditure	-	-	-	-	-	-
Fixed Assets	-	-	-	-	-	-
Others	-	-	-	-	-	-
ii> Revenue Expenditure	-	-	-	-	-	-
Salaries, Wages and allowances etc.	-	-	-	-	-	-
Rent	-	-	-	-	-	-
Other Administrative Expense	-	-	-	-	-	-
TOTAL (c)	-	-	-	-	-	-
NET BALANCE AS AT THE YEAR-END (a+b-c)	14,70,42,154	7,55,877	2,060	1,26,939	14,79,27,030	13,36,66,357
Add: Balance of Sponsored projects of Schemes (Laibility)	-	-	-	-	4,16,56,860	5,84,56,123
Total Balance as on 31.3.2023	14,70,42,154	7,55,877.00	2,060.00	1,26,939.00	18,95,83,890	19,21,22,480

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules Forming Part of Balance Sheet as at 31.03.2023

Schedule 4: Secured Loans and Borrowings

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
1. Central Government		0.00		0.00
2. State Government (Specify)		0.00		0.00
3. Financial Institutions				
a> Term Loans	0.00		0.00	
b> Interest Accrued and due	0.00	0.00	0.00	0.00
4. Banks:				
a> Term Loans	0.00		0.00	
- Interest accrued and due	0.00		0.00	
b> Other Loans (Specify)	0.00		0.00	
- Interest accrued and due	0.00	0.00	0.00	0.00
5. Other Institutions and Agencies		0.00		0.00
6. Debentures and Bonds		0.00		0.00
7. Others (Specify)		0.00		0.00
TOTAL Rs.		0.00		0.00

Note: Amounts due within one year Nil

Schedule 5: Unsecured Loans and Borrowings

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
1 Central Government		0.00		0.00
2 State Government (Specify)		0.00		0.00
3 Financial Institutions		0.00		0.00
4 Banks		0.00		0.00
a) Term Loans	0.00	0.00	0.00	0.00
b) Other Loans (Specify)	0.00	0.00	0.00	0.00
5 Other Institutions and Agencies		0.00		0.00
6 Debentures and Bonds		0.00		0.00
7 Fixed Deposits		0.00		0.00
8 Others (Specify)		0.00		0.00
TOTAL Rs.		0.00		0.00

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules Forming Part of Balance Sheet as at 31.03.2023

Schedule 6: Deferred Credit Liabilities

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
a) Acceptance secured by hypothication of capital equipment and other assets	0.00	0.00	0.00	0.00
b) Others	0.00	0.00	0.00	0.00
TOTAL Rs.		0.00		0.00

Note: Amounts due within one year Nil

Schedule 7: Current Liabilities & Provisions

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
A. Current Liabilities :-				
1. Acceptances	-	-	-	-
2. Sundry Creditors:				
a) For Goods		21,41,555		5,70,323
3. Advances Received	-	-	-	-
4. Interest Accrued but not due on:				
a) Secured Loans/borrowings	-	-	-	-
b) Unsecured Loans/borrowings	-	-	-	-
5. Statutory Liabilities:				
a) TDS Payable	1,18,422		12,91,509	
b) PF Commissioner A/c	-		3,15,631	
c) P.F. New Pension Scheme	-		85,761	
d) GST Payable	-		-	
e) State Profession Tax	-	1,18,422	23,400	17,16,301
6. Other current Liabilities	1,49,20,601	1,49,20,601	1,48,07,100	1,48,07,100
7. Unspent Balance of Grant	27,52,325		3,08,83,079	
8. Earnest Money Deposit	10,000		76,000	
9. Security deposit	1,61,695		3,62,255	
10. Other Tution Fees & University Share	96,075		37,940	
11. Recovery of Bank Loan	-		1,500	
12. Workshops Meetings etc.	9,08,546		16,58,851	
13. Retention Money	1,52,967	40,81,608	1,52,967	3,31,72,592
Total (A)		2,12,62,186		5,02,66,317

