



# Annual Report

2018-19

विज्ञान और  
इंजीनियरी  
अनुसंधान बोर्ड



Science and  
Engineering  
Research Board







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Engineering  
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वार्षिक रिपोर्ट 2018-19 **Annual Report**

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## *From the Secretary's Desk*

I am very pleased to share the 8<sup>th</sup> Annual Report (2018-2019) of Science and Engineering Research Board (SERB). This report brings comprehensive details of activities supporting fundamental and applied research in India and a description of programs supporting our scientists at all levels. Science and Engineering Research Board has observed increase in R&D funding to ensure that Indian science remains relevant and contemporary in terms of its impact at the global stage, while still aligning our research outcomes with social responsibility and national missions. Increase in transformative R&D activities is visible in context of excellent research publications, valued fellowships and quality human resource capacity building exercise. With a pan-India reach through our comprehensive investigator database, we are able to reach S&T personnel in every part of our country, academic institutions and research laboratories and offer project support on a competitive basis in all areas of investigations from atoms to astrophysics.



SERB is proud of adopting and implementing modern research management practices to ensure online submissions of new projects, progress reports and financial documents. Such a smooth workflow has resulted in complete automation, which leads to easy extraction of data relevant to funding support, outreach and other crucial statistical parameters.

Apart from conventional research support programs, we have also formulated new programs to address the needs of active researchers across the disciplines. Currently, SERB serves as the nodal agency for implementing unique IMPRINT-India initiative to address major S&T research challenges to energize, enable, and empower the nation for self-reliance, growth and R&D dominance at the world stage. This could be achieved via development of products/processes and viable technologies, through focused translational projects in high priority technology thrust areas, and by enabling technology diffusion to industry and other stakeholders, and build capability and competence in selected technology thrust domains. The Board has also initiated a bold approach to embed a participatory, inclusive and sustainable culture of social responsibility among its investigators by integrating a 'Scientific Social Responsibility' policy in SERB projects.

As we move ahead, SERB remains firmly committed to support competitive science across the nation, with due diligence and transparency in evaluation and assessment. Our efforts will significantly contribute to strengthen Indian research ecosystem and produce highest quality science to put India on the global map.

Jai Hind!

**Sandeep Verma**  
Secretary, SERB



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# 1 THE ORGANIZATION

The Science and Engineering Research Board (SERB), a Statutory body of the Department of Science and Technology has been established for planning, promoting and funding of internationally competitive research in emerging areas; and identify major inter-disciplinary research areas, and individuals, groups or institutions and funding them for undertaking research. The Board (SERB), since its operationalization in 2011 is instrumental in building up substantial research infrastructure in academic and research institutions and creating environment for scientific pursuit in the country. An Oversight Committee constituted under the provisions of the SERB Act, advise and assist the Board.



Figure1.1: SERB Office at Vasant Kunj, New Delhi.

## ►► 1.1 Vision, Mission & Goals

To better focus in its energies and resources on realization of its mandate, SERB defined its vision, mission and goals as per the following-

### Vision

To position science and technology as the fulcrum for social and economic change by supporting competitive, relevant and quality scientific research and development.

### Mission

As the premier national research funding agency, raise the quality and footprint of Indian science and engineering to the highest global levels in an accelerated mode, through calibrated, competitive support of research and development.

### Goals

- I** Stimulating the search for new knowledge and encouraging invention, discovery, innovation and development by supporting bottom-up research competitively and at all levels of our research eco-system.
- II** Support conceptually new directions, even when risky, but having the potential for non-incremental and transformative success. Strengthen deep-expertise in specific domains and link them through inter-disciplinary and multi-institutional 'top-down' programmes that address challenging national problems.
- III** Develop funding programmes which connect with needs of our society and identify key scientific questions, both basic-science and application that have concrete societal values.
- IV** Launch and strengthen programmes to bring in researchers from under represented regions, weaker and marginalized segments of the society.
- V** Realizing the importance of gender parity, ensure that all programmes pro-actively have mechanism to encourage enhanced and equitable representation of women scientists.
- VI** Initiate and strengthen schemes that link teachers in colleges and resource-poor universities with opportunities in active research, thereby aiding in expanding the footprint of quality science.
- VII** Through global bilateral and multilateral partnerships support collaborative top-quality research in cutting-edge areas to ensure the rapid growth of quality science in India.
- VIII** Scout, mentor, incentivize and reward exceptional performers, teams and institutions.
- IX** Show unstinted commitment towards science by constantly improving our methods and swiftness for research support, while ensuring the highest adherence to financial processes.
- X** Recognizing that all research support has at its base the development of quality, well-trained researchers; initiate and strengthen programmes of identifying research potential, mentoring, training and hands-on workshops, on a broad-based national scale.
- XI** Make SERB the vehicle of choice for all R&D funding agencies for their core programmes by developing inclusive processes and proactively synergizing with them for the requisite integration and consolidation of the research effort in Science and Engineering in the country.

## ►► 1.2 Organization and Programmatic Chart

### a) Organizational Chart

The organization structure of SERB is given in Figure 1.2.

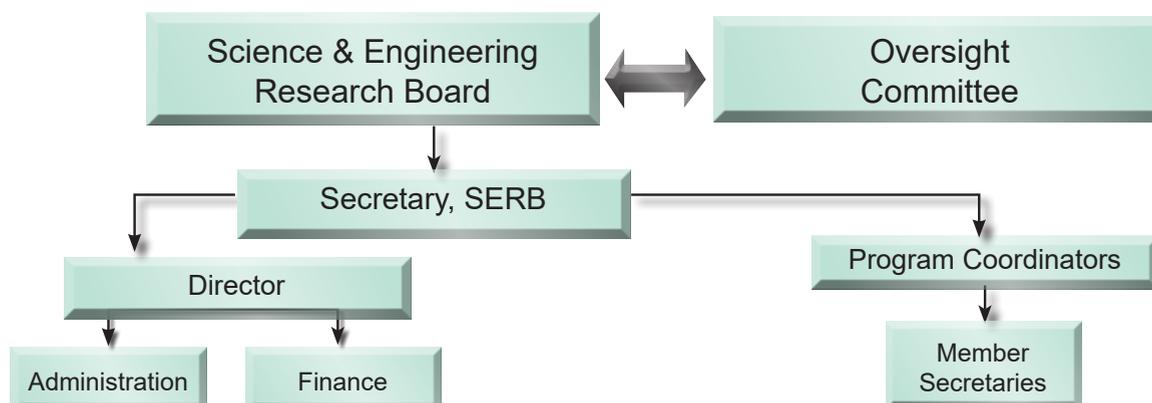


Figure 1.2: Organization Chart

### b) Programmatic Chart

Scientific programs and schemes of SERB are given below (Figure 1.3).

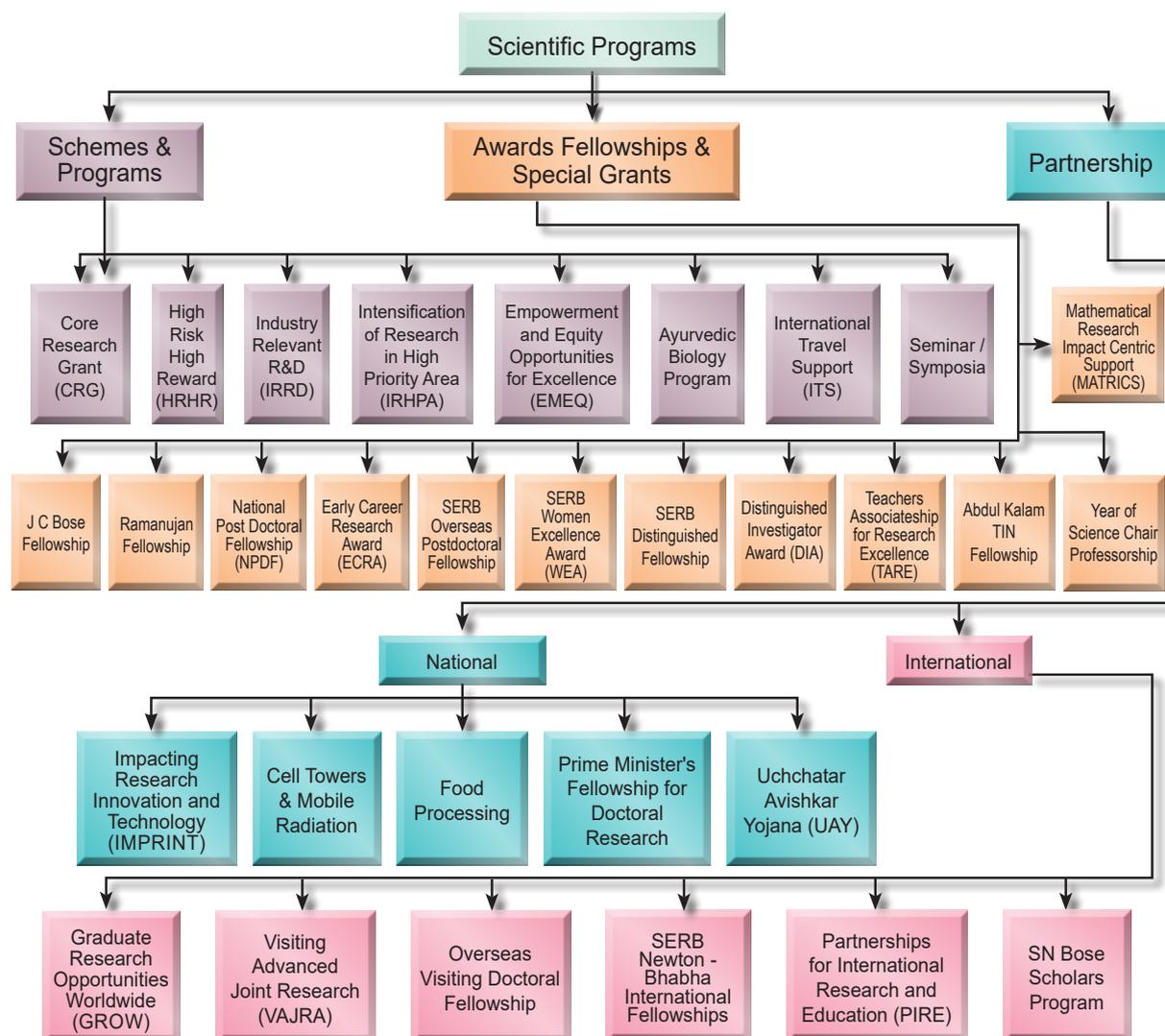


Figure 1.3: Programmatic Chart of SERB

### ▶▶ 1.3 Board & Oversight Committee

#### a) The Board

The Board, chaired by Secretary, Department of Science and Technology (DST), is comprised of 16 members including a few eminent Indian Scientists and six Secretaries to the Government

of India. Following are the members of the Board (Figure 1.4). The Board met 4 times in the reporting period and had taken significant decisions on S&T.

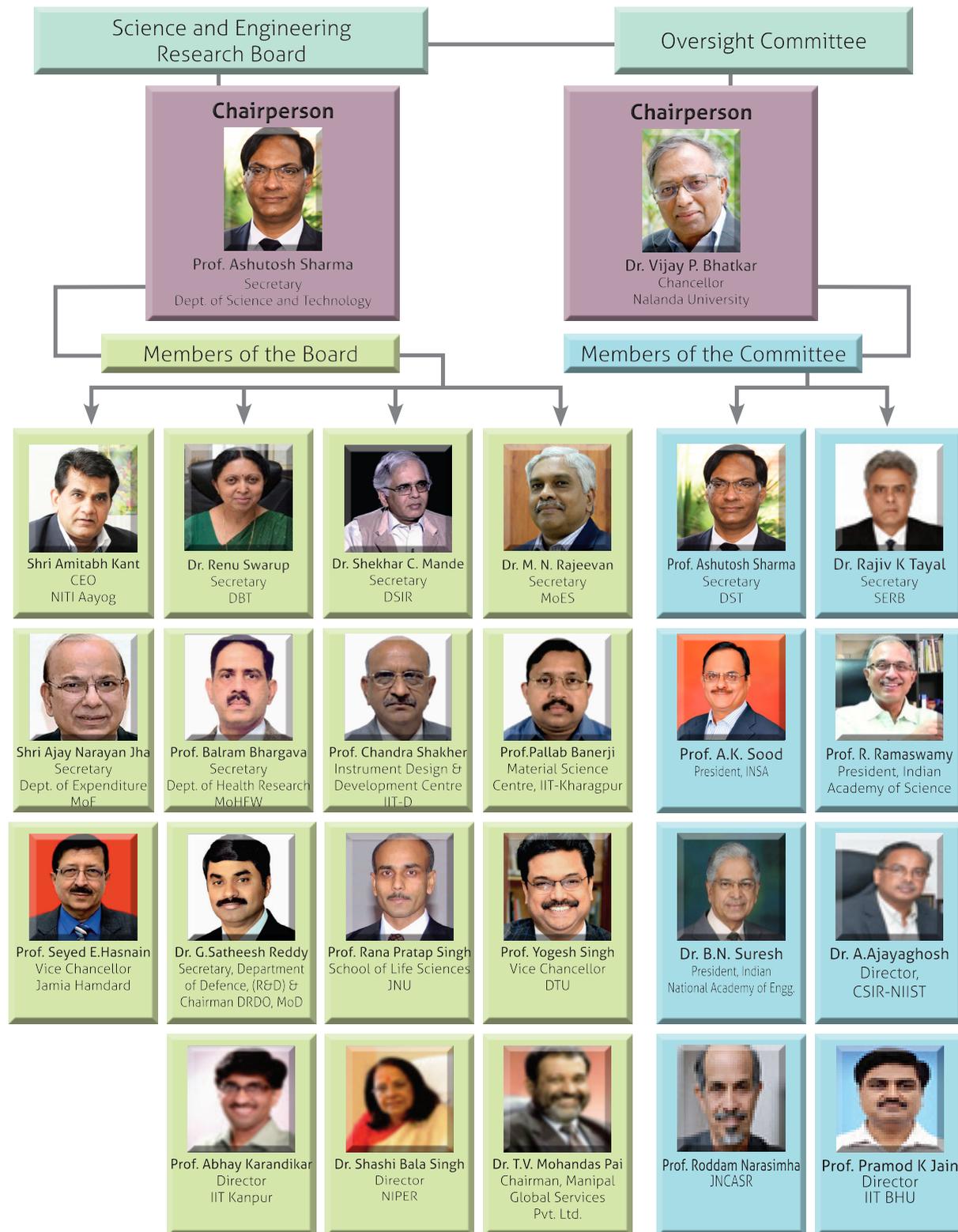


Figure 1.4: Members of the Board and Oversight Committee.

## b) The Oversight Committee

The SERB Act provides for constitution of an Oversight Committee to advise and assist the Board. A scientist of eminence and international repute chairs the Oversight Committee with Secretary to the Government of India in DST as Vice Chairperson and a few distinguished experts,

Secretary to the Board and Presidents of Indian National Science Academy, Indian Academy of Sciences and Indian National Academy of Engineering as members. The members of the Oversight Committee are depicted in Fig 1.4.

## ►► 1.4 The Peer Review Committees

The Board has a robust peer review mechanism for taking funding decisions. The proposals received under various schemes and programmes follow a peer review process, which involves two levels of appraisals. At first stage, the proposals are sent to domain experts for their comments. At second

stage, the proposals are generally evaluated by specific Committees. Several Committees have been constituted to evaluate R&D proposals and other applications for seeking support under various schemes and programmes. Major Committees are listed below:

### 1.4.1 Programme Advisory Committee (PAC)

Programme Advisory Committee (PAC) is the first level peer review committee in the system. Thirteen PACs in various disciplines, each with a composition of 7 - 10 core members and a cohort of experts who can be co-opted in the

committees whenever required were constituted. The members were drawn from Universities / National Labs / IITs/ IISc. PACs role is critical in taking decision on R&D proposals submitted to the Board.

### 1.4.2 Empowered Committee

If the cost of the proposal recommended by PAC is greater than 80 lakhs, it is referred to an Empowered Committee. This committee is empowered to approve projects up to Rs. 5

crores, whereas for proposals costing more than Rs. 5 crores the same committee will serve as an appraisal body to the Board.

### 1.4.3 Expert Committees / Task Force

Five Expert Committees were re-constituted to help the Board in taking decision on Early Career Research Award (ECRA) and National Postdoctoral Fellowship (NPDF) proposals. A Task Force constituted under the Board takes

decision on proposals received under EMEQ Scheme. These Committees take decisions for funding on proposals received under the mentioned schemes.



## 2 OVERVIEW

SERB over the years has risen as a premier funding agency for planning, promoting and funding of internationally competitive research in emerging areas. It identified major research areas and potential scientists and funding them for undertaking competitive research. The SERB support schemes have resulted in enhancing research infrastructure of academic and research institutions across country and enabled synergy between academic institutions, R&D laboratories and industry for promoting basic research in S&T. SERB has evolved a management system, which was based on modern management practices, for delivery of time bound funding decisions and monitoring of ongoing schemes.

### ▶▶ 2.1 Growth Profile

The Board has come up with several innovative programmes and schemes to identify potential scientists and support them for undertaking R&D in frontier areas of Science and Engineering. The

Board interventions were primarily focused to expand the research base in the country without compromising the quality of research.

#### 2.1.1 Milestones

The Board has come a long way in its journey from the erstwhile SERC to its current profile as

depicted. Some of the major milestones over the years are shown in Figure 2.1.

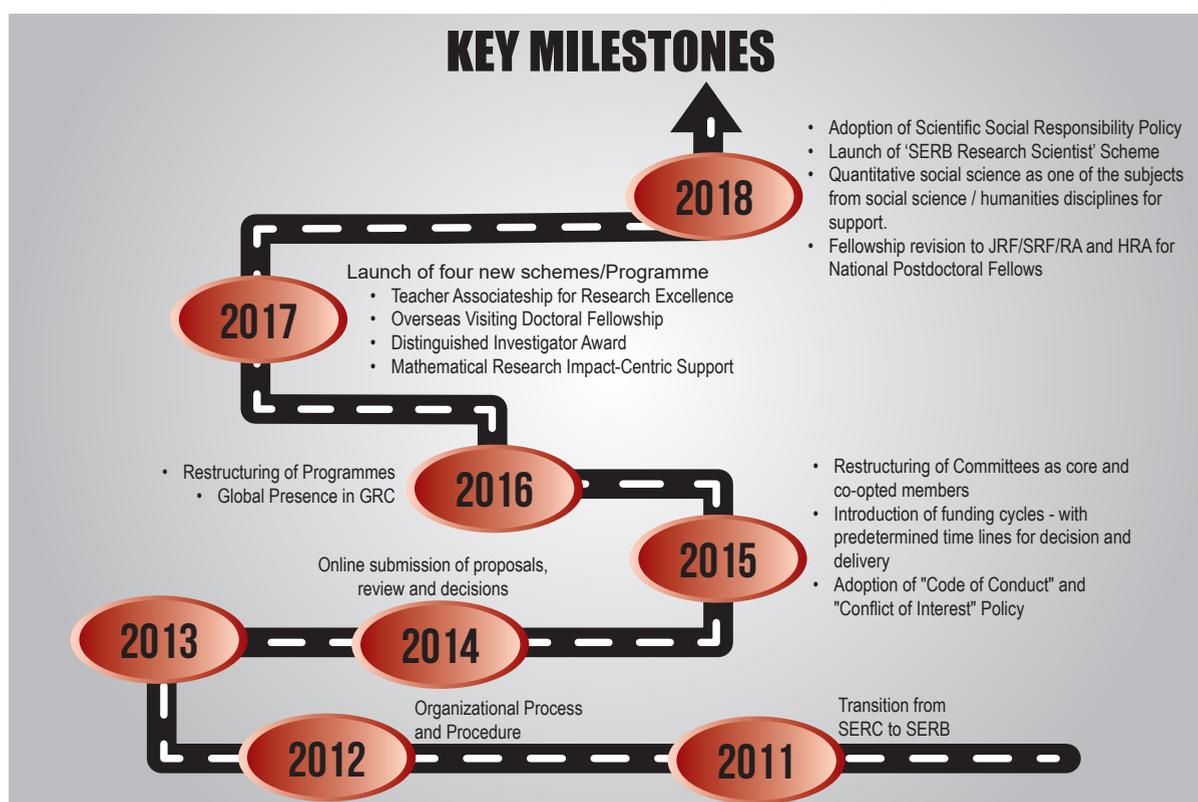


Figure 2.1 : Key Milestones of SERB since inception

### 2.1.2 Adaptability

The Board, since inception had introduced several schemes and programmes to cater various segments of the scientific community. Its

adaptability to suit the changing S&T needs of the country is depicted in Figure 2.2.

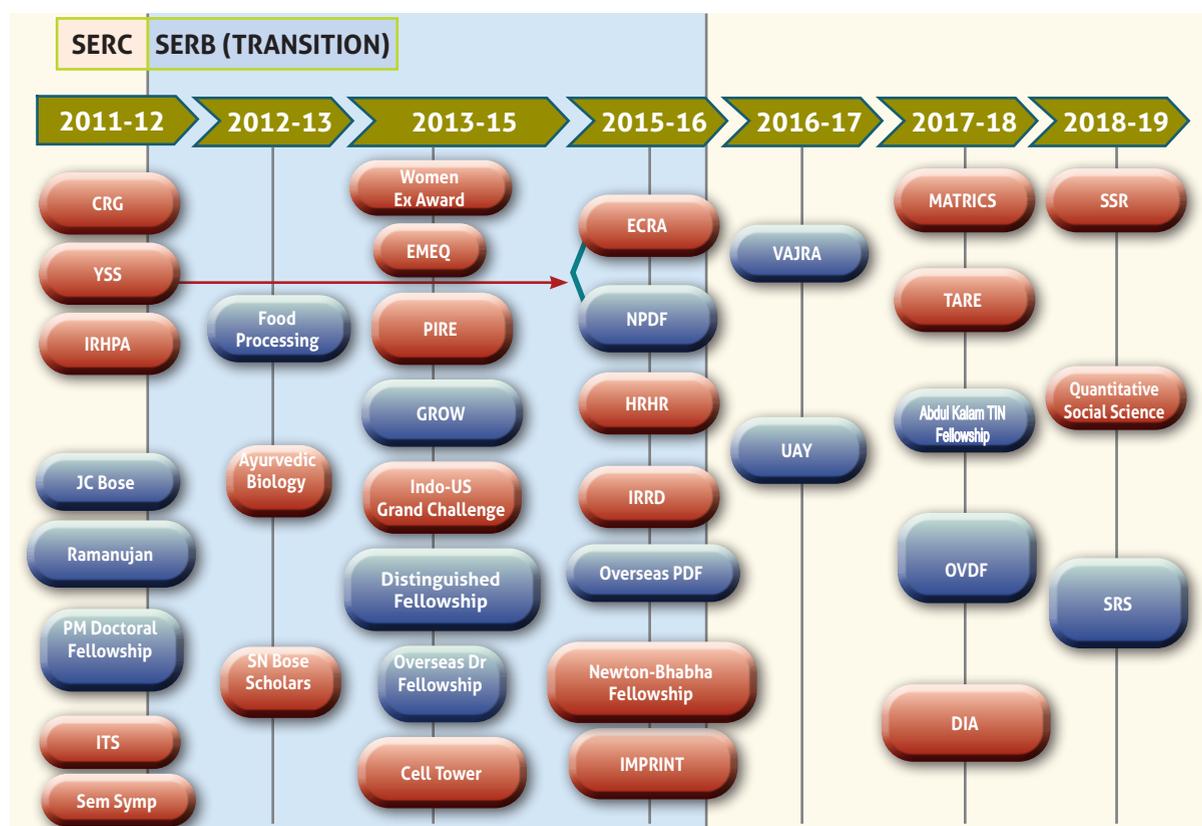


Figure 2.2 : The Growth Profile of SERB Programmes since inception.

### 2.1.3 Budget

A steady growth in terms of the budgetary allocation for SERB was observed over the past many years. The allocation for SERB since inception is shown in Figure 2.3.

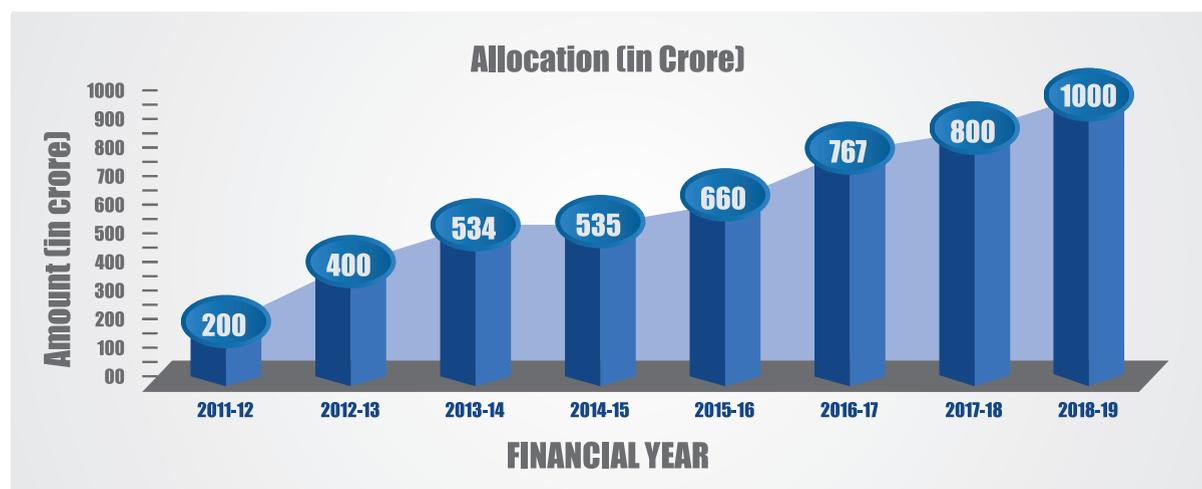


Figure 2.3 : Budget allocated as grant to SERB.

## ►► 2.2 Schemes and Programmes

SERB seeks to achieve its mandated objectives through activities built around six programmatic themes as described below:

### 2.2.1 Support for Core Research & Innovations (SCRI)

The activities are broadly centered on following components:

#### 2.2.1.1 Core Research Grant (CRG)

Individual centric competitive mode of funding is provided under CRG. The Board supports potential scientists for undertaking research in frontier areas of S&T. There is no upper limit to the funding. The grant is provided for manpower, equipment,

consumables, national travel, contingencies and overheads. One call for proposals was solicited and 5214 grant applications were received. A total of 1280 projects were sanctioned in frontier areas of Science and Engineering.

#### 2.2.1.2 Mathematical Research Impact Centric Support (MATRICS)

The scope of the MATRICS Scheme, which provides a fixed grant to active researchers pursuing Mathematical Sciences, has been expanded to include other Theoretical Sciences. The Scheme name has also been modified as: MATRICS/ CREST (Catalytic Research Support for Theoretical Sciences) including economics & other social sciences involving quantitative

analysis, mathematical modelling & use of physico - chemical or mathematical sciences. One call for proposals was solicited and 1853 proposals were received. The Peer Review Committee recommended 133 proposals for support. 302 projects were sanctioned in the reporting period.

#### 2.2.1.3 High Risk High Reward (HRHR)

The scheme is aimed at supporting proposals that are new, challenge existing hypothesis, and provide 'out of box' solutions on important problems. It should contain significant risk elements but promise of high reward if the difficulties could be circumvented. It is expected that the success of such proposals will have far reaching implication in S&T. Outcome could be new and significant theoretical or experimental

advances, formulation of new hypothesis, or breakthrough science, which will lead to new technologies. The funding is provided normally for a period of three years. The proposals can be submitted by an individual or by a team of investigators. In the reporting period a total of 223 proposals were received and only 1 was supported under the discipline of Earth & Atmospheric Sciences.

#### 2.2.1.4 Industry Relevant R & D (IRRD)

The scheme is aimed at supporting ideas that address a well-defined problem of industrial relevance. The proposal shall be jointly designed and implemented by the academic partner (which includes a partner from national laboratories/ recognized R&D institutions as the case may be) and industry. The participating industry should ensure that the objectives are

industrially relevant. The funding is shared between SERB and industry. The support from SERB is extended only to the academic partner and not to the industry. The industry share should not be less than 50% of the total budget. The funding can be provided for a maximum period of three years. Two projects were funded in partnership with Industry.

#### 2.2.1.5 Intensification of Research in High Priority Areas (IRHPA)

The IRHPA programme supports proposals in high priority areas where multi-disciplinary/ multi-institutional expertise is required which will put our nation in international science map in that

particular discipline. The Board identifies the priority areas in consultation with the stakeholders. The Scheme is under review.

#### 2.2.1.6 Empowerment and Equity Opportunities for Excellence in Science (EMEQU)

The scheme is instituted to ensure enhanced participation of weaker sections of the society

in research and development. The applicant should be an active researcher belonging to the

Schedule Caste and Schedule Tribe category working in academic institutions/ national labs or any other recognized R&D institutions in the field of Science and Engineering. The call for

applications is made once a year. A total of 1485 proposals were received, and 248 proposals were supported for funding in the reporting period.

## 2.2.2 Fostering the Young Researchers (FYR)

Young researchers in the country are supported through the following schemes:

### 2.2.2.1 Early Career Research Award (ECRA)

The scheme aims to provide research support to the young researchers who are in their early career for pursuing exciting and innovative research in frontier areas of science and engineering. Applicants must hold a regular academic/ research position in a recognized academic institution/ or national laboratories or any other recognized R&D institutions and must apply not later than the first two years of their

regular service. The Early Career Research Award is a one-time award and carries a research grant of up to Rs. 50 Lakhs for a period of three years. The call for applications is notified through the website. One call for proposals was solicited and 2897 grant applications were received. A total of 622 projects were sanctioned to young scientists in frontier areas of Science and Engineering.

### 2.2.2.2 National Post-Doctoral Fellowship

The SERB-National Post-Doctoral Fellowship (N-PDF) is aimed to identify motivated young researchers and provide them support for doing research in frontier areas of science and engineering. The fellows are required to work under a mentor. The fellowship is purely a temporary assignment and is tenable for a period of 2 years. The upper age limit for the fellowship is 35 years at the time of the submission of application. Age relaxation

of 5 years is given to candidates belonging to SC/ST/OBC/Physically Challenged & Women candidates. The call for applications for SERB-N PDF is notified once in a year through the website. One call for applications was solicited and 4490 grant applications were received. A total of 570 Fellowships were sanctioned to budding scientists in frontier areas of Science and Engineering.

### 2.2.2.3 Teachers Associateship for Research Excellence (TARE)

The scheme aims to facilitate mobility of faculty members working in a regular capacity in state universities / colleges and in private academic institutions to carry out research work in an established public funded institution such as IITs, IISc, IISERs, NITs, CSIR, ICAR, ICMR labs and other central institutions and central universities, located preferably closer to the institution where the faculty member is working. Research work

will be carried out to ensure that the principal investigator continues to work in the host institute as well as his / her parent institute on mutually agreed terms between the PI and the mentor. One call for applications was solicited and 959 applications were received. A total of 152 applications were recommended for support. A total of 126 sanctions were issued in the reporting period.

## 2.2.3 Building Research Networks (BRN)

SERB has developed significant domestic and international partnership programmes with several agencies. The details are given below:

### 2.2.3.1 Partnership Programmes – National

#### 2.2.3.1.1 IMPRINT (Impacting Research Innovation and Technology)

IMPRINT (Impacting Research Innovation and Technology), is a programme piloted by the Ministry of Human Resource Development (MHRD) which aims to address and provide solutions to the most relevant engineering challenges faced

by our nation by translating knowledge into viable technology (product and processes) in selected technology domains. IMPRINT2, a new and revised edition of IMPacting Research INnovation and Technology (IMPRINT) Programme, has been launched to streamline and simplify the processes and sharpen the focus on translational

research and also to attract wider participation of stakeholders including industry. IMPRINT – 2 is sourced on a corpus set up jointly by the Ministry of Human Resource Development (MHRD) and DST and it also intends to derive contribution from various participating Ministries. SERB has been entrusted for the implementation of IMPRINT projects. In response to an announcement for inviting preliminary proposals, a total no of 2145 proposals were received (IMPRINT – II A&B) out of which 126 proposals were recommended. Finally, 118 projects were sanctioned in 2018-19.

#### **2.2.3.1.2 Partnering with MHRD for Uchhatar Avishkar Yojana (UAY)**

The Uchhatar Avishkar Yojana (UAY) has been launched by the Ministry of Human Resource Development (MHRD) with a view to promote innovation of a higher order that directly impacts the need of the industries, thereby improving the competitive edge of Indian Manufacturing capabilities. The industry-sponsored, outcome-oriented research projects are funded. While MHRD funds 50% of the project cost, industry and other participating Ministries share the balance project cost (25% each). SERB is partnering with MHRD for funding UAY projects. One new project was sanctioned. The Scheme was merged with IMPRINT.

#### **2.2.3.1.3 PM Doctoral Fellowship**

The Prime Minister's Fellowships for Doctoral Research is a Public-Private Partnership (PPP)

### **2.2.3.2 Partnership Programmes – International**

#### **2.2.3.2.1 Visiting Advanced Joint Research (VAJRA) Faculty Scheme**

The Scheme aims to tap the expertise of Overseas Faculty / scientists including Non-resident Indians (NRIs) & OCIs. It offers adjunct / visiting faculty positions to overseas scientist / faculty / R&D professional to undertake high quality collaborative research in public funded academic and research Institutions in India. The Scheme facilitate collaborative research in frontier areas of S&T including the interdisciplinary areas of national priorities such as energy, water, environment, health, security, nutrition, waste processing, advanced materials, high performance computing, cyber-physical systems, smart machines and manufacturing, etc. and stimulate the latent potential of our academic and research sector. The VAJRA Faculty will reside in India up to 3 months in a year and they will

between SERB; Confederation of India Industry (CII) and FICCI. The scheme is for supporting aspiring PhD. Scholars with double scholarship, 50% of which is provided by government (SERB) and balance 50% by a sponsoring industry for doing industrial research for a period of four years. 37 Fellowships were awarded in the reporting period.

#### **2.2.3.1.4 R & D Scheme on Food Processing (MoFPI)**

The Scheme, developed in partnership with Ministry of Food Processing Industries (MoFPI), aimed at extending financial assistance to individual scientists working in various institutions/ universities, Public funded organizations and recognized R&D laboratories both in public and private sector, to promote and undertake demand driven R&D work in the field of Food Processing Sector for product and process development, design and development of equipment, improved storage, shelf-life, packaging etc. The Scheme is closed from SERB side.

#### **2.2.3.1.5 Cell Tower and Mobile Radiation Programme**

The programme aims at studying the effects of cell tower radiations of the population living in the vicinity of the towers. The study was jointly supported by SERB and Department of Telecommunication, Ministry of Communication & Information Technology. No new proposals were solicited.

be provided a lump-sum amount of US \$ 15000 in the first month of residence and US \$ 10000 p.m. after that. The faculty would be physically available for 1-3 months in Indian institutions but maintain an adjunct faculty/scientist status round the year and keep the collaborative lab and co-guided Ph.D. students in India for the whole term providing round the year mentoring and support to students and other researchers. During the reporting period 8 accomplished scientists have been offered VAJRA Facultyship. From the earlier batch, 8 scientists had made their collaborative research visits.

#### **2.2.3.2.2 Overseas Doctoral Fellowship Scheme**

The Board offers Overseas Doctoral Fellowship to build national capacity where the talent supply of researchers in areas of interest to the

country is sub-critical. The Scheme is limited to only specified Universities namely, Cambridge University, Stanford University, University of Southern California, Carnegie Mellon University, University of California, Rice University and University at Buffalo, The State University of New York and University of British Columbia, Canada with which SERB had entered a MoU. The MoU ensures that each and every SERB Overseas Doctoral Fellow will be getting tuition fee waiver / support from the University concerned. Selected fellows are provided US \$24,000 per annum for a period of 4 years. In addition, one-time Contingency/ Preparatory allowance of Rs. 60,000/- and to & fro Airfare (Economy) is given to the fellows. 13 students have been awarded the fellowship in the reporting period.

#### **2.2.3.2.3 Overseas Visiting Doctoral Fellowship Scheme**

The Scheme is designed with a primary objective to offer opportunities for PhD students admitted in the Indian institutions for gaining exposure and training in overseas universities / institutions of repute and areas of importance to country for period up to 12 months. The first call for application under the scheme was announced in the year 2018-19 and 40 researchers have been selected for the fellowship to pursue their short-term doctoral research in 24 different countries around the world under renowned guides of various Institutions/ Universities. Under the SERB-Purdue University OVDF programme 25 students were selected. Under the SERB-UAlberta OVDF scheme 10 students were selected.

#### **2.2.3.2.4 Newton – Bhabha International Fellowships**

It is a joint initiative with the Royal Society of the United Kingdom to enhance capacity in the area of research and innovation. A MoU has been signed between The Royal Society and SERB to institute 15 Newton – Bhabha International Fellowships per year to the Indian research community, covering fields of Science, Technology, Engineering and Mathematics (STEM). Applicants must hold regular positions in institutions based in India or should have completed PhD degree in science, engineering and mathematics from recognized institutions in India. The awards are given up to two consecutive years in length spent in the UK, undertaking research at a host university or research institute. The awards provide a stipend, research expenses and relocation expenses and provide up to an

amount of £99,000 for two years. All applicants must identify a UK co-applicant who will host them whilst they are in the UK. 15 researchers have been offered the fellowship in the reporting period.

#### **2.2.3.2.5 SN Bose Scholars Program**

SN Bose Scholars Program is a dynamic student exchange programme developed in partnership with Indo-U.S. Science and Technology Forum (IUSSTF) and Winstep Forward. It provides an opportunity to Indian and U.S. students enrolled in Bachelors and Masters programs to undertake a research internship. The internship programme is conducted for 50 Indian students to intern at partner Universities in the U.S. for a period of 10-12 weeks beginning each summer. The programme also supports 30 U.S. students to intern at a recognized Indian educational institution for a similar duration. The SERB through IUSSTF will pay Stipend, Accommodation and Air-fare of the Indian Scholars; and Scholars from US will receive dollars equivalent amount of Rs. 50,000/- as Stipend. 50 students have been offered Internship in the reporting period.

#### **2.2.3.2.6 SERB-NSF Graduate Student Exchange Programme**

The scheme is a coordinated effort between National Science Foundation (NSF), USA and SERB to provide opportunities for enhanced professional development through research collaboration in top caliber research environments for U.S Graduate Research Fellows (GRF) under the Graduate Research Opportunities Worldwide (GROW) program. U.S GRF is placed in select top research institutions in India for a period of 3-12 months. The selection of the GRF was done by NSF with the concurrence of the Indian host. Two NSF Graduate Research Fellows had undertaken the research visit in the reporting period.