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
B. PROVISIONS				
1. For Taxation	-		-	
2. Gratuity	8,47,28,750		9,05,66,469	
3. Superannuation/Pension	-		-	
4. Accumulated Leave Encashment	7,52,49,548		7,03,87,889	
5. Trade Warranties/Claims	-		-	
6. Others				
- Salary payable for March	-		92,68,985	
- Audit fees	96,000		1,94,700	
- Electricity & Power	1,54,404		8,31,147	
- Postage & Telephone	25,000		31,696	
- Campus maintainance	-		4,216	
- Security Service Charges	-		1,42,956	
- Water Charges	-		1,60,775	
- Farm Expense	54,729		-	
- Hired Labour Charges	-		29,753	
Total (B)		16,03,08,431		17,16,18,586
Total (A+B)		18,15,70,617		22,18,84,903

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004
Schedules Forming Part of Balance Sheet as at 31.03.2023

Schedule 8 : Fixed Assets

Amount - Rs.

Sr No	Asset	Gross block as at 01/04/2022	Rate of Depreciation	Addition > 6 months	Addition < 6 months	Deletions during the year	Total WDV	Depreciation for current year	Net block as at 31/03/2023	Net block as at 31/03/2022
I	Land	1,74,914	0%	-	-	-	1,74,914	-	1,74,914	1,74,914
II	Building	5,63,69,400	10%	3,185	19,13,798	-	5,82,86,383	57,32,948	5,25,53,435	5,63,69,400
III	Furniture and Fixtures	3,00,41,837	10%	15,78,007	21,28,883	-	3,37,48,727	32,68,429	3,04,80,299	3,00,41,837
IV	Plant and Machinery									
	Computer and Computer software	35,39,242	40%	24,684	4,95,668	-	40,59,594	15,24,704	25,34,890	35,39,242
	Vehicles	5,49,431	15%	-	-	-	5,49,431	82,415	4,67,016	5,49,431
	Books	19,92,817	40%	14,76,782	-	-	34,69,599	13,87,840	20,81,759	19,92,817
	Equipments	12,02,51,823	15%	3,89,27,230	13,38,92,352	-	29,30,71,405	3,39,18,784	25,91,52,620	12,02,51,822
	Other Fixed assets	34,27,761	15%	0	-	-	34,27,761	5,14,164	29,13,597	34,27,761
V	Capital WIP	20,57,913	0%	-	-	-	20,57,913	-	13,36,115	20,57,913
	Total	21,84,05,138		4,20,09,888	13,84,30,701	-	39,88,45,727	4,64,29,284	35,16,94,645	21,84,05,138

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules Forming Part of Balance Sheet as at 31.03.2023

Schedule 9: Investments from Earmarked/ Endowment Funds (Long Term)

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1. In Government Securities	-	-
2. Other approved Securities	-	-
3. Shares	-	-
4. F.D.R. with Indian Bank (Dr. A.B. Joshi Donation)	2,50,000	2,50,000
5. Subsidiaries and Joint Ventures	-	-
6. Others (Fixed Deposits) (Dr. A.D. Agate Donation)	5,001	5,001
7. Others Fixed Deposits from Lab. Reserve Fund (Tech. Dev. Fund A/c:SBI)	9,95,58,605	9,59,50,605
8. Others (FD against LC)	6,37,225	6,37,225
TOTAL (Rs.)	10,04,50,831	9,68,42,831

Schedule 10: Investments - Others

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
In Government Securities	0.00	0.00
Other approved Securities	0.00	0.00
Shares	0.00	0.00
Debentures and Bonds	0.00	0.00
Subsidiaries and Joint Ventures	0.00	0.00
TOTAL (Rs.)	0.00	0.00