#### **2.2.3.2.7 Partnership for International Research and Education (PIRE)**

PIRE is a highly prestigious international collaborative programme of NSF aimed to leverage the monetary resources of funding agencies as well as intellectual capabilities of research groups all over the world in front line areas of research and education. India has joined the PIRE programme through a bilateral agreement between SERB and NSF. One project being implemented at Indian Institute of Astrophysics, Bengaluru was completed in the reporting period.

## 2.2.4 Strengthening Linkages with Society (SLS)

SERB adopted policies to connect its programmes with the society.

### 2.2.4.1 Scientific Social Responsibility (SSR) Policy

In order to effectively utilize the R&D infrastructure and expertise of SERB grantee to benefit other S&T stakeholders and the society and also to embed a participatory, inclusive and sustainable culture of social responsibility among SERB grantee, the SERB Board has adopted a Scientific Social Responsibility (SSR) policy as an integral part in SERB Programmes. The number of SERB grantees

involved in SSR activities in a year would be more than 10000 and beneficiaries of the SSR efforts would be about 20000 researchers, 20000 faculty, 1000 students through internships, 20000 students through one-day visit to PI institution and about 1.5 lakh students through individual lectures and millions of people through public outreach activities.

## 2.2.5 Awards & Recognitions (A&R)

### 2.2.5.1 J C Bose Fellowship

J C Bose Fellowship is instituted to recognize and support active Indian scientists and engineers for their outstanding performance in R&D and significant contribution towards scientific

research. The fellowship is scientist-specific and very selective. 59 Fellowships were awarded in the reporting period.

### 2.2.5.2 Ramanujan Fellowship

Ramanujan National Fellowships are offered to brilliant scientists returning from all over the world to take up scientific research positions in India. It is directed to scientists and engineers below the age of 45 years, who want to return to India from

abroad. The Ramanujan Fellows can work in any of the scientific institutions and universities in the country. The duration of Ramanujan Fellowships is five years. 46 Fellowships were awarded.

### 2.2.5.3 SERB Distinguished Fellowship

SERB Distinguished Fellowship Scheme is meant for eminent and performing senior scientists to continue active research even beyond their

superannuation. 11 Fellowships were awarded in the reporting period.

### 2.2.5.4 Year of Science Chair Professorship

The Chair Professorship is presented as benchmark of performance, stature, value and eminence in the national and international arena. The Awardee should be a distinguished Indian Scientist who has made outstanding contributions in any one or more areas of Science & Technology, Engineering and Mathematics and should have proven track record of exceptional research

achievements during last 10 years, including continued excellent research output in the last 5 years preceding the year of consideration, mentoring young researchers and involved in policy making. The tenure of YoSCP would be for a period of five years initially and extendable through assessment based on performance. 2 awards were conferred in the reporting period.

### 2.2.5.5 Distinguished Investigator Award (SERB-DIA)

This is a one-time career award to reward good performance as well as to motivate ongoing PIs to perform exceedingly well. This positive reinforcement strategy would effectively improve the productivity of research undertaken and

overall efficiency of the research ecosystem. Submission of application under SERB-DIA Scheme is only by invitation. A total of 12 awards were given to performers. The Scheme is under review.

### 2.2.5.6 SERB Women Excellence Award

SERB Women Excellence Award is a one-time award given to women scientists below 40 years of age and who have received recognition

from any one or more of the following national academies such as Young Scientist Medal, Young Associate etc.

- a. Indian National Science Academy, New Delhi
- b. Indian Academy of Science, Bangalore
- c. National Academy of Sciences, Allahabad
- d. Indian National Academy of Engineering, New Delhi
- e. National Academy of Medical Sciences, New Delhi
- f. National Academy of Agricultural Sciences, New Delhi

8 Awards were conferred to women scientists in the reporting period.

## 2.2.6 Support for Science and Technology Events (SSTE)

### 2.2.6.1 International Travel Support Scheme (ITS)

ITS scheme is designed to provide financial assistance for presenting a research paper or chairing a session or delivering a keynote address in an international scientific event (conference/seminar/symposium/ workshop etc.) held abroad. In addition, support is also provided to young scientists (age limit 35 years as on date of

conference) for attending training programs and short-term schools/workshop/courses. Economy class airfare by shortest route, airport taxi and visa fees are provided under the scheme. Registration fee is also provided to young scientists in addition to the above support. A total of 1703 researchers were supported.

### 2.2.6.2 Assistance to Professional Bodies & Seminar/Symposia

The programme extends partial support for organizing seminar/symposia/training program/workshop/conferences at national as well as international level. The support is provided to Research Institutes/ Universities/ Medical and Engineering colleges and other Academic Institutes/ Professional bodies who organize such events for the scientific community to

keep them abreast of the latest developments in their specific areas. It is generally given for encouraging participation of young scientist and research workers in such events and publication of proceedings and abstract for wider dissemination. The programme also supports S&T professional bodies. 509 events were partially supported in the reporting period.

## ▶▶ 2.3 Midcourse Review

SERB connects the S&T system through 34 Schemes and Programmes operating at various levels with well-defined objectives. Some of the schemes lived more than 4 decades and some completed 3 years and a few just started its operation. The Board revisited the SERB portfolio and approved the following:

### A. Programs to Continue - Following programmes continue with the stated objectives:

- i. Core Research Grant
- ii. EMEQ
- iii. TARE
- iv. NPDP
- v. JC Bose Fellowship
- vi. Ramanujan Fellowship
- vii. Women Excellence Award
- viii. PM Doctoral Fellowship
- ix. Abdul Kalam TIN Fellowship

- x. SRS
- xi. VAJRA
- xii. ITS
- xiii. Seminar Symposia
- xiv. IMPRINT 2

### B. Programs to phase out- Following programmes were decided to discontinue:

- i. Cell Tower Radiation
- ii. R&D Scheme of MoFPI
- iii. UAY (Concluding in FY 2021-22)
- iv. Ayurvedic Biology (To be kept in abeyance)
- v. GROW
- vi. Indo-US Grand Challenge
- vii. PIRE
- viii. Newton Bhabha International Fellowship (Discontinue once the MoU period is concluded)

- ix. SN Bose Scholar Program
  - x. Overseas Doctoral Fellowship (Discontinue once the MoU period is concluded)
  - xi. Overseas Visiting Doctoral Fellowship (To be integrated with national programmes)
- C. Programs to redefine/ restructure - Board approved modifications in the following schemes:**
- i. Early Career Research Award (ECRA) Scheme is renamed as 'Start-up Research Grant (SRG)'
  - ii. High Risk High Reward - To give an appropriate name to elucidate the intent of the scheme.
  - iii. Industry Relevant R&D
  - iv. Intensification of Research in High Priority Areas (IRHPA)
  - v. Distinguished Investigator Award (DIA)
  - vi. Year of Science Professorship and Distinguished Fellowship - Merger of Schemes to 'National Science Chair'.
  - vii. Overseas Postdoctoral Fellowship (OPDF) – Renamed as SERB International Research Experience (SIRE) Program
  - viii. MATRICS – To include quantitative social science

## ▶▶ 2.4 New Initiatives

### 2.4.1 SERB Research Scientist (SRS)

SERB introduced a new scheme titled 'SERB Research Scientist (SRS)' for the awardees of INSPIRE Faculty and Ramanujan Fellowships, who

fail to secure regular positions after completion of the regular tenure of five years in the respective schemes.

### 2.4.2 Intellectual Property Right Policy

SERB continues to adopt the following IPR policy:

- The projects supported by the SERB that have potential for generating know-how in the form of product/ process/ design etc. through patents, copyrights etc. should follow their Institute mechanism for, patenting/ copyright.
- The right to IP ownership will normally remain with the grantee institution(s), unless SERB decides to invoke its primacy over the ownership in specific cases and circumstances with proper justification.
- IPR generated through joint research projects by institution(s) and industrial concern(s) through joint efforts can be owned jointly by them as may be mutually agreed to by them through a written agreement.

### 2.4.3 Restructuring of Programme Advisory Committees (PAC) in Life Sciences

The Board approved replacement of the existing PACs in Life Sciences by the following PACs:

- Organismal and Evolutionary Biology
- Interdisciplinary Biological Sciences
- Biomedical Sciences and Health Systems

### 2.4.4 Policy on co-funding of R&D projects from National Laboratories and Institutes

The Board approved that

- The proposals from National Laboratories and Research Institutions should be in line with the mandated research work of the lab/ institutions. It follows a certification from the Institute concerned.
- All National Laboratories and Research Institutions should share 50% of the non-recurring cost in all EMR Projects.
- Projects that go to the Empowered Committee (over 80 lakhs), 50% of non-recurring & consumables cost should be shared by National Laboratories and Research Institutions.

### 2.4.5 Adoption of revision of fellowship for JRF/SRF/RA in SERB Programmes

The Board approved the adoption and payment of revised fellowship as given in DST Office Memorandum No. SR/S9/Z-08/2018 dated 30.01.2019 in SERB sponsored R&D Programmes for JRF/SRF/RA categories of researchers with effect from 1st January 2019.

## 2.5 Process and Procedural Flows

The applications from the candidates in majority of the online programmes undergo the following process of scrutiny, selection and recommendation, prior to the funds are disbursed (Figure 2.4a & 2.4b).

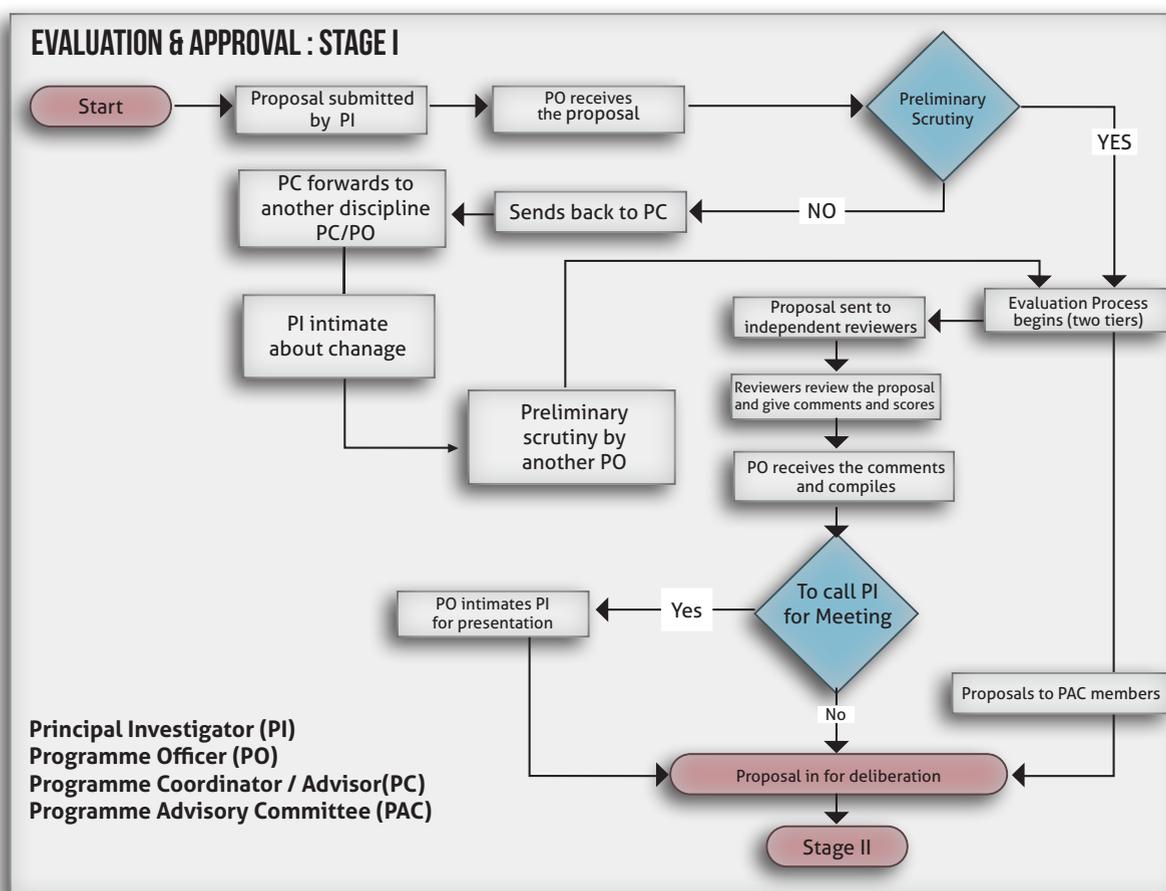


Figure 2.4a : Acceptance of proposal for final evaluation.

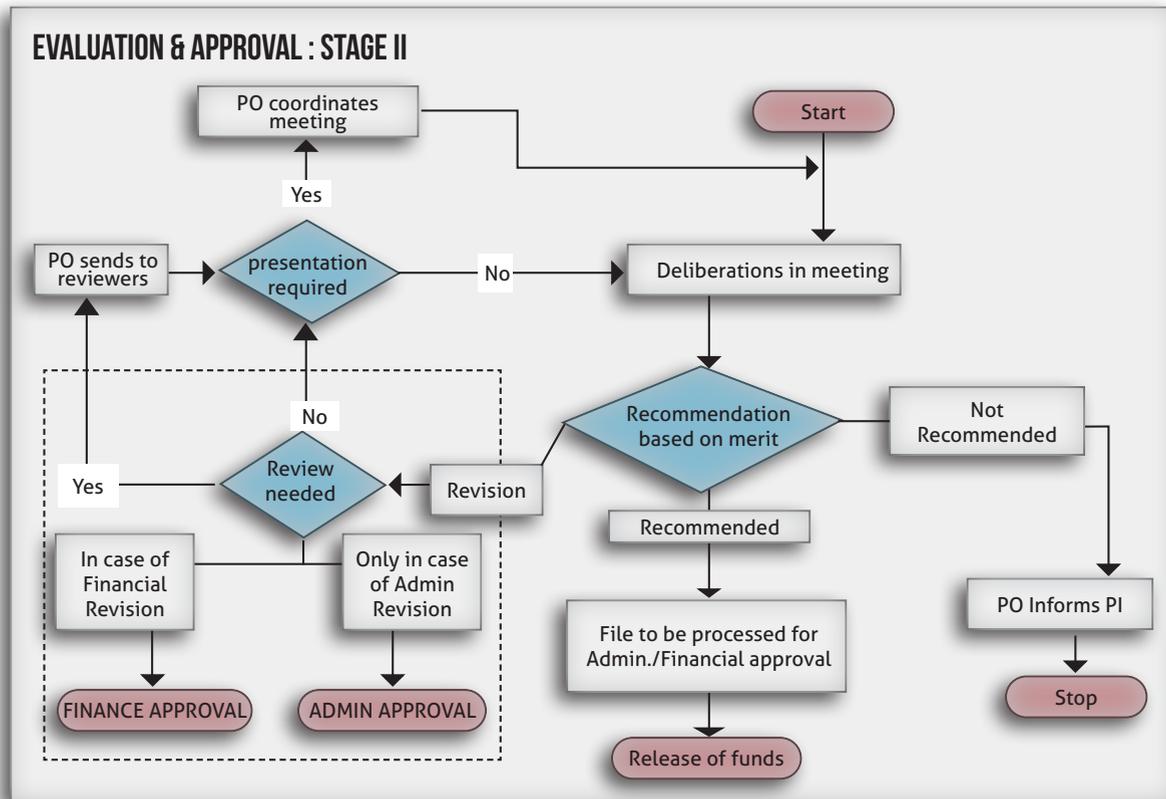


Figure 2.4b : Technical approval procedure prior to release of funds.

## ▶▶ 2.6 VITAL STATISTICS

### 2.6.1 Sanctioned Proposals During the Last Six Years

The number of sanctioned projects/fellowships under major schemes namely CRG/EMR, YSS, ECRA and NPDF are given below (Figure 2.5).

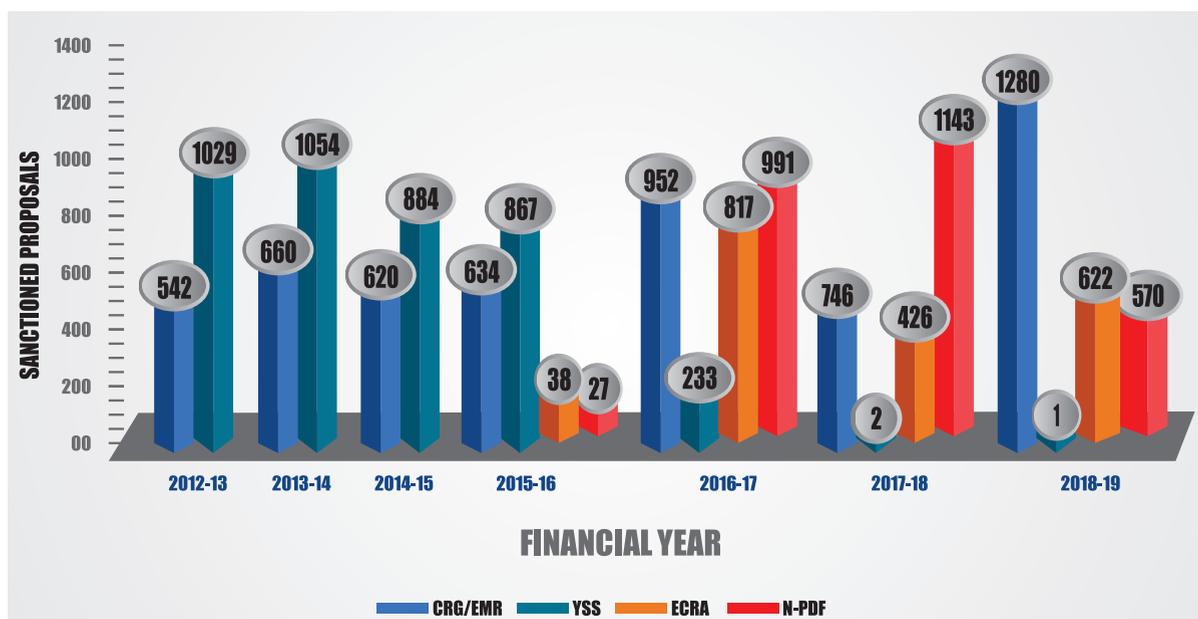


Figure 2.5: Number of sanctioned projects/fellowships under the major schemes during the last few years.

### 2.6.2 Total Expenditure for the Year 2018-19

The chart given below shows the total expenditure (in crore) in the year 2018-19 under different schemes and administrative heads (Figure 2.6).

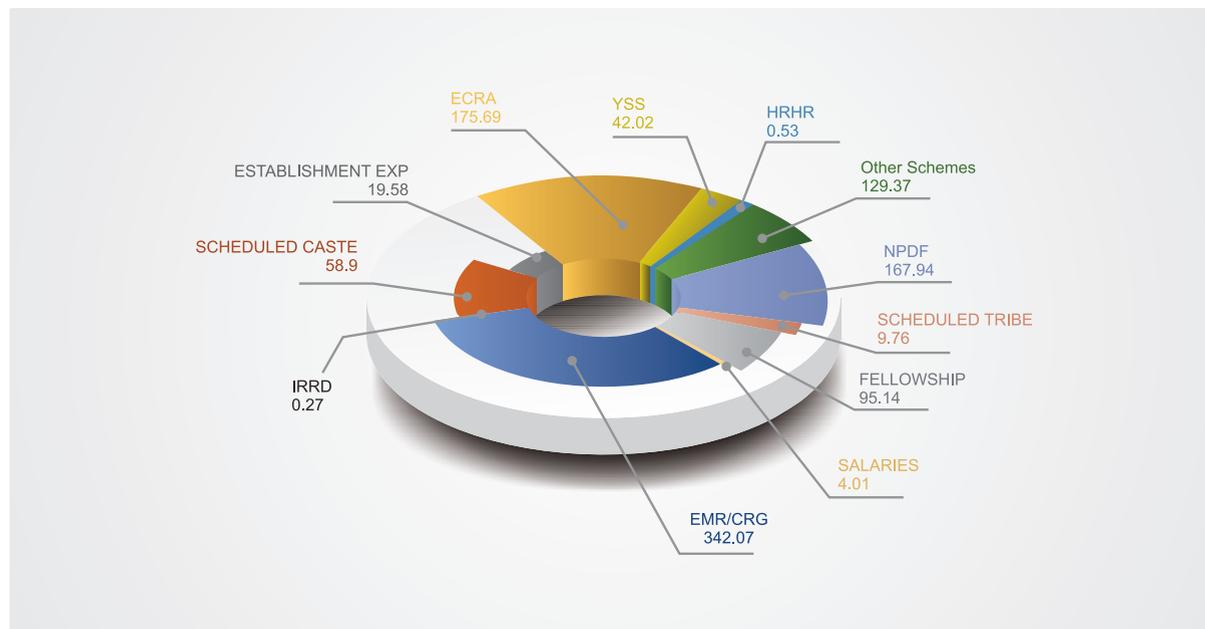


Figure 2.6: The total expenditure in the year 2018-19 under different heads.

As seen from the diagram maximum funds have been disbursed under the three major schemes namely CRG/EMR, NPDF, ECRA.

### 2.6.3 New Proposals Sanctioned During the Year 2018-19

The number of new proposals sanctioned in the year 2018-19 under CRG scheme distributed sub-discipline wise is given below (Figure 2.7).

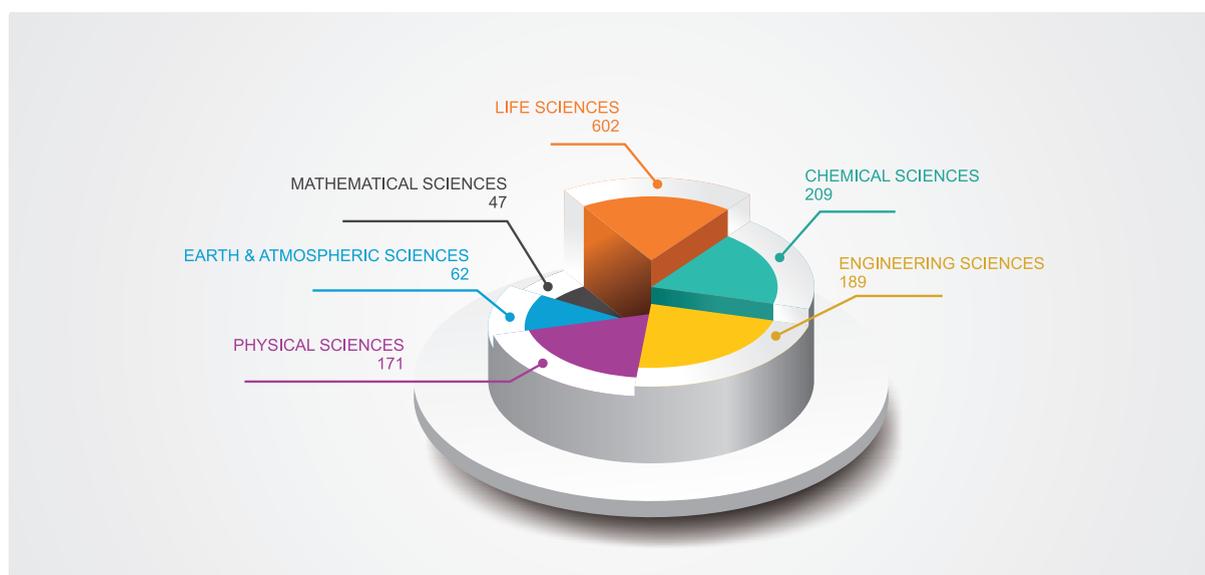


Figure 2.7: New Proposals sanctioned under CRG scheme in the financial year 2018-19.

As seen from the figures, it is evident that Life Sciences forms a major part of the funding under CRG scheme.

The number of new proposals sanctioned in the year 2018-19 under ECRA and N-PDF scheme distributed sub-discipline wise is given below in Figure 2.8(I) and 2.8(II).

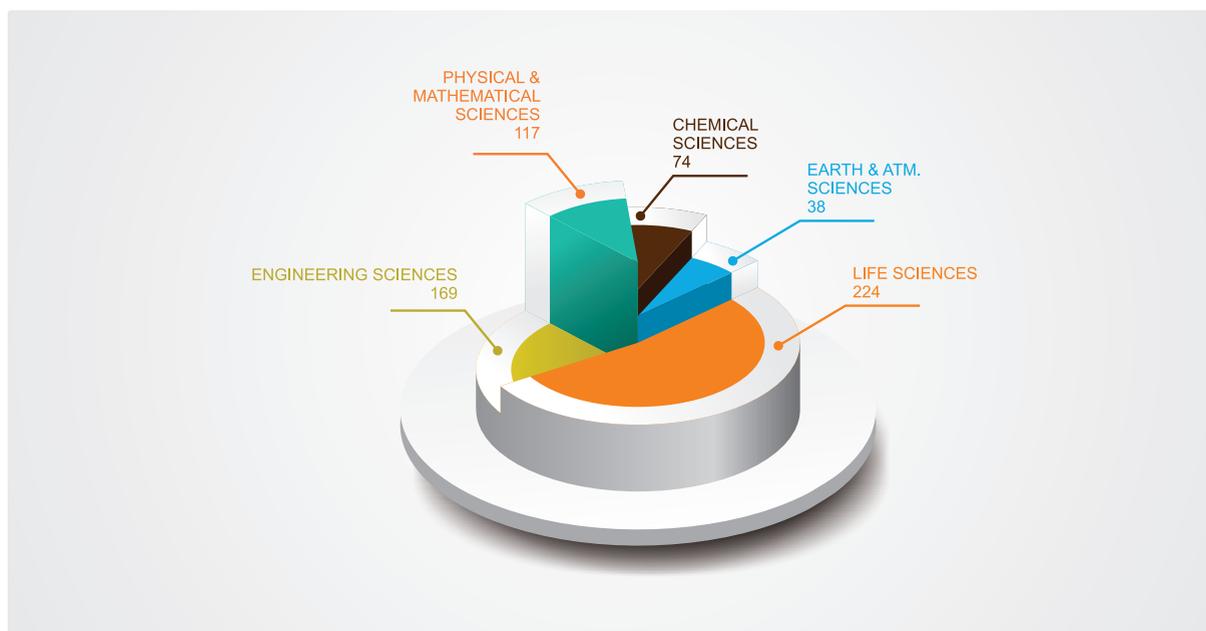


Figure 2.8 (I): New Proposals sanctioned under ECRA scheme in the financial year 2018-19.

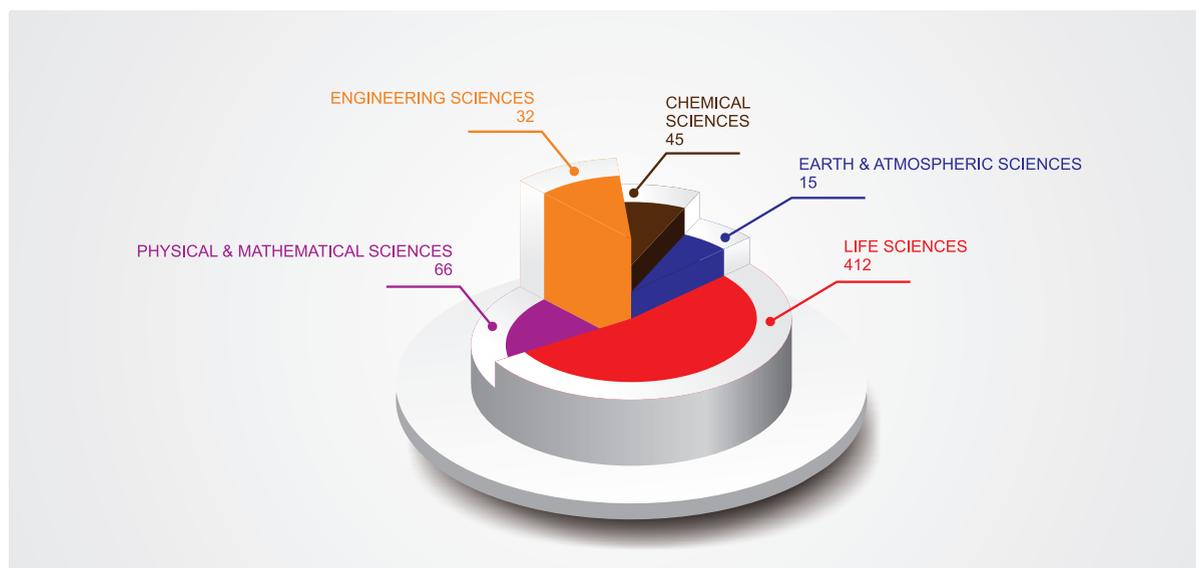


Figure 2.8 (II): New Proposals sanctioned under N-PDF scheme in the financial year 2018-19.

As seen from the figures, it is evident that Life Sciences forms a major part of the funding under all the schemes followed by Engineering Sciences and Physical and Mathematical Sciences.

## 2.6.4 Participation of Women

The participation of women under major schemes of SERB in the financial year 2018-19 is given below (Figure 2.9).

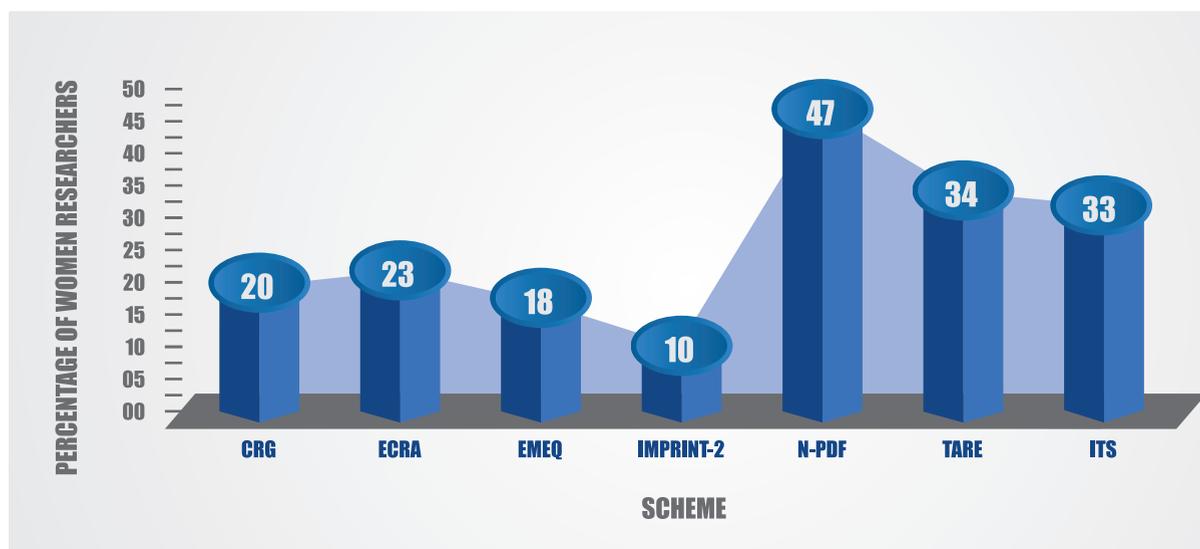


Figure 2.9: Scheme-wise Percentage of Women Researchers

## 2.6.5 Participation of Researchers in the Age Category $\leq 40$ years

The participation of researchers in the age category of less than or equal to 40 years under some of the major schemes in SERB for the year 2018-19 are given below (Figure 2.10).

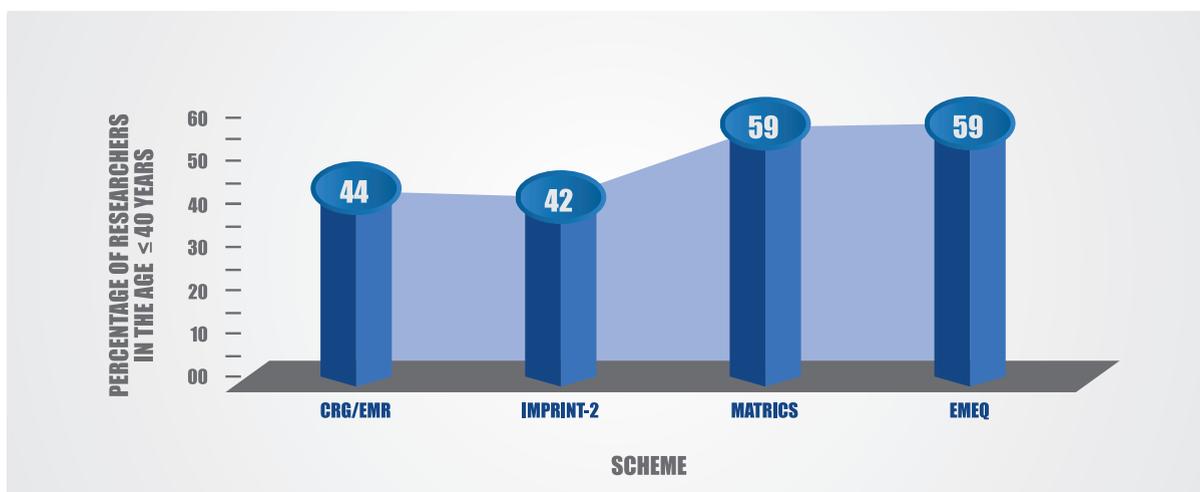


Figure 2.10: Participation of researchers in the age  $\leq 40$  years

As seen from the figure, young researchers have received significant support under major SERB programmes.

## ►► 2.7 Human Resource Development

HRD initiatives undertaken through financial support, training/schools and various schemes of SERB are detailed below in table 2.1 and 2.2.

**Table 2.1** : Manpower sanctioned under different Schemes/Programs during the year 2018-19

Name of the schemes	JRF/SRF	Staff other than JRF/SRF	Total
CRG	893	256	1149
EMEQ	228	7	235
ECRA	434	72	506
IMPRINT	150	138	288
<b>Total</b>	<b>1705</b>	<b>473</b>	<b>2178</b>

**Table 2.2** : Training/Schools conducted during the year 2018-19.

S.No.	Title	Place of Training/Schools	No. of Participants
1.	Theoretical High Energy Physics	School of Physics, University of Hyderabad	40
2.	Theoretical High Energy Physics	IISER, Pune	40
3.	Nonlinear Dynamics	Department of Physics, Guru Nanak Dev University, Amritsar	40
4.	Ultrahigh intensity laser produced plasmas	Raja Ramanna Centre for Advanced Technology, Indore	40
5.	Experimental High Energy Physics	TIFR, Mumbai	40
6.	Nuclear Astrophysics	Saha Institute of Nuclear Physics, Kolkata	40
7.	Numerical Modeling & Forecasting of Desert Storms and Cloudburst (NUMCLOUDS)	Department of Atmospheric Science, Central University of Rajasthan	45
8.	Application of Isotope Techniques in Water Resources Management	KSCSTE- Centre for Water Resources Development (CWRDM), Kozhikode	23
9.	Annual SERB School in Chemical Ecology	National Centre for Biological Sciences, TIFR, GKVK, Bangalore	25
10.	SERB school in Evolutionary Biology	Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur, Bangalore	27

## ▶▶ 2.8 SERB REACH

SERB connects large segment of researchers through its various programmes. A snapshot of the SERB Reach is depicted in Figure 2.11.

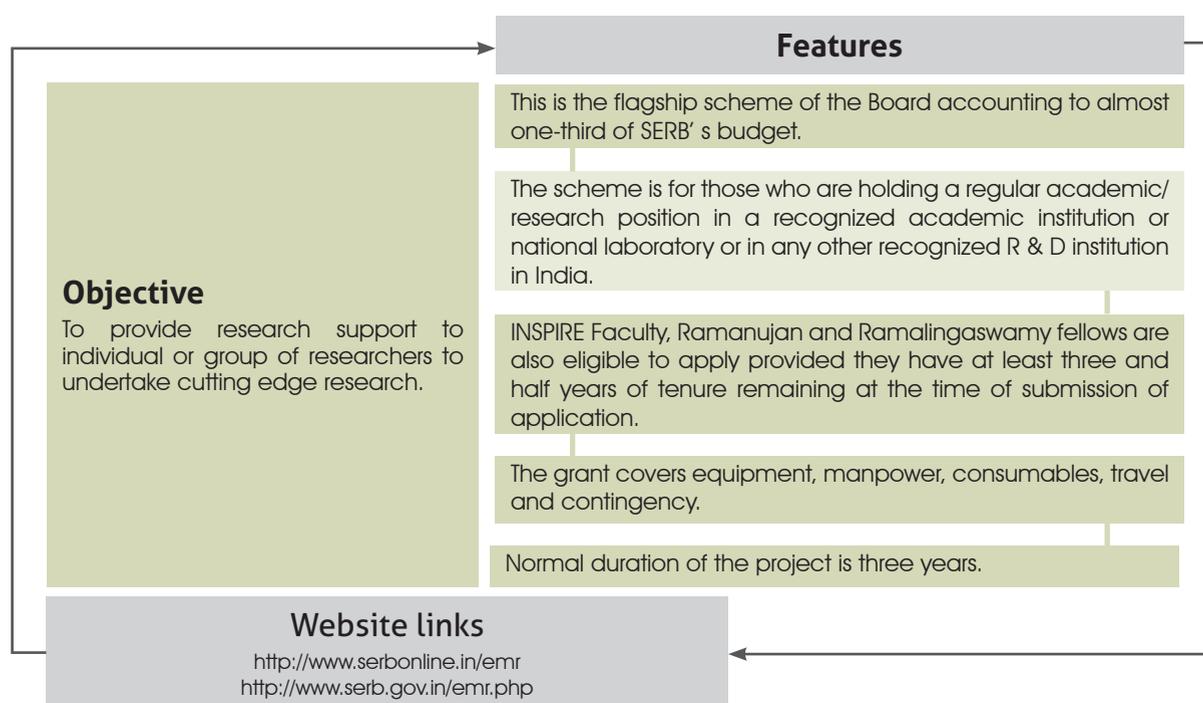


Figure 2.11: SERB Connectivity-Major Schemes.

### 3 SUPPORTING CORE RESEARCH & INNOVATION

At the outset, it is imperative to note that the Indian scientific eco-system is critically balanced on different funding programs under SERB. Potential scientists are supported across the country for undertaking research and development in frontier areas of Science and Technology under CRG, IRRD, HRHR, IRHPA and EMEQ.

#### ▶▶ 3.1 Core Research Grant (CRG)



A national call inviting proposals from prospective scientists was done in June-July 2018. The proposals received and recommended under various disciplines are given in the table below (Table 3.1).

**Table 3.1:** The table shows number of proposals received and recommended under CRG scheme in the financial year 2018-19.