Schedule 11: Current Assets, Loans & Advances

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
A. CURRENT ASSETS:				
1. Inventories:				
a> Stores and Spares				
b> Publications	5,91,090		5,91,090	
c> Stock-in-trade of consumables (as taken valued and certified by the Management)	2,94,611	8,85,701	2,12,616	8,03,706
2. Sundry Debtors:				
a> Debts Outstanding for a period exceeding six months				

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
3. Cash balances in hand(including cheques/drafts and imprest)	8,328	8,328	15,000	15,000
4. Bank Balances:				
a> With scheduled Banks				
-On Current Accounts	3,84,40,630		2,98,15,472	
-On Deposit Accounts	-		-	
-On Savings Accounts	61,17,789		13,53,90,034	
- On Current Accounts(TDF)	4,66,56,154	9,12,14,573	4,12,84,178	20,64,89,684
TOTAL (A)		9,21,08,602		20,73,08,390
<u>B.LOANS,ADVANCES AND OTHER ASSETS</u>				
1. Loans:				
a> Staff (For HBA, Vehicle Advance and Computer)	-		-	
d) Amount receivable from Schemes	28,02,982	28,02,982	22,97,205	22,97,205
2. Advances and other amounts recoverable in cash or in kind or for value to be received:				
a> On Capital & Revenue Expenditure	-		-	
b> Prepayments(Cash Insurance)	-		-	
c> Advances to staff (For TA etc.)	4,18,805		37,409	
d> Deposits kept with Govt. Agencies (MSEB, Telephone, Gas Cylinder etc.)	17,00,464	21,19,269	10,96,413	11,33,822
3.Income Accrued:				
a> On Investments from Earmarked/Endowment Funds	41,29,412		32,72,003	
4. Sundry Debtors	3,659		2,537	
5. Advance to Suppliers (Prior to 2013-14)	6,87,528		6,87,528	
6. Income Tax (TDS) Current	21,52,844		25,53,119	
7. Refund Receivable from MACS	-		6,21,213	
8. GST TDS	6,788			
9. GST Input /Service Tax Input	41,89,330		42,03,324	
10. Kumar Krishi Mitra Fellowship	31,281		31,281	
11. Sponsored Projects of Schemes (Asset)	4,16,56,860	5,28,57,701	5,84,56,123	6,98,27,128
TOTAL (B)		5,77,79,952		7,32,58,155
TOTAL (A+B)		14,98,88,555		28,05,66,545

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules forming part of Income & Expenditure Account for the year ended 31.03.2023

Schedule 12: Income From Sales/Services

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1. Income from Sales		
a) Sales of Finished Goods (Farm Produce)	-	75,186
b) Sale of Raw Material	-	1,956
c) Sale of Scraps	5,15,765	52,392
d) Sale of Wistar Rats	22,160	32,080
2. Income from Services		
b) Cultural Identification Charges / Analytical Services	9,76,237	14,81,250
d) Others	-	9,105
e) Testing fees-Soyabean/Wheat	-	24,000
f) Consultancy Services	33,898	33,898
g) Sale of wistar rates GST Apply	32,000	89,460
Total (Rs.)	15,80,060	17,99,327

Schedule 13: Grants/Subsidies

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1. Central Government	35,75,00,000	32,47,00,000
Grant in Aid General	5,50,00,000	4,71,00,000
Grant in Aid Salary	21,25,00,000	17,26,00,000
Grant in Aid Capital	9,00,00,000	10,50,00,000
Less: Transferred to Schedule 1 (Capital Fund)	9,00,00,000	10,50,00,000
Less: TSA (Treasury Single Account)	4,75,27,196	-
Total Grant (GIA General & GIA Salary)	21,99,72,804	21,97,00,000
Add: Unspent balance at the beginning of the year	3,08,83,079	2,29,02,026
Add: Interest Earned on Grant (2022-23)	4,46,614	16,05,122
Less: Unspent balance at the year end	27,52,325	3,08,83,079
Less: Interest refund back to DST (2021-22)	16,05,122	14,47,869
Sub-Total	24,69,45,050	21,18,76,200
2. State Government	-	-
3. Government Agencies	-	-
4. International Organisations	-	-
5. Others (Specify)	-	-
Net Surplus of sale of Assets	-	-
Total (Rs.)	24,69,45,050	21,18,76,200