Area	PAC	Total Proposal Received	No. of Proposal Recommended by PAC
Chemical Sciences	Organic Chemistry	250	45
	Inorganic and Physical chemistry	391	60
Earth and Atmospheric Sciences	Earth and Atmospheric Sciences	185	20
Engineering Sciences	Civil and Mechanical Engineering	603	46
	Materials, Mining and Minerals Engineering	105	21
	Electrical, Electronics and Computer Engineering	772	57
	Chemical & Environmental Engineering	261	42

Area	PAC	Total Proposal Received	No. of Proposal Recommended by PAC
Life Sciences	Animal Sciences	257	53
	Plant Sciences	455	42
	Health Sciences	955	86
	Biochemistry, Biophysics, Molecular Biology and Microbiology	380	21
Mathematical Sciences	Mathematical Sciences	93	15
Physical Sciences	Physical Sciences	507	98
Total		5214	606

Altogether, the CRG scheme indicates a pass percentage of 11.62 in the reporting period.

### 3.1.1 Chemical Sciences

#### 3.1.1.1 Organic Chemistry

A total of 85 projects were sanctioned in different sub disciplines as given in Figure 3.1.

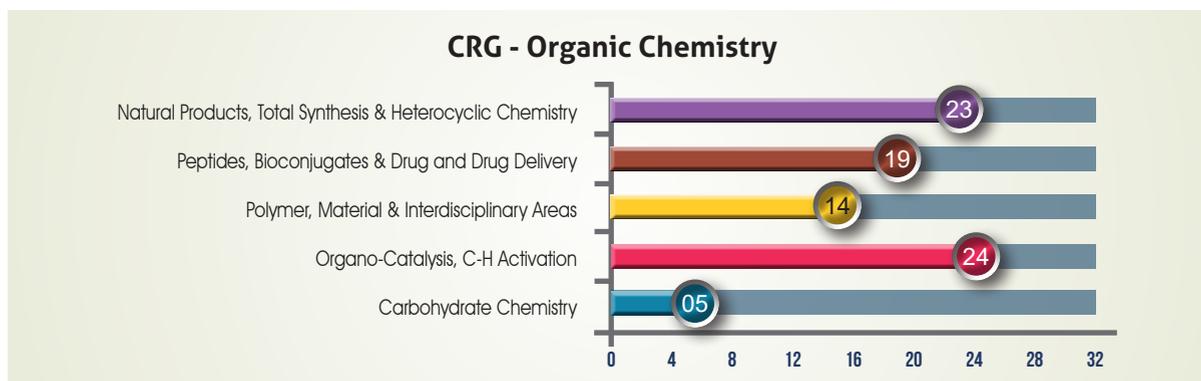


Figure 3.1: Projects supported in different sub disciplines of Organic Chemistry.

### Research Highlights

**Chemical methodologies directed towards the synthesis of antibody-drug conjugates:** Protein-based therapeutics is experiencing rapid global growth. Its capability to render target-specific treatment of chronic diseases, especially cancer has invited considerable attention. In this perspective, the chemical toolbox for precise engineering of proteinosis is essential. Unfortunately, the limited understanding in the area has been the major roadblock and kept the community away from success. In this perspective, precision protein engineering technology has been developed in this project by a group of researchers at IISER Bhopal.

The initial work involved the understanding of diverse parameters that regulate the protein modification. This knowledge led to the development of chemical methods that can

engineer a single Lys residue in a protein. In parallel, it also inspired the genesis of a technique capable of modifying a single His residue in a protein. The combined knowledge acquired over the first couple of years of the project led to the disruptive innovation of linchpin directed modification, the first ever modular platform for single-site engineering of native proteins.

The technology has opened the gateway for understanding and steering the properties of proteins in biological systems. It operates under very mild conditions and ensures that the structure and function of modified proteins are not affected adversely. For example, the cellular uptake of modified insulin and its downstream signalling process remain unperturbed. Finally, it was demonstrated that these methods could deliver homogeneous antibody-drug conjugates

(ADCs) for directed cancer chemotherapeutics. It was demonstrated that the ADCs exhibit selective anti-proliferative activity toward HER-2 positive SKBR-3 breast cancer cells. These ADCs target the breast cancer cells at very low concentration

without harming the healthy cells. The studies will help the community in the development of drugs for the aggressive type of breast cancer that is HER2-positive. (Figure 3.2).

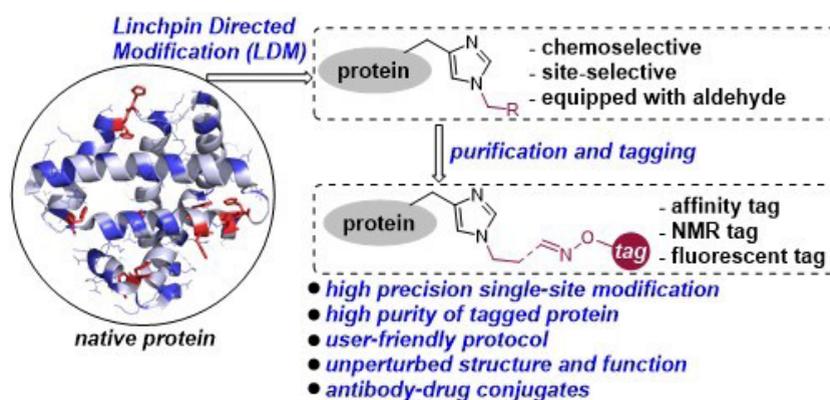


Figure 3.2: Precision technology for protein engineering.

### 3.1.1.2 Inorganic and Physical Chemistry

A total of 124 projects were sanctioned in different sub disciplines as given in Figure 3.3.

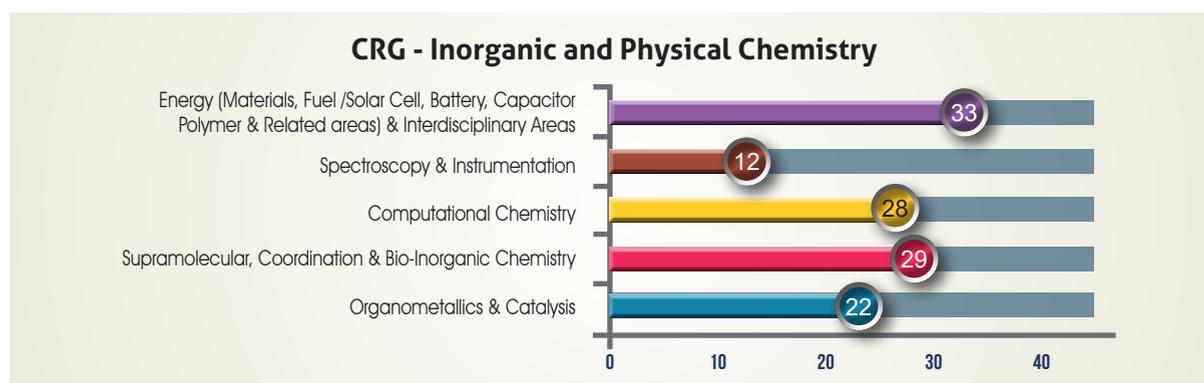


Figure 3.3: Projects supported in different sub disciplines of Inorganic and Physical Chemistry.

## Research Highlights

### Synergistic participation of redox non-innocent azo-aromatic ligand(s) and metal in catalysis:

With the advent of forward-looking digital technologies like Internet of Things (IoT), Artificial Intelligence (AI), automotive vehicles, Non-Volatile Memories (NVM) are becoming ubiquitous. Flash memories are currently the commercial product in use as NVM; however, they are unable to meet the requirements demanded by the industry and hence an alternative is being heavily sought for. Resistive memory devices, a two-terminal electrical switch that retains the state of internal resistance based on the history of applied voltage overcomes both the limitations and is considered as an alternative. While a variety of materials has historically been studied as resistive memories, oxide-based devices have been

the most successful out of the lot. Almost all the devices, including oxides, work on a filamentary mechanism which is a stochastic process, brings forth device-inconsistencies- the biggest challenge in resistive memory technology. This is where organic devices come into the picture which, apart from providing a cost-effective fabrication and mechanical flexibility could, in principle, also offer a molecular level precise control of the film conductance. Despite decades of efforts, such devices lack far behind the metrics. Primary challenges include lack of consistency, low endurance, high switching voltage and incomplete mechanistic understanding.

A new class of resistive memory devices based

on solution processed, spin-coated metal complexes of redox active azo-aromatic ligands have been developed (Figure 3.4 a) by a group of researchers at IACS, Kolkata which can potentially offer a quantum leap in organic-memristor research. An organic memory device (Figure 3.4 b & c) which shows high reproducibility over 350 devices (Figure 3.4 d & e) and offers excellent endurance (1012 cycles) and stability ( $10^6$  s, at 350K) along with ultra-low switching energy, when scaled down to  $\sim 60\text{nm}^2$  area. The reproducibility and device consistency reported in this work have no parallel in literature. The molecule has three ligands coordinated to the metal centre. The film conducts when the ligands are in the same electronic (i.e. redox) state while it shows

a low conductance when they are in a mixed redox state. The choice of 2-(phenylazo) pyridine ligand is crucial since it offers low lying  $\pi^*$  orbitals which when coordinated to  $\text{Ru}^{\text{II}}$ , brings the Lowest Unoccupied Molecular Orbital (LUMO) energy of the complex down to  $-4.42$  eV. Besides offering a remarkable performance, the devices are well understood based on *in-situ* spectroscopic techniques. In terms of performance, these devices meet all the requirements specified in the International Technology Roadmap for Semiconductors (ITRS, 2015). At present, based on the understanding developed in the process, new molecules and device-geometries are being developed to realize an increase in number of controlled conductance plateaus.

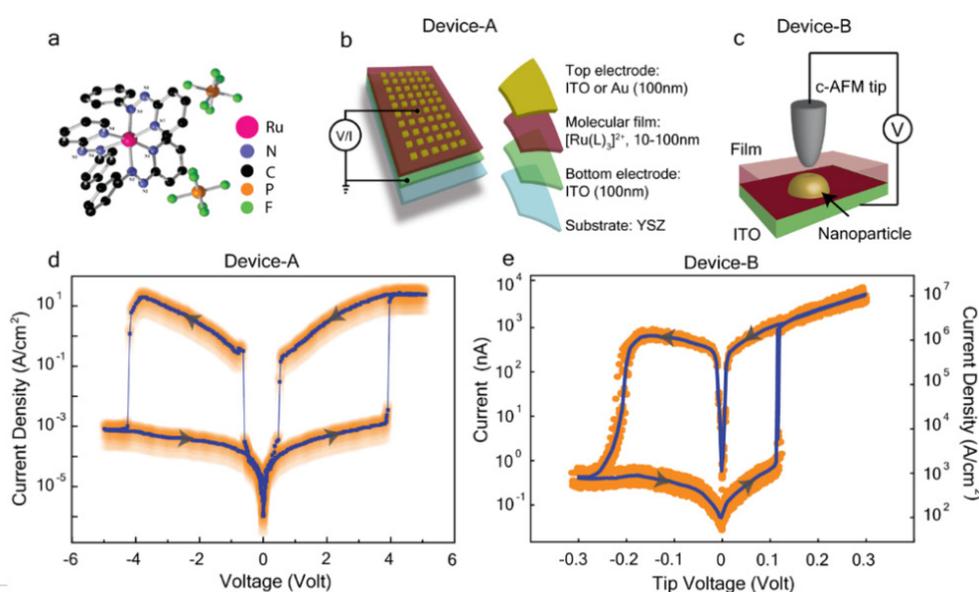


Figure 3.4: (a) Molecular view of the compound mer-[Ru(L)3] (PF6)2, (b, c) Schematic of our devices, (d, e) J(V) of (d) device-A and (e) device-B.

### 3.1.2 Earth & Atmospheric Sciences

A total of 62 projects were sanctioned in different sub disciplines as given in Figure 3.5.

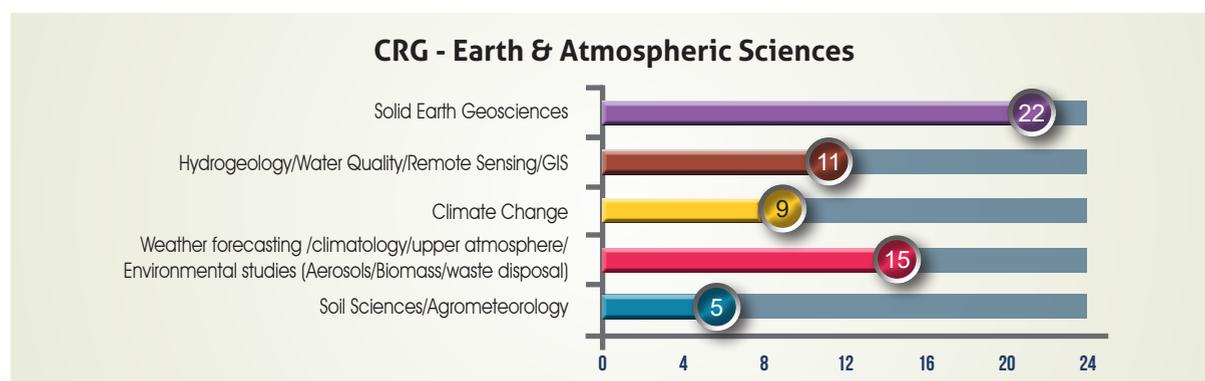


Figure 3.5: Projects supported in different sub disciplines of Earth & Atmospheric Science.

## Research Highlights

### Sedimentology and climatic events of the Gangotri Glacier Area, Garhwal Himalaya, India:

Gangotri Glacier is one of the longest glaciers located in Kumaun and Garhwal Himalaya. It has attracted international attention due to its rapid rate of retreat. However, different scientists have proposed different views for pattern of retreat for the Gangotri glacier due to difficulties in the identification of landforms because of their modification by non-glacial processes (Singh et al., 2017). It has also been explained that only glacial morphological zones can provide accurate information for the pattern of retreat. It has been indicated that the rate of Gangotri Glacier is continuously decreasing and is not in accordance with the anthropogenically induced global warming (Singh et al., 2017). For the first time total glacial and non-glacial geomorphic features were explained by a research group in Centre of Advance Study in Geology, University of Lucknow, Lucknow-226 007. The non-glacial processes include mass movement, fluvial, pluvial, lacustrine, and landslide lake outburst flooding (LLOF) or glacial lake outburst flooding (GLOF). These processes originate due to deglaciation over a wide range of timescales (Singh et al., 2017). It is difficult to identify various types of diamictites and landforms (Owen, 1992) the facies for all the landforms were established which is important to differentiate between various types of landforms/diamictites. It has been described that in a glaciated terrain the glacial landforms are modified by non-glacial landforms which was reconfirmed after Kedarnath tragedy. The sedimentary facies for all the landforms of the Gangotri Glacier area have been identified for

the first time. The sediment grain parameters for all the geomorphic features were analysed. The palaeo-sedimentary environments were reconstructed and finally the sedimentology of the area was established. The textural/litholog, sediment grain parameters and sedimentary facies helps to differentiate between various types of landforms and diamictites [Figure 3.6]. The fluvial deposits have been identified near snout of the Gangotri Glacier for the first time. The study explains the glacial stages and weak Indian Summer Monsoon (ISM) around 19.5, 14.5, 13.1, 10.1, 8.6, 7.5, 2.2, 0.54, 0.08 ka BP and warm and intense ISM during 23.9, 22.7, 19.4, 1.15, 0.05 ka BP. The higher percentage of clay around 0.65-0.2 ka BP (1300-1750 AD) and higher percentage of silt and low clay content around 1.15-0.55 ka BP (800-1400 AD) validates the LIA (Little Ice Age) and MWP (Medieval Warm Period) respectively (Singh et al., 2019). A model for the generation and transportation of debris/sediments has been proposed. The glaciated terrain consists of boulder and so far, better and accurate sedimentary analysis boulders have been sub-divided into three; small size (25-60cm), medium size (60-150cm) and large size (>150cm). Three main depositional regions were identified- 1) glaciogenic environment having ice contact zone in which deposition takes place at lateral and frontal margins of the glacier, 2) proglacial environment having glaciofluvial zone in which deposition takes place in flat area in front of the glacier, and 3) paraglacial environment having periglacial zone in which deposition takes place away from the glacier by lacustrine, mass movement, fluvial and flash floods.

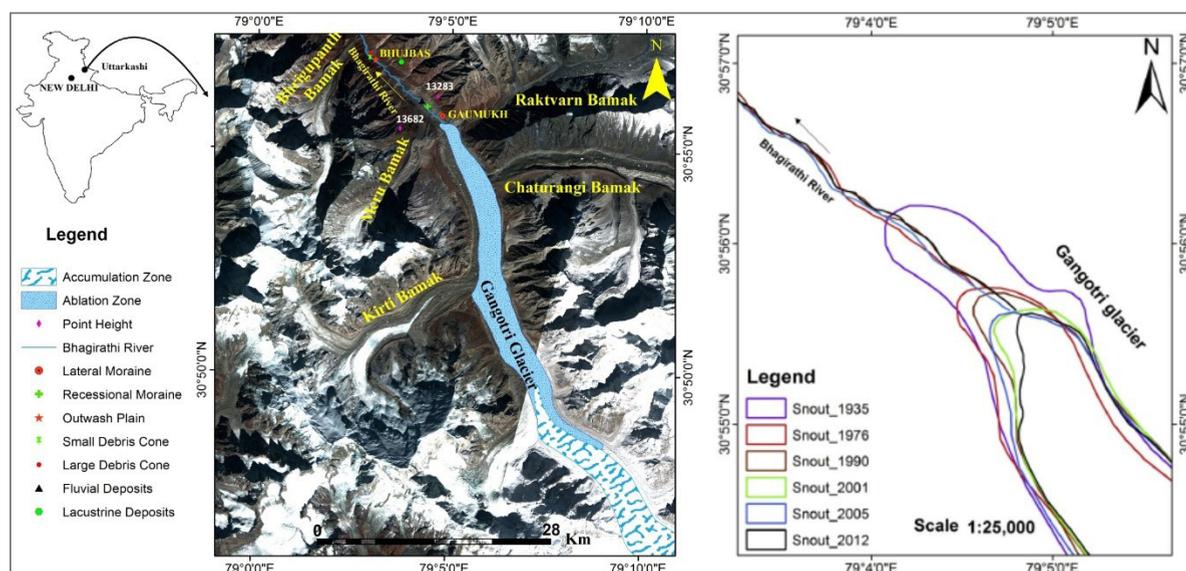


Figure 3.6: Map showing location of stations of textural/lithologies in Gangotri Glacier Area.

### 3.1.3 Engineering Sciences

#### 3.1.3.1 Civil and Mechanical Engineering

A total of 44 projects were sanctioned in different sub disciplines as given in Figure 3.7.

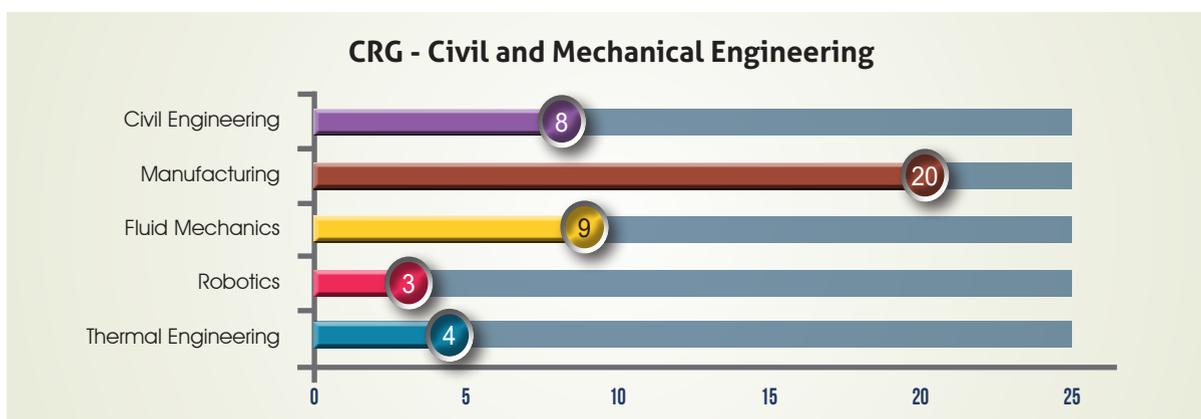


Figure 3.7: Projects supported in different sub disciplines of Civil and Mechanical Engineering.

### Research Highlights

#### Trapping microalgal cells on fungal highways- One stop solution to algal biofuel dilemma:

Given its abundance in nature, Algae can be major source of bioenergy for meeting fast growing energy needs of increasing energy intensive world. However, there are significant techno-economic challenges that need to be overwhelmed in the area of recovery of algal biomass from the culture medium or wastewater. A team of researchers at IIT Delhi developed a method for rapid flocculation of *Chlorella pyrenoidosa* cells with *Aspergillus fumigatus* fungal pellets. The process could

flocculate 99% algal cells within 3 h. This is the fastest reported process of algal harvesting using this method and has been filed for a patent. In nature, algal fungal interactions are ubiquitously seen due to the nutritional interdependency in both the species. Lichens are well known example of a highly complex algal-fungal symbiosis. Other natural fungal populations are being benefited by algae due to their host-parasite kind of relationship. These interactions drive us to mimic such interactions in artificial system, which can be applied for algal biomass harvesting as given in Figure 3.8.

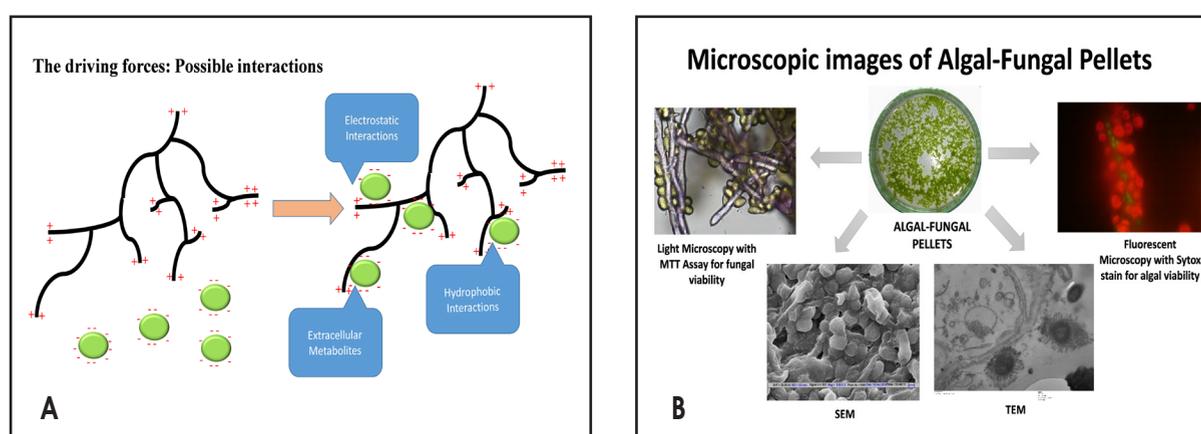


Figure 3.8 : (A) Possible interaction mechanism of algae and fungi (B) Microscopic images of algal-fungal pellet.

### 3.1.3.2 Materials, Mining and Minerals Engineering

A total of 34 projects were sanctioned in different sub disciplines as given in Figure 3.9.

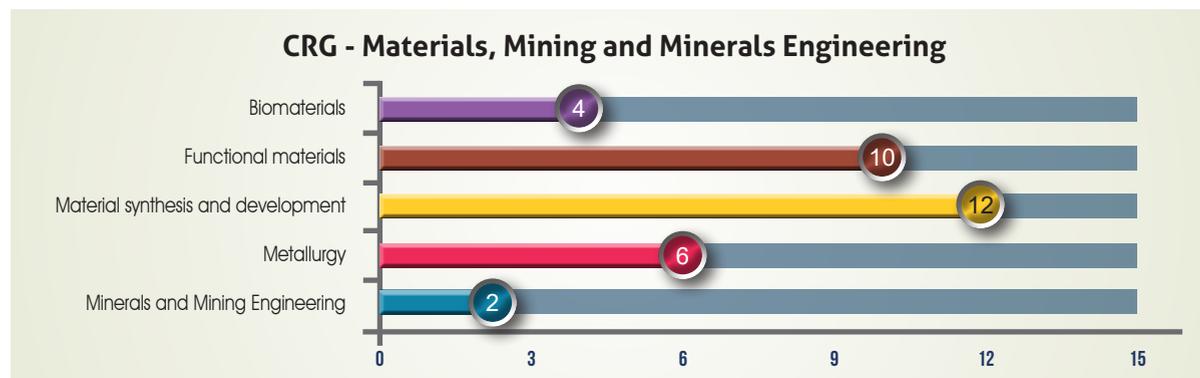


Figure 3.9 : Projects supported in different sub disciplines of Materials, Mining and Minerals Engineering.

### Research Highlights

**Polymeric Nanocomposites as Radar Absorbing Materials:** Radar Absorbing Materials (RAMs) is used in stealth technology to disguise a vehicle or structure from radar detection. Polymer nanocomposites and coatings offer a unique and efficient strategy which can replace metals in stealth technology due to their corrosion resistance and light weight attributes. A team of researchers at the Indian Institute of Science, Bangalore have developed polymer nanocomposite based light weight, flexible and heat stable RAMs using a core-multi-shell heterostructure based approach. A team of researchers at the Indian Institute of Science,

Bangalore have extensively explored the use of polymeric nanocomposites as potential RAMs. Instead of using the conventional technique whereby the conducting and magnetic nanoparticles are incorporated separately in the polymer matrix to design RAMs, they have developed a core-multi-shell nanoparticle-based system (Figure 3.10) whereby nanoparticles with a magnetic core i.e. Iron Oxide ( $\text{Fe}_3\text{O}_4$ ) and conducting outer shell (carbon nanotubes) supported on a dielectric spacer here Silicon Dioxide ( $\text{SiO}_2$ ) have been synthesised by a very simple industrial viable technique.

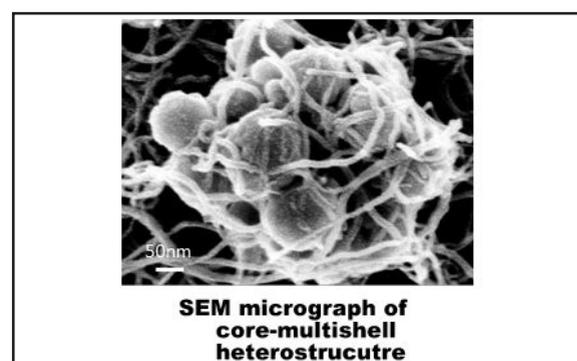
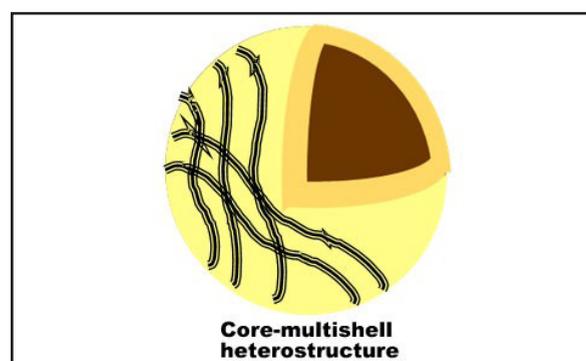


Figure 3.10: Core-multishell nanoparticle-based system.

This unique Core-multishell heterostructure is designed to shield microwave frequencies. Incorporation of this heterostructure in a polymer matrix (here Polyvinylidene fluoride - PVDF) creates multiple interfaces in the system due its unique

morphology and thereby leading to excellent radar wave attenuation (40 dB i.e. nearly 99.99% attenuation) dominated by absorption (80%), which is highly desirable in the current market scenario.

### 3.1.3.3 Electrical, Electronics and Computer Engineering

A total of 68 projects were sanctioned in different sub disciplines as given in Figure 3.11.

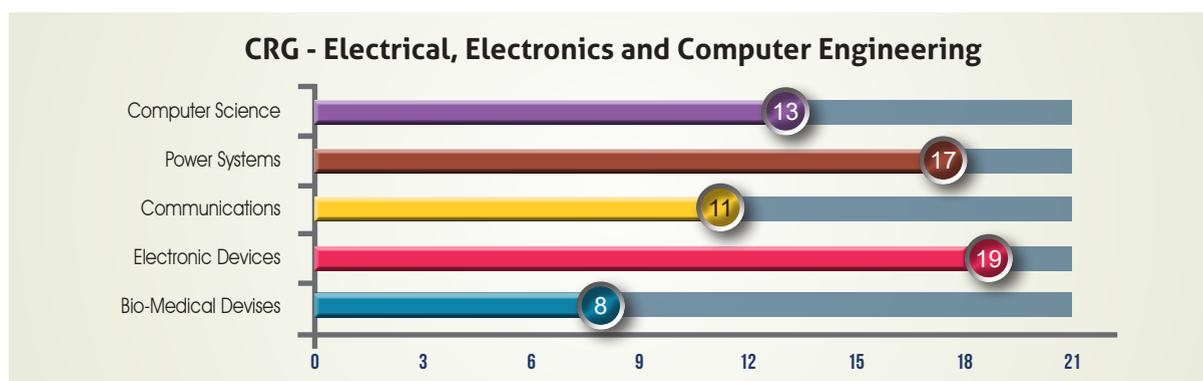


Figure 3.11: Projects supported in different sub disciplines of Electrical, Electronics and Computer Engineering.

## Research Highlights

**Nano- and Micro- structured Plasmonic Biochips for Enhanced Sensitivity of Surface Plasmon Resonance Imaging:** A team of researchers at the Indian Institute of Technology, Delhi had performed this research. The primary objective of this project was to enhance the Sensitivity of SPR Sensing and Imaging using narrow-groove plasmonic nano-gratings. In reference to objectives, Non-uniform narrow groove nano grating based SPR and SPRI sensing platforms were modeled using FDTD

simulations. Nano-grating configurations consisting of a gold coating on a thin conformal layer of hafnium oxide ( $\text{HfO}_2$ ), which is deposited on silicon nano-gratings was also modeled [Figure 3.12(a)]. Figure 3.12 depicts that binding or adsorption of the biomolecules on the surface of these nano-gratings can lead to a localized change of refractive index at the metal-dielectric interface (i.e. on the surface of the metallic nano-gratings).

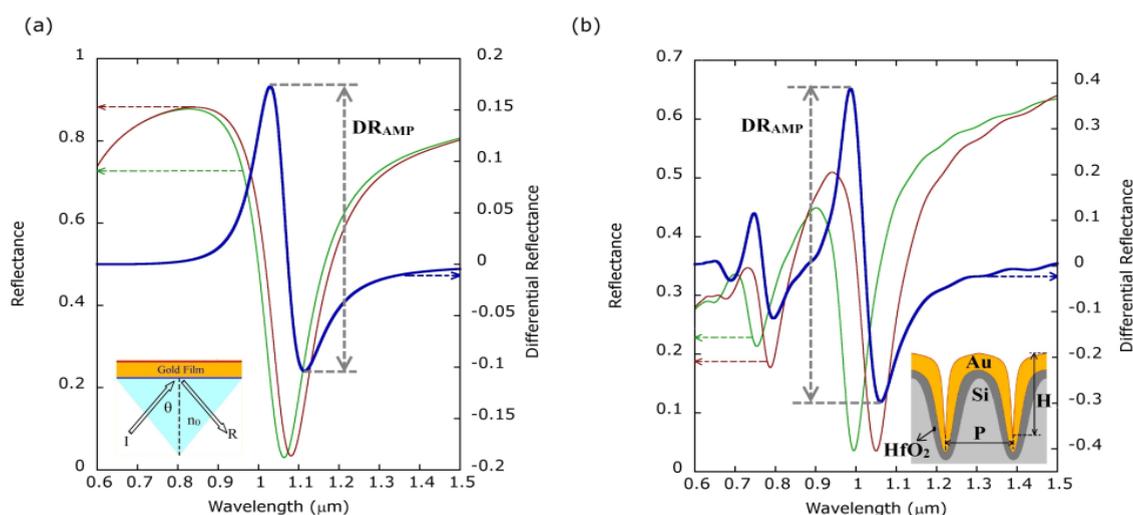


Figure 3.12: RCWA simulations for a continuous gold film employing the Kretschmann configuration. (a) SF10 glass prism, in sky blue color with 1 nm adhesion layer of titanium being present in between the gold layer. (b) FDTD simulations for non-uniform gold-coated silicon nano-gratings showing the reflectance spectra (RI=1.3 -Green; RI= 1.53- Red).

The gold nanopillar arrays having different cross-sectional geometries were simulated using Rigorous Coupled Wave Analysis (RCWA), which is a semi-analytical technique in computational

electrodynamics. The differential reflectance spectrum for a continuous gold film or for nanostructured gold films deposited on a glass prism (i.e. for the Kretschmann configuration)

was calculated using the RCWA method, and it was observed that the differential reflectance amplitude is much greater for a nanostructured gold film with gold nanopillars present on the surface of the gold film when compared with just a continuous gold film (which is conventionally employed for SPR sensing and imaging). While the maximum differential reflectance amplitude (DRAMP) is 0.11 for a continuous gold film, the maximum value of the differential reflectance amplitude ( $DR_{AMP}$ ) is 0.39 when cylindrical gold nanopillars are present on top of gold films to form nanostructured gold films. Moreover, the

value of the differential reflectance amplitude ( $DR_{AMP}$ ) varies as the ratio of the periodicity ( $P$ ) and the diameter ( $D$ ) of the nanopillars was varied.

While the fabrication of the ideal rectangular aperture-based nano-grating structures (i.e. narrow-groove nano-gratings having parallel sidewalls) can be very difficult, the proposed non-uniform gold-coated narrow groove nano-gratings (Figure 3.13) can be easily fabricated using the conventional nanofabrication processes.

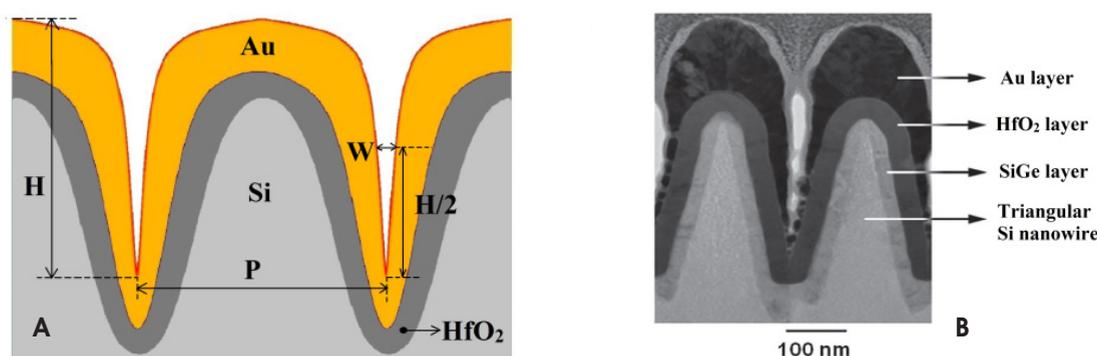


Figure 3.13: (a) A schematic diagram illustrating gold-coated silicon nano-gratings. Periodicity and height of the nano lines in the nano-gratings. (b) SEM/TEM cross-section of gold coated silicon nano-gratings over-coated with hafnium oxide ( $HfO_2$ ) layer for smooth deposition of metallic gold film.

A SPR imaging system was developed by assembling a monochromator in front of a white light source, optics to collimate light, a prism (for Kretschmann configuration), a nanostructured

plasmonic chip fixed on the prism, and spectrometer followed by a CCD. SPR image was acquired by employing this set-up.

### 3.1.3.4 Chemical & Environmental Engineering

A total of 43 projects were sanctioned in different sub disciplines as given in Figure 3.14.

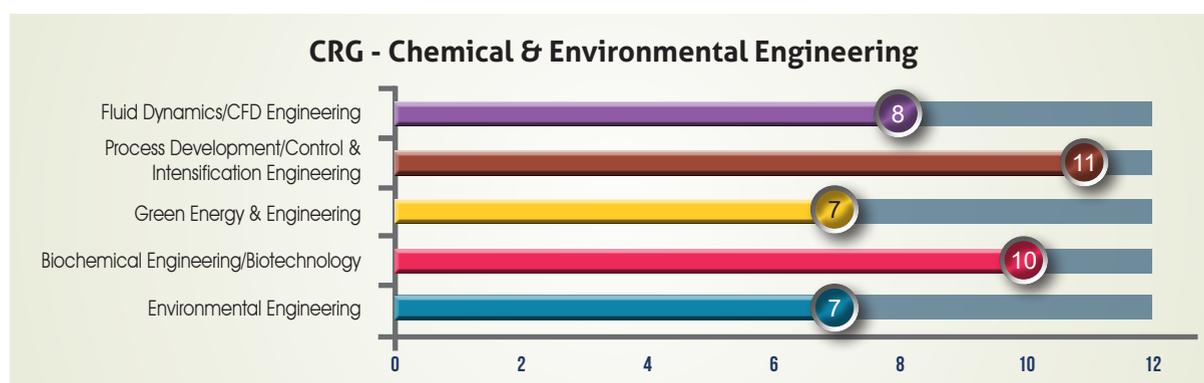


Figure 3.14: Projects supported in different sub disciplines of Chemical & Environmental Engineering.

## Research Highlights

**Ionic Liquid Department of Chemical Engineering:** A team of researchers at the Indian Institute of Technology, Guwahati had performed this research. The main goal of the project is

to predict hydrogen gas solubility in ammonia borane-Ionic Liquid mixtures using Quantum Chemical Method based COSMO-RS theory. Thereafter the top four/five Ionic Liquids (IL) from

various cation family will be selected based on the model predictions. For validation the Ionic Liquids will be used as a media for thermal hydrogenation with Amine Boranes. Finally, the

kinetic data will be used to design a prototype sustainable working model for continuous hydrogen generation and storage.

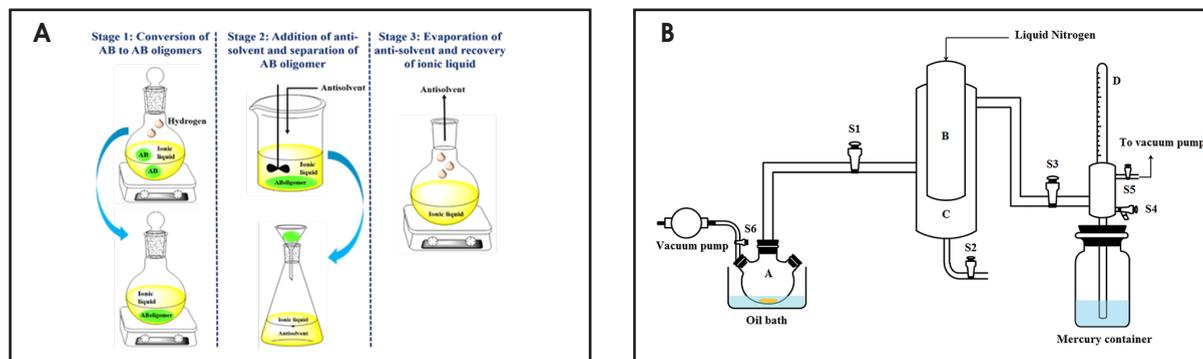


Figure 3.15 : (a) Thermal Dehydrogenation of Ionic Liquid and Amine Borane Mixtures (Energy and fuels, 31(2017) 5428–5440) (b) Thermal Dehydrogenation set up for measuring equivalents of hydrogen released.