* Unspent balance of grant is against recurring balance & non-recurring balance is regrouped under Schedule I Capital Fund

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules Forming Part of Income & Expenditure Account for the Year Ended 31.03.2023

Schedule 14: Fees/Subscriptions

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1. Entrance Fees (Library Membership fees)	-	19,200
2. Annual Fees(Licence fees)/Subscriptions	-	10,212
3. Seminar/Program Fees	-	-
4. Others (Ph.D. Tuition fee, Ph.D. Provisional Admission fee)	-	1,53,528
Total (Rs.)	-	1,82,940

Schedule 15: Income From Investments

Amount - Rs.

INCOME FROM INVESTMENTS: (Income on Invest. From Earmarked/ Endowment Funds transferred to Funds.)	INVESTMENT FROM EARMARKED FUND		INVESTMENT - OTHERS	
	CURRENT YEAR	PREVIOUS YEAR	CURRENT YEAR	PREVIOUS YEAR
1. Interest				
a> On Govt. Securities	0.00	0.00	0.00	0.00
b> Other Bonds/Debentures	0.00	0.00	0.00	0.00
2. Dividends				
a> On Shares	0.00	0.00	0.00	0.00
b> On Mutual Fund Securities	0.00	0.00	0.00	0.00
3. Rents	0.00	0.00	0.00	0.00
4. Others (Interest on bank deposits)	0.00	0.00	0.00	0.00
Total Rs.	0.00	0.00	0.00	0.00
TRANSFERRED TO EARMARKED/ ENDOWMENTFUND	0.00	0.00	0.00	0.00

Schedule 16: Income from Royalty, Publications, etc.

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1. Income from Royalty	-	-
2. Income from Publications	-	56
3. Others (Sale of Tender Forms/I Cards)	-	(40)
4. Application Money	45,600	60,280
Total (Rs.)	45,600	60,296

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules forming part of Income & Expenditure Account for the year ended 31.03.2023

Schedule 17 : Interest Earned

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1. On Term Deposits		
a) With Scheduled Banks	-	-
b) With Non-Scheduled Banks	-	-
2. On Saving Accounts		
a) With Scheduled Banks	39,24,254	15,20,119
b) With Non-Scheduled Banks	-	-
c) Post Office Savings Accounts	-	-
3. On Loans		
a) Employees/Staff (On HBA, Vehicle and Computer Advance)	-	-
b) Interest Received on L.C	-	-
4. Interest on Debtors and Other Receivables	-	-
Total (Rs.)	39,24,254	15,20,119

Schedule 18: Other Income

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1) Profit on Sale/Disposal of Assets:		
a) Owned Assets	-	-
b) Assets acquired out of grants, or received free of cost	-	-
2) Export Incentives realized	-	-
3) Fees for Miscellaneous Services	-	1,31,556
4) Miscellaneous Income	60,000	54,291
Total (Rs.)	60,000	1,85,847

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules forming part of Income & Expenditure Account for the year ended 31.03.2023

Schedule 19: Increase/(Decrease) In The Stock Of Finished Goods & Work In Progress

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
a) Closing stock		
- Laboratory Consumables	2,94,611	2,12,616
- Finished Goods	-	-
- Publications	5,91,090	5,91,090
	8,85,701	8,03,706
b) Less: Opening Stock		
- Laboratory Consumables	2,12,616	2,23,839
- Finished Goods	-	-
- Publications	5,91,090	20,525
	8,03,706	2,44,364
Net Increase/(Decrease)	81,995	5,59,342