The salient features of the research work could be described as, (i) Reaction Kinetics for the Thermolysis of Amine Boranes complexes, (ii) Selection of Potential Ionic Liquid using Conductor like Screening Model-Segment Activity Coefficient model (COSMO-SAC) (iii) Thermal Dehydrogenation of Ethylene Diammine

bis-Borane (EDAB) with Ionic Liquids (Figure 3.15) (iv) ReaxFF Reactive Force Field Simulations on EDAB Dehydrogenation. Time resolved <sup>1</sup>H NMR of AB/ [TDTHP][Phosph] and Proposed Schematic Diagram of AB/[TDTHP][Phosph] Process Flow Sheet were shown in Figure 3.16 and 3.17 respectively.

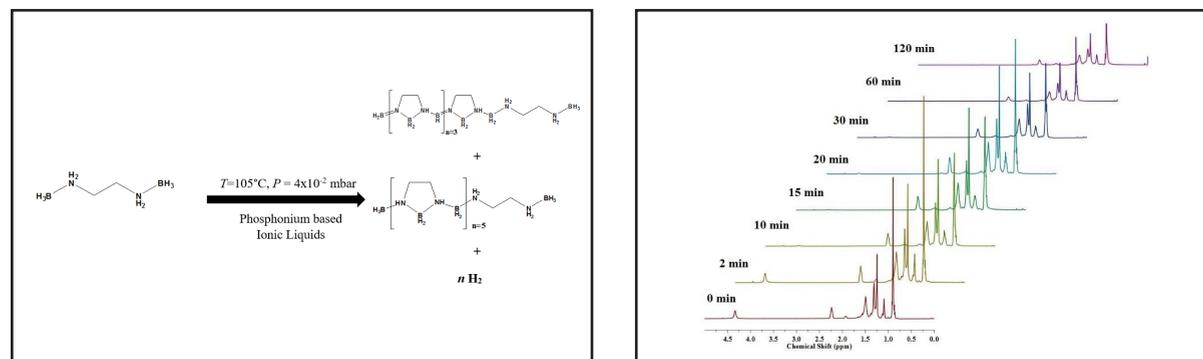


Figure 3.16: Time resolved <sup>1</sup>H NMR of AB/[TDTHP][Phosph]. Chemical shift for IL: 0.9-2.24 ppm Chemical shift for AB: 4.34 ppm (-NH<sub>3</sub>), 1.25-1.5 ppm (-BH<sub>3</sub>). (AB: Ammonia Borane; [TDTHP][Phosph]: trihexyltetradecylphosphonium Phosphinate).

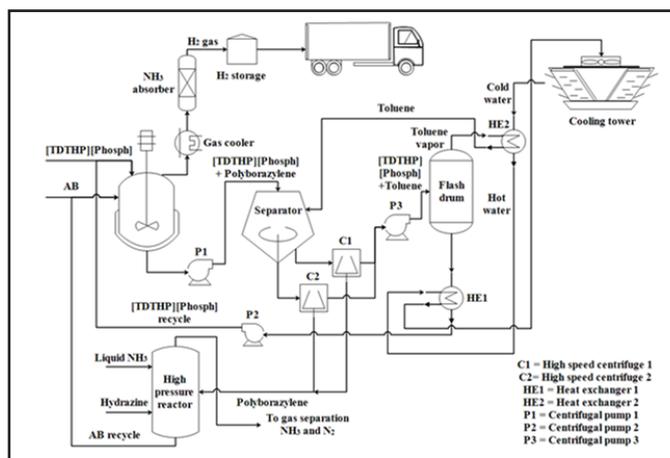


Figure 3.17: Proposed Schematic Diagram of AB/[TDTHP][Phosph] Process Flow Sheet.

### 3.1.4. Life Sciences

#### 3.1.4.1. Animal Sciences

A total of 128 projects were sanctioned in different sub disciplines as given in Figure 3.18.

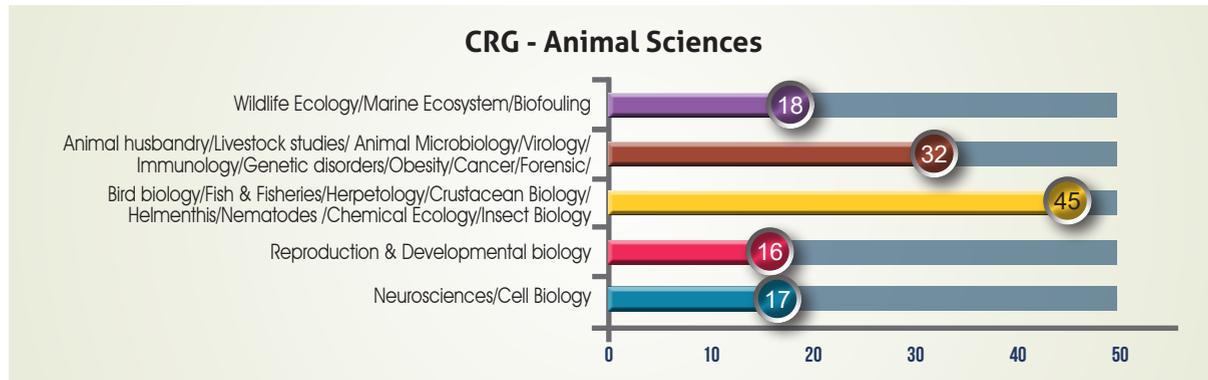


Figure 3.18: Projects supported in different sub disciplines of Animal Sciences.

### Research Highlights

**Factors Determining Population Structure and Reproductive Biology of the Western Ghats-Endemic *Xanthophryne* Toads (Anura: Bufonidae):** Climatic and landscape parameters determine distribution, abundance and reproductive ecology of organisms. All-natural populations are structured to an extent due to landscape and environmental heterogeneity. *Xanthophryne* is a genus of toads narrowly endemic to the northern Western Ghats and contains two closely related species. Both species are habitat specialists that breed exclusively on rocky outcrops in the northern Western Ghats, making them vulnerable to climate change and habitat disturbance. In the past year, the investigator group sequenced all the populations of this species and analysed advertisement calls, which are used in courtship (Figure 3.19; 3.20; 3.21; 3.22 and 3.23). Sequencing showed

that populations are structured across different plateaus. However, there are no cryptic species i.e., all the populations belong to the same species. The analysis of advertisement calls of newly discovered populations showed similar call properties to the populations already known, reinforcing the conclusion that different plateaus host populations that are closely related and only slightly differentiated in their advertisement calls. *Xanthophryne* species have been considered local and geographically isolated on different plateaus, but the weak population structure seems to suggest that there is unrecognized dispersal across different populations. This information sheds light on how endemism and genetic diversity have originated and are maintained on the rocky outcrops. The group is further studying detailed analysis of their reproductive strategies in their environmentally uncertain habitat.



Figure 3.19: *Xanthophryne netigerina* in breeding coloration.



Figure 3.20: *X. tigerina* calling to attract females.



Figure 3.21: *X. tigrina* males fighting over a female.



Figure 3.22: Metamorphosis of *Xanthophryne* tadpoles.



Figure 3.23 A *X. tigrina* pair in amplexus

### 3.1.4.2 Plant Sciences

A total of 101 projects were sanctioned in different sub disciplines as given in Figure 3.24.

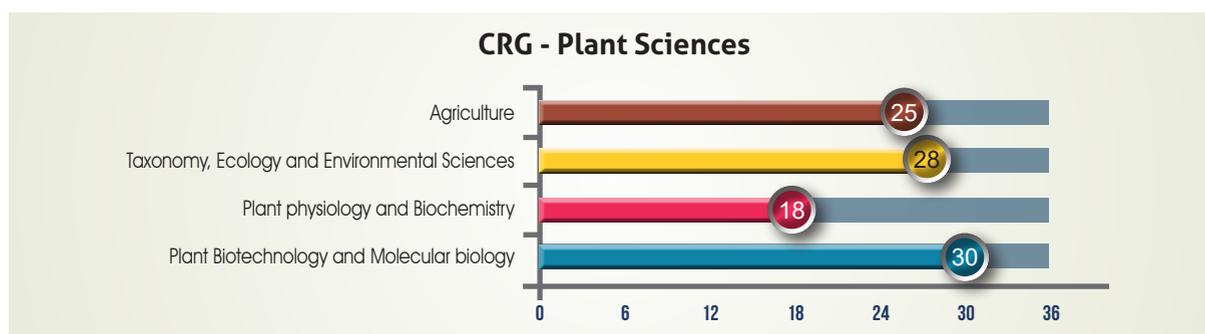


Figure 3.24 : Projects supported in different sub disciplines of Plant Sciences.

### Research Highlights

**Genetic analysis of the regulation of Hsp100 promoter activity by heat shock factor in rice and *Arabidopsis*:** Entire rice Hsf family containing 25 member proteins was screened for binding

with OsClpB-cyt/Hsp100 promoter. To perform promoter binding, a yeast one-hybrid screen was used. For this, OsClpB-cyt/Hsp100 promoter (696 bp taking "A" of ATG translation initiation codon

as +1) was cloned in vector pLacZi (Clontech) and was integrated into the genome of A2279 yeast cells. Y1H assays revealed that surprisingly, OsHsfA6a specifically interacts with OsClpB-C promoter in HSE-dependent manner and activates the promoter. The interaction of OsHsfA6a was further confirmed by EMSA. Since only OsHsfA6a interacted with OsClpB-cyt/Hsp100 promoter, transactivation potential of all Hsfs was analysed. The results showed that overall, six OsHsfs, namely A3, A6a, A6b, A8, C1a and C1b possess TA potential with A6a having highest activity.

Regulation of expression of OsClpB-cyt/Hsp100 that was shown to be governed by binding of OsHsfA6a on the promoter of OsClpB-cyt/Hsp100 in yeast and it was further regulated by a classB Hsf namely HsfB4b. ClassB Hsfs were known to act as repressors and in yeast OsHsfB4b repressed the activity of OsHsfA6a by almost 50%. The supra-regulation was confirmed in planta by transient expression in *Arabidopsis* mesophyll protoplasts (TEAMP) assays in protoplast system. Experiments were designed to analyze the role of OsHsfA6a/OsHsfB4b protein-protein interaction with respect to OsClpB-C promoter regulation. Protoplasts were transiently co-transformed with a reporter plasmid containing OsClpB-C promoter driven luciferase gene and effector plasmids expressing OsHsfA6a and OsHsfB4b. Promoter activity was determined by measuring luciferase activity. OsHsfA6a strongly activated the OsClpB-C promoter. However, co-expression of OsHsfB4b with OsHsfA6a repressed promoter activity by about 50%, in agreement with the Y1H results. This experiment also affirmed the negative role of OsHsfB4b in modulation of OsHsfA6a binding with OsClpB-C promoter.

In *Arabidopsis thaliana* (At), Hsp100 has been shown to be essential for thermotolerance. It was analyzed as to which class A Hsf was involved in the transcriptional regulation of AtClpB-cyt gene by virtue of binding to its promoter. The binding of 14 *Arabidopsis* class A Hsfs to the AtClpB-cyt promoter was analyzed using yeast one-hybrid screen. Strikingly, none of the *Arabidopsis* classA Hsfs showed binding with the AtClpB-cyt promoter. On the other hand, rice HsfA6a protein showed distinct binding with OsClpB-cyt promoter in the same screen, which was used as a positive control in this study. In silico analysis showed that OsHsfA6a has diverged from A6a/A6b Hsf forms of *Arabidopsis* and tomato and has no expressologs. The work suggested the existence of other possible mechanisms for transcriptional regulation of AtClpB-cyt gene.

Transgenic lines of rice overexpressing OsHsfA6a and antisense lines showing downregulation of OsHsfA6a was developed (Figure 3.25).

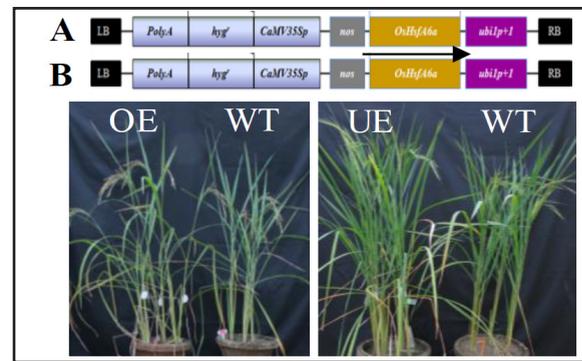


Figure 3.25: Constructs for altering OsHsfA6a levels in rice A. Construct for raising rice plants with over expression (OE) of HsfA6a. B. Construct for raising transgenic rice plants under expression (UE) HsfA6a.

### 3.1.4.3 Health Sciences

A total of 228 projects were sanctioned in different sub disciplines as given in Figure 3.26.

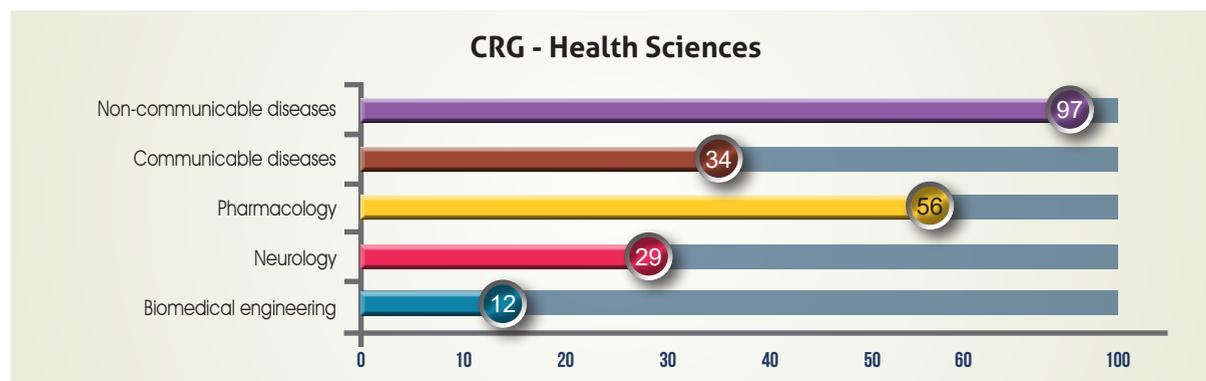


Figure 3.26: Projects supported in different sub disciplines of Health Sciences.

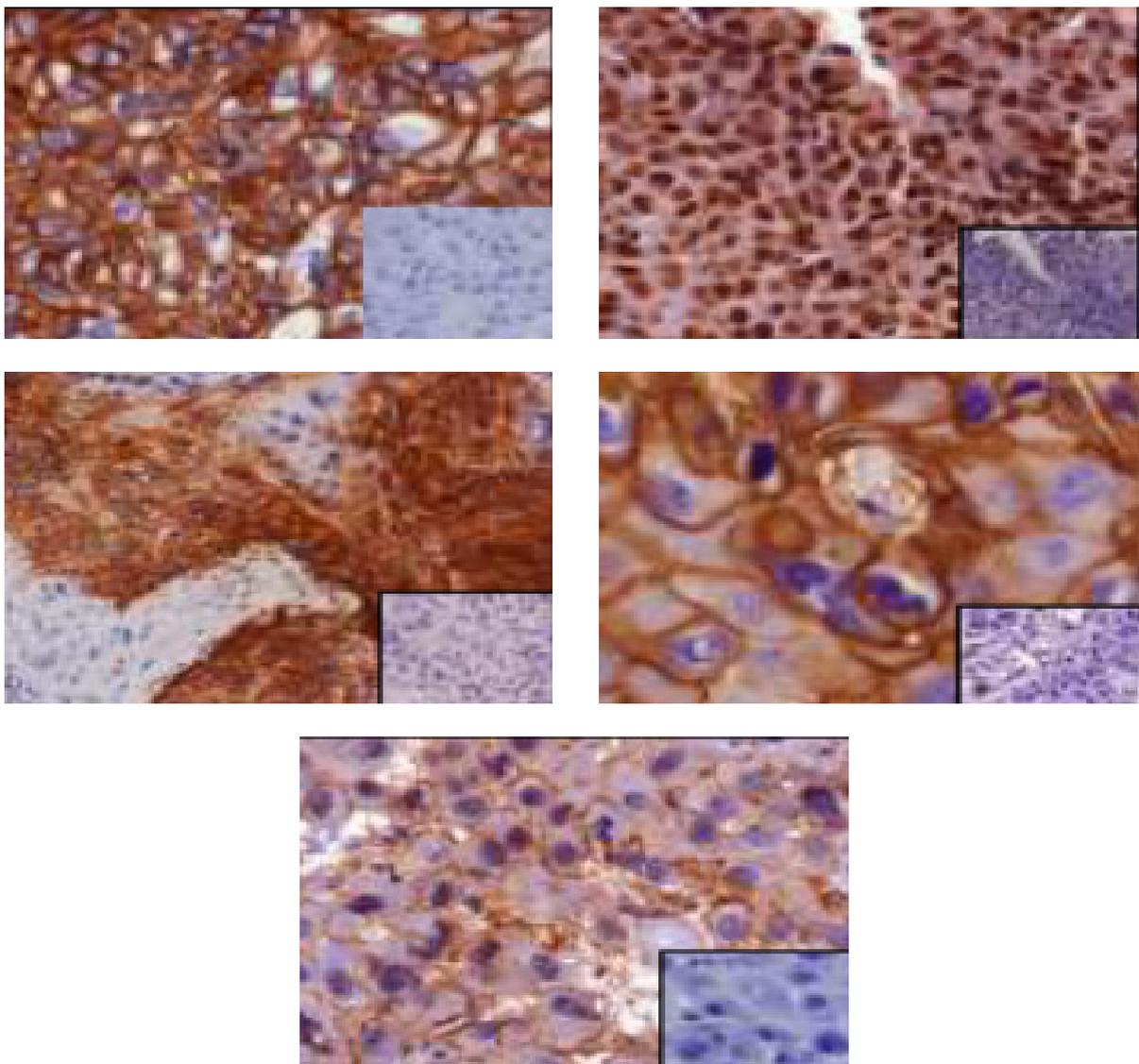
### Research Highlights

Analysis of HPV, EGFR and hypoxia markers and their association with outcome in

subjects with locally advanced squamous cell carcinoma of head and neck (HNSCC):

HNSCC is the sixth most common malignancy worldwide with several distinct subtypes. Despite advances in multimodality therapies available for the treatment of HNSCC survival rates, functional outcomes and toxicities of therapy remain poor. In general prediction of treatment failure has been gauged based on clinical and radiological features like T-stage, invasion and tumor volume. However, the above parameters fail to predict 30% treatment failures. Apart from clinical parameters, sensitivity of a carcinoma to chemo/radiotherapy was determined by hypoxia, repopulation rate and intrinsic cellular treatment sensitivity. The recognition of the prognostic value of human papillomavirus (HPV) status and the advent of biologically targeted therapies with potential for decreased toxicities with increased sensitivity towards combating the HNSCC cancer.

The comprehensive evaluation of various biomarkers such as HPV, EGFR, HIF-1 $\alpha$  and stem cell marker viz CD44, CD98 independently on the prognosis. In the current project the investigator envisions to analyse the above molecular markers in patients treated with nimotuzumab and further to correlate with the clinical outcome. For this study the investigator has recruited 400 patients. As per the demographic data analysis the median age of the participants was 54 years. In the recruited patients the major tumor was found to be in pharyngeal and laryngeal sites. Out of 400 cases 197 samples were detected for prevalence of HPV in HNSCC using p16 as a surrogate marker. Out of 197 cases 13 cases showed positive to p16 staining and 184 cases showed negative to the surrogate marker.