Schedule 20: Establishment Expenses

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1) Salaries and Wages	14,66,31,156	13,23,78,065
2) Allowances and Bonus	18,09,000	20,02,316
3) Contribution to Provident Fund & New Pension Scheme	1,54,64,143	1,67,62,203
4) Contribution to Other Fund (D.L.I.F.)	2,16,285	2,22,176
5) Staff Welfare Expenses	10,34,939	15,90,965
6) Expenses on Employees Retirement and Terminal Benefits	87,16,041	16,50,018
7) Stipend to Research & Fellowship Students	29,29,647	34,04,034
8) Encashment of Earned Leave for LTC	16,25,302	6,53,176
TOTAL	17,84,26,513	15,86,62,953

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules forming part of Income & Expenditure Account for the year ended 31.03.2023

Schedule 21: Other Administrative Expenses

Amount - Rs.

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Advertisement & Publicity	76,737	92,366
Auditors Remuneration	96,000	2,01,160
Electricity & Power	78,59,799	79,30,040
Exhibition Organaised By Arai	7,27,352	3,54,000
Farm Expenses	24,63,638	29,12,436
Hospitality Expenses	2,62,814	1,50,599
Insurance	3,381	3,735
Legal & Professional Fess	9,86,465	5,91,704
Other Office Expenses	4,80,159	3,37,573
Postage, Telephone & Communication	3,35,334	3,45,379
Printing & Stationery	8,07,942	5,69,364
Purchases Of Chemicals & Glassware	1,92,57,683	73,33,308
Rent Rates & Taxes	16,78,788	16,30,278
Repairs & Maintenance	1,31,27,161	73,68,880
Retired Staff Medical Expenses	8,02,823	12,39,075
Security & Labour Expenses	1,28,70,520	1,15,63,346
Seminar /Workshop Expenses	28,50,884	1,54,991
Subscription Fees	10,22,639	1,20,124
Travelling & Conveyance	17,88,144	1,62,952
Vehicle Running And Maint Exps	1,38,245	1,61,908
Water Charges	12,73,002	13,36,299
Commission To Agency	35,980	-
Publication	5,000	-
Other Staff Expenses	2,77,648	-
TOTAL (Rs.)	6,92,28,137	4,45,59,517

Schedule 22: Expenditure on Grants, Subsidies etc.

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
a) Grants given to Institutions/Organisation	0.00	0.00	0.00	0.00
b) Subsidies given to Institutions/ Organisations	0.00	0.00	0.00	0.00
TOTAL Rs.	0.00	0.00	0.00	0.00

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules forming part of Income & Expenditure Account for the year ended 31.03.2023

Schedule 23: Interest

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
a) On Fixed Loans	0.00	0.00	0.00	0.00
b) On Other Loans (including Bank Charges)	0.00	0.00	0.00	0.00
c) Others (Specify)				
TOTAL Rs.		0.00		0.00

M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules forming part of Income & Expenditure Account for the year ended 31.03.2023

Schedule D: Transfer to Capital Fund

Amount - Rs.

PARTICULARS	CURRENT YEAR		PREVIOUS YEAR	
<u>Other Fixed Assets</u>				
Books	14,76,782		3,18,004	
Computer / Peripherals/Softwares	5,20,352		17,96,791	
Office Furniture & Dead Stock	37,06,890		1,75,508	
App. & Equipments	17,28,19,582		3,58,35,477	
Temporary Structures	19,16,983		-	
		18,04,40,589		3,81,25,780

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

(D.K. SHARMA)FINANCE & ACCOUNTS OFFICER
MACS-ARI

Place: Pune

Date: 28/06/2023

(P.K. DHAKEPHALKAR)DIRECTOR
MACS-ARI**Nikhil Gugale**

Partner

UDIN: 23177609BGTGRA6252

FORM OF FINANCIAL STATEMENTS: Non –profit making organization

Name of Entity: M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules forming part of the Accounts for the period ended 31st March 2023

Schedule 24: Significant Accounting Policies

a. Accounting Convention

The Financial statements are prepared under the historical cost convention and in accordance with the applicable Accounting Standards except where otherwise stated. Accrual system of accounting is generally followed to record the transaction in the financial statements.

b. Fixed Assets

Fixed assets are stated at their original cost of acquisition, less depreciation.

c. Method of Depreciation

Effective from 01.04.2022, the Trust has changed its method of computing depreciation from Straight Line (SLM) methods to the Written Down (WDV) method for the Trust's Fixed Assets. Based on provisions of Income Tax Act, 1961 the Trust determined that the change in depreciation method from Straight Line value method to a Written Down Value Method is a change in accounting estimate affected by a change in accounting principle. A change in accounting estimate affected by a change in accounting principle has been applied prospectively with effect from 01.04.2022 due to inadequate information for past years.

It is not possible for us to verify the actual date of asset put to use and hence the same has been taken on the basis of information and explanation given by the management. Accordingly, depreciation is calculated irrespective of put to use for the whole year.

d. Extra-ordinary Items, Prior Period Items, Changes in Accounting Policies

On the basis of information and explanation given by the management Extra-ordinary Items, Prior Period Items, Changes in Accounting Policies are separately disclosed in the financial Statement but are integrated through various items appearing under the same.

e. Foreign Currency Transactions

Transactions denominated in foreign currency are accounted as the exchange rate prevailing at the date of the transaction; however foreign exchange gain loss is not calculated and accounted for.

f. Investments

1. Long term investments are valued at cost and where required, provision is made for permanent diminution in the value of such investment.
2. Investment classified as "Current" is valued at cost and market value.
3. Cost means acquisition cost which includes acquisition expenses like brokerage, transfer stamp, etc.

g. Revenue Recognition

1. All Revenue receipts are on accrual basis.
2. All Expenses are generally accounted on accrual basis.

h. Accounting for Government Grants

1. Government grants of the nature of contribution towards capital cost of setting projects are transferred to Capital Fund

i. Retirement Benefits

1. Generally, liability towards gratuity payable on death/retirement and leave encashment of the employees is provided based on Actuarial Valuation.
2. Provision for accumulated leave encashment benefit to the employees is accrued and computed on the assumption that the employees are entitled to receive the benefit as each year end which is also done on Actuarial Valuation.

j. Capitalization

1. All direct expenses attributable to fixed asset acquired are capitalized.

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

(D.K. SHARMA)

FINANCE & ACCOUNTS OFFICER
MACS-ARI

Place: Pune

Date: 28/06/2023

(P.K. DHAKEPHALKAR)

DIRECTOR
MACS-ARI

Nikhil Gugale

Partner
UDIN: 23177609BGTGRA6252

FORM OF FINANCIAL STATEMENTS: Non –profit making organization

Name of Entity: M.A.C.S'S AGHARKAR RESEARCH INSTITUTE, PUNE - 411 004

Schedules forming part of the Accounts for the period ended 31.03.2023

Schedule 25: Contingent liabilities and Notes on Accounts (Illustrative)

1. Contingent liability:

- a) Claims against the entity not acknowledged as debts- Nil (Previous Year- Nil)
- b) In respect of:
 - Bank guarantee given by on behalf of the entity -N.A.(Previous Year- Nil)
 - Letter of credit opened by bank on behalf of the entity - Nil(Previous Year- Nil)
 - Bill discounted with banks - Nil (Previous Year- Nil)
- c) Disputed demands in respect of:
 - Income tax - Nil (previous Year- Nil) Sales tax - Nil (Previous Year- Nil)
 - Municipal Taxes - Nil (Previous Year- Nil)
- d) In respect of claims from parties for non-execution of orders, but contested by the entity Nil (Previous Year- Nil)

2. Capital Commitments

Estimated value of contracts remaining to be executed on capital account and not provided for (Net of Advances)-Nil (Previous Year)-Nil

3. Lease obligation

Further obligation for rental under finance lease arrangements for plant and machinery is Nil (previous Year Nil)

4. Current Assets, Loans and Advances

In the opinion of the management, the current assets, loans and advances have a value on realization in the ordinary course of business, equal to the aggregate amount shown in the Balance Sheet. Some of balance of sundry debtors, deposits, loans and advances are subject to confirmation from the respective parties and consequential reconciliation adjustments arising there from, if any.

5. Taxation

In view of there being no taxable income under Income Tax Act 1961, No provision for income tax has been considered necessary. In view of this, no disclosure is required as per accounting standards -22 issued by The Institute of Chartered Accountants of India (ICAI).

6. Grants

Grants are recognized on receipts. Grants received from Department of Science & Technology (DST) for Creation of Capital Assets are treated as Capital Fund of the Institute. Grants received for GIA General and GIB Salaries are treated as of revenue nature and shown under Income & Expenditure Account.

7. Retirement Benefit

Generally, liability towards gratuity payable on death/retirement of employees is provided based on Actuarial Valuation and provision for accumulated leave encashment benefit to the employees is accrued and computed on the assumption that employees are entitled to receive the benefit at each year end which is also done on Actuarial Valuation.

The principle assumption used in determining the gratuity and leave encashment obligation are as per below:-

Sr. No.	Particular	Gratuity	Leave Encashment
1	Withdrawal Rate	3.00%	3.00%
2	Discounting Rate	7.47%	7.47%
3	Future Salary Rise	7.00%	7.00%
4	Encashment Rate while in service	-	5.00%

The position of gratuity payable on death/retirement of employees and leave encashment as on 31st March, 2023 is as below:

Particulars	Provision for Gratuity	Provision for Leave Encashment
Opening balance as on 1 st April 2022	9,05,66,469	7,03,87,889
Add:- Addition during the year 2022-23	-----	48,61,659
Less:- Deduction during the year 2022-23	58,37,719	-----
Closing Balance as on 31 st March 2023	8,47,28,750	7,52,49,548

8. Impairment of Assets

As per Accounting Standard-28 "Impairment of Assets" issued by the institute of Chartered India, comes in to effect, in respect of accounting commencing on or after 1st April, 2005. We have relied upon the management on the matters related to impairment of assets, in view of management there are no impairment losses.

9. Previous year figures are rearranged, recast or regrouped wherever necessary, to make them comparable with those of the year under audit.
10. Provisions are recognized when the firm has present obligation as a result of past event; it is more likely that an outflow of resources will be required to settle the obligation; and the amount has been reliably estimated.
11. In case of items debited to Income and Expenditure account, it was informed to us that the expenditure is not of capital nature.
12. Depreciation on fixed assets has been provided on written down method (WDV) as per the rates prescribed under Income Tax Act, 1961. Assets are regrouped as per the requirements of the Act wherever required.
13. Interest earned on grants-in-aid is payable to Department of Science & Technology (DST) as per Rule 230(8) of GFR, 2017.
14. There is no separate Corpus Fund created by the Institute, it is the balance of Income & Expenditure Account i.e. Surplus/ Deficit and expenditure done for purchase of equipments during the financial year is transferred to Capital Fund Schedule.
15. Current year provision are made on bases of available grant balance.
16. Unspent balance of grant is against recurring balance & non-recurring balance is regrouped under Schedule I Capital Fund.

As per our report of even date
For **A. R. SULAKHE & CO.**
Chartered Accountants
FRN: 110540W

(D.K. SHARMA)

FINANCE & ACCOUNTS OFFICER
MACS-ARI

Place: Pune

Date: 28/06/2023

(P.K. DHAKPHALKAR)

DIRECTOR
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Nikhil Gugale

Partner

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Maharashtra Association for the Cultivation of Science Agharkar Research Institute

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