**Figure 3.27:** 184 HPV negative cases (IHC for EGFR, HIF-1 $\alpha$ , CAIX CD44 and CD98 (heavy chain) in the tumor affected sites. High expression of the EGFR (A) and HIF-1 $\alpha$  (B) in the tumor affected sites. In 196 both HPV positive and negative cases CAIX (C), CD44 (D) and CD98 (E).

Unlike EGFR and HIF-1 $\alpha$  the expression of the above markers was noted only in 40% of the cases. From these new observations the investigator inferred that there is a low prevalence of active HPV in the recruited study group (Figure 3.27). There is a positive correlation between EGFR and HIF1 $\alpha$ . The down regulation of stem cell marker CD44 was observed in majority of the HPV negative cases. The above

study will enlighten to understand the relevance of the molecular markers (either single or in combination) and their association with clinical outcomes including treatment response, recurrence and survival. Further this approach may help in patient stratification to avoid under and over treating of the patients, thus reducing the morbidity associated with the treatment.

#### 3.1.4.4. Biochemistry, Biophysics, Molecular Biology and Microbiology

A total of 145 projects were sanctioned in different sub disciplines as given in Figure 3.28.

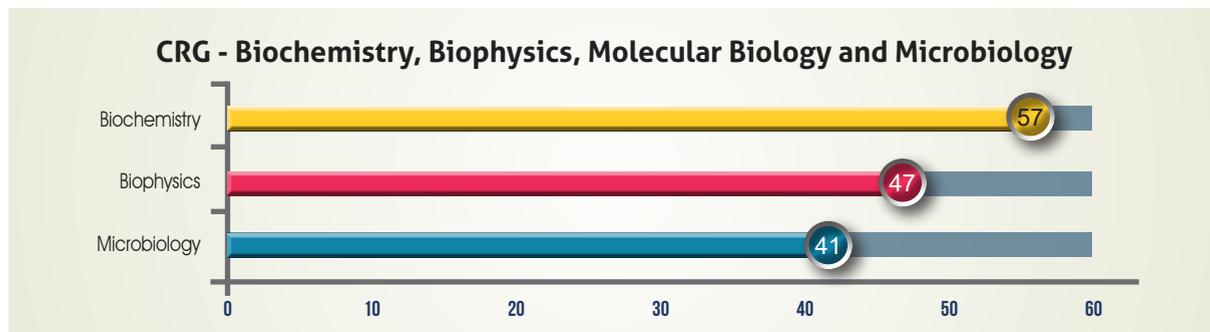


Figure 3.28: Projects supported in different sub disciplines of Biochemistry, Biophysics, Molecular Biology and Microbiology.

### Research Highlights

**Development of Synthetic Transcription Factors Against Pluripotency to Target Cancer Stem Cells:** Extant drugs are mostly targeted to proteins. However, new drug targets were needed to address therapeutic needs arising out of lifestyle and age-related disorders. So far, DNA has not been successfully targeted for therapeutic interventions.

Transcription factors (TF), the pillars of cellular regulation required to engineer synthetic peptides to mimic a class of transcription factors, called homeodomain-containing transcription factors, and act as antagonists was developed (Figure 3.29).

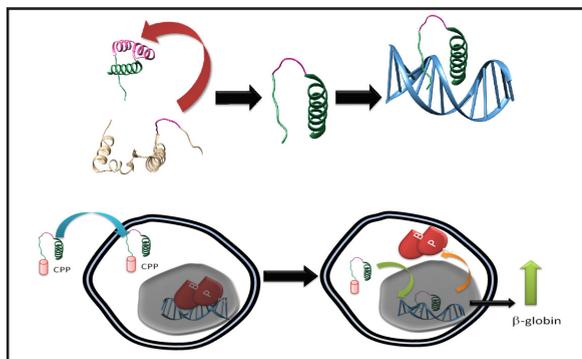


Figure 3.29: General strategy of gene regulation by synthetic peptides.

Homeodomain transcription factors play pivotal roles in many diseases, including

tumors. Investigator group have focused on two transcription factors, BP1/DLX4 and OCT4. Overexpression of the former TF represses  $\beta$  globin gene and causes certain classes of  $\beta$  hemoglobinopathies; the latter is crucial in maintaining cancer stem cells, the cells from which many cancers originate. A relatively small peptide mimicking the homeodomain of the transcription factor BP1 was designed and synthesized (Figure 3.30).

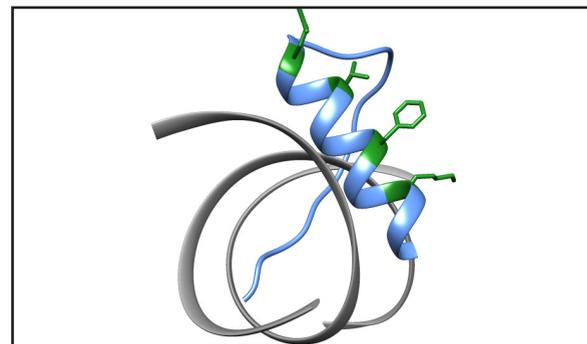


Figure 3.30: Design of the peptide targeted against BP1 binding sites.

The DLX-4 mimicking peptide binds to BP1 target sites on the regulatory region of the globin gene cluster with native-like affinity and specificity *in vitro*. When taken inside the cells, it up-regulated some of the genes repressed by BP1 or its isoforms, such as  $\beta$ - and  $\gamma$ -globin genes by displacing BP1 from its binding sites (Figure 3.31).

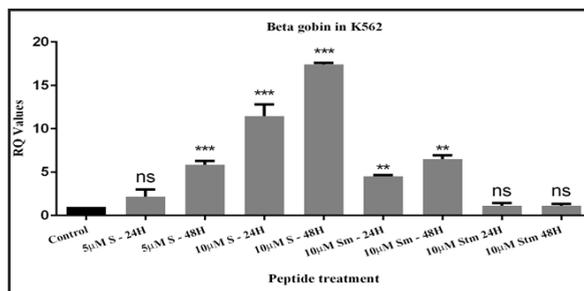


Figure 3.31: Upregulation of the  $\beta$ -globin gene upon treatment of the peptide in cell lines.

The Oct4 homeodomain mimicking peptide was designed from the crystal structure of Oct4 protein in complex with its target DNA (Figure 3.32).

This peptide was synthesized by solid phase peptide synthesis and purified by High Performance Liquid Chromatography. The binding interaction between the Oct4-mimicking peptide and its target DNA was studied by Isothermal Titration Calorimetry (ITC). The Oct4-mimicking peptide binds fairly tight to its target DNA sequence. A tighter binding constant was obtained with the fluorescence anisotropy assay.

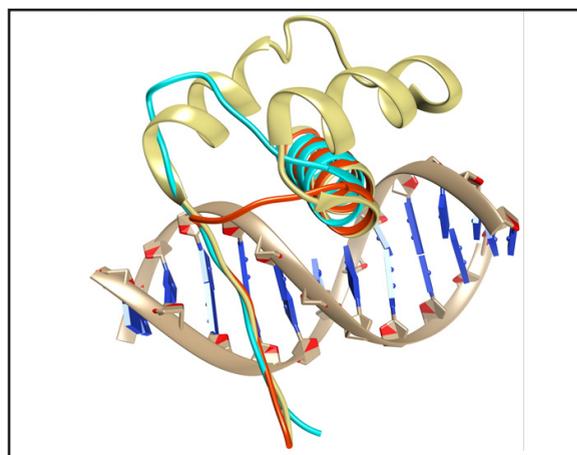


Figure 3.32: Design of the OCT4 mimicking peptide.

The project work is demonstrated that it is possible to design relatively small peptides to specifically target DNA sites on the chromatin where transcription factors bind. These peptides bind to the target sites with high affinity and specificity, and they show high specificity of gene regulation within the cell as well. These achievements open possibilities of regulating genes specifically by molecules delivered from outside and may open chromatin DNA as a new class of therapeutic target.

### 3.1.5 Mathematical Sciences

A total of 47 projects were sanctioned in different sub disciplines as given in Figure 3.33.

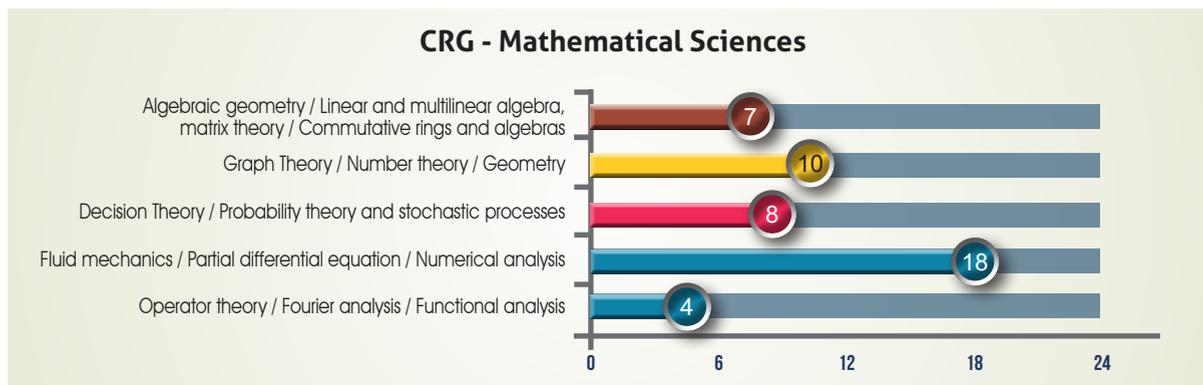


Figure 3.33: Projects supported in different sub disciplines of Mathematical Sciences.

**Emergent dynamics in ecological networks: Spreading of disease and its control:** In ecological landscapes, species tend to migrate between nearby patches in search of a better survivability condition. By this dispersal process, they form connectivity between the patches and thereby may develop various correlated or partially correlated population dynamics among species living in the patches. In this project, various possible emergent

collective population patterns have been explored using a simple ecological network model of all-to-all connected patches where a particular type of dispersal process that is controlled by a weighted mean-field diffusion is used to include the failed migration between the interacting patches.

The population dynamics of both the prey and predator in every patch is represented

modified Rosenzweig-MacArthur (mRM) model that incorporates an additional effect of habitat complexity. The model is extended to  $N$  all-to-all connected network of patches, where the local dynamics of each patch is governed by the mRM model. Dispersal of both the prey and predator between the patches is considered to be diffusive type, but the diffusion process is governed by the mean-field density of both the species with a weighing factor ' $q$ '. The theoretical investigations on the network dynamics, using numerical and to some extent analytical techniques, show various complex patterns, namely, 2-cluster, 3-cluster and multicluster states, and chimera states (where coherent and incoherent subgroups coexist), besides synchrony (1-cluster) and homogeneous steady states (HSS) in a migrating metapopulation.

An important observation is that addition of habitat complexity in the Rosenzweig-

MacArthur (RM) model makes qualitative changes in the collective behaviours. Specially to mention that it shrinks the region of synchrony and broadens the region of HSS in parameter space and thereby leads to better survival probabilities and increased population persistence in a natural ecosystem. Figure 3.34A shows that the dynamics of an isolated patch exhibits relaxation type oscillation. Figure 3.34B gives an overview of different collective states represented by colours. A unique state of complete coherence (1-cluster) is seen (orange) in a large region of parameter space, where populations of both species in all patches oscillate in a common rhythm and the population densities in all patches are identical in time. The parameter region of complete coherence (orange) is seen to form a typical Arnold-tongue-like structure. This coherent state (1-cluster) represents a globally synchronous state.

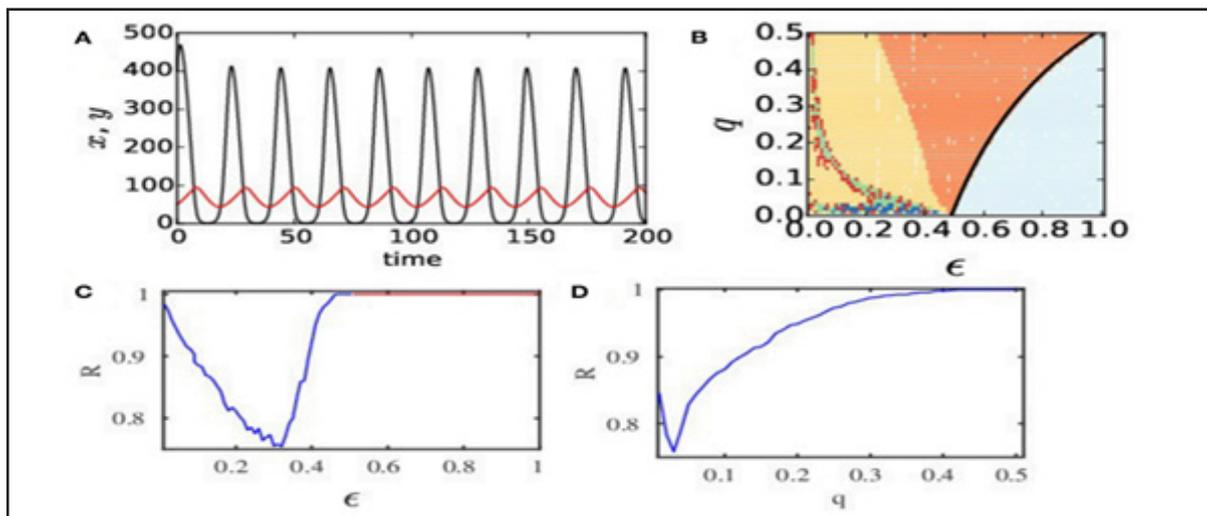


Figure 3.34: (A) shows that the dynamics of an isolated patch exhibits relaxation type oscillation. (B) gives an overview of different collective states represented by colours (C & D) Graphical representation of  $R$  against  $\epsilon$  &  $q$ .

If population in any one of the patches goes extinct at any arbitrary instant of time then all other patches will follow the same trend, and thus enhances the possibility of a global extinction. We notice complex patterns such as chimera states (blue) for low  $q$  and a range of  $\epsilon$  values. The complexity in collective behaviour is clearly visible in the lower range of  $q$  value.

In the HSS (homogeneous steady states) region, both species reach a constant density in all the patches; they coexist with non-zero identical population density in each patch and they are safe. In dynamical sense, a stable steady state has the ability to return to its original stable state after a transient time under a perturbation and

thus HSS signifies robustness of a population to external attacks. Besides these coherent oscillatory states (synchrony) and HSS, the regions of 2-cluster (yellow), 3-cluster (red), and multi-cluster (green) states can be found.

For global coherence (1-cluster), or synchrony measure, the complex Kuramoto order parameter ( $R$ ) is used. The plot  $R$  against  $\epsilon$  (Figure 3.34C) decreases first, indicating a decreasing level of coherence with higher clusters and emergence of chimera states. Then  $R$  increases for increasing  $\epsilon$ , indicating a decrease in cluster size, but finally  $R = 1$  when the network transits to synchrony (blue line) at  $\epsilon = 0.45$  and it continues until  $\epsilon = 0.5$ . Similar study was done with respect to the

variation of  $q$  for a fixed dispersal rate  $\epsilon = 0.31$ , as shown in figure 3.34D. It follows a monotonic increase to  $R=1$ , indicating existence of clustered and chimera states before reaching synchrony.

a region of synchrony that existed for lower rates of dispersal of prey and higher dispersal of predator, disseminated into larger varieties of complex patterns in presence of habitat complexity.

Furthermore, in the absence of habitat complexity,

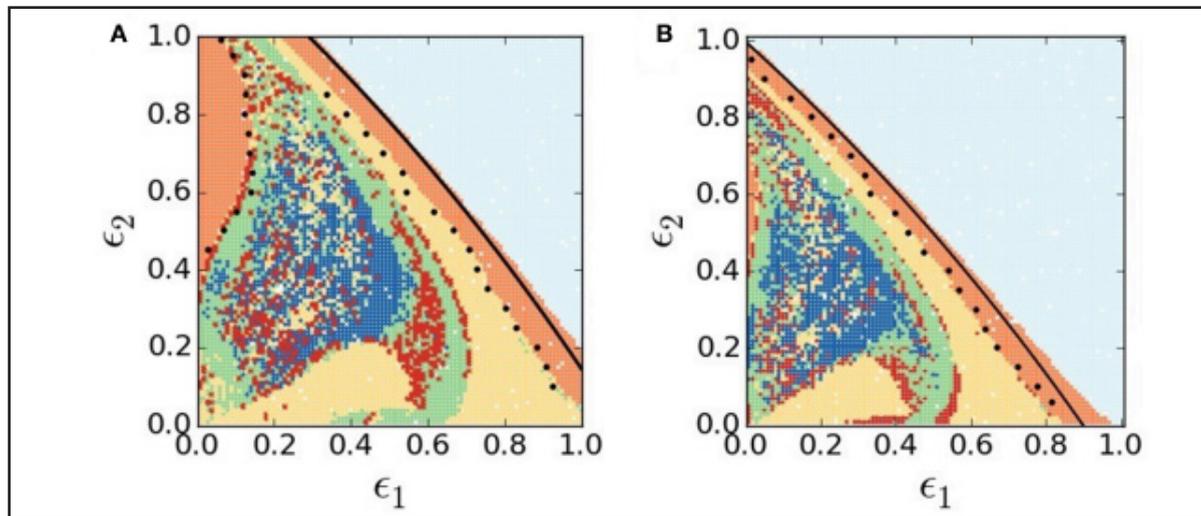


Figure 3.35: A comparative understanding of the collective dynamics in presence and absence of habitat complexity.

Figure 3.35 shows a comparative understanding of the collective dynamics in presence and absence of habitat complexity. The region of HSS had been enlarged significantly, in parameter

space, by the addition of habitat complexity in our proposed mRM model, indicating an increased parameter region of dispersal rates that provided an improved condition of persistence.

### 3.1.6 Physical Sciences

A total of 171 projects were sanctioned in different sub disciplines as given in Figure 3.36.

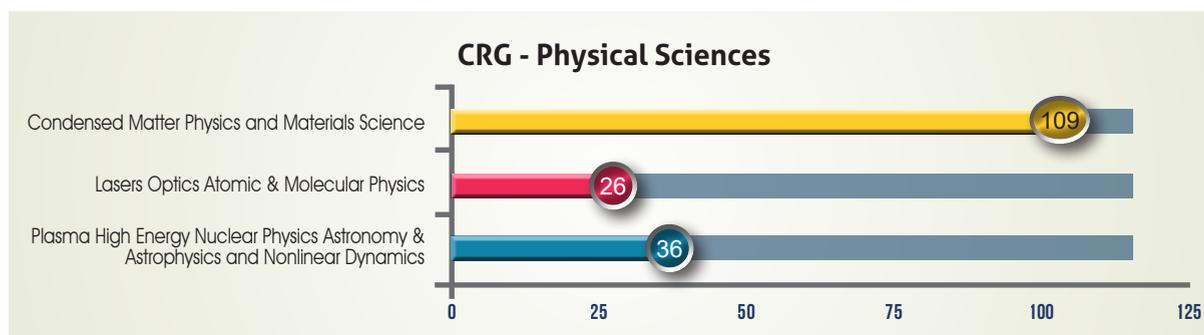


Figure 3.36: Projects supported in different sub disciplines of Physical Sciences.

### Research Highlights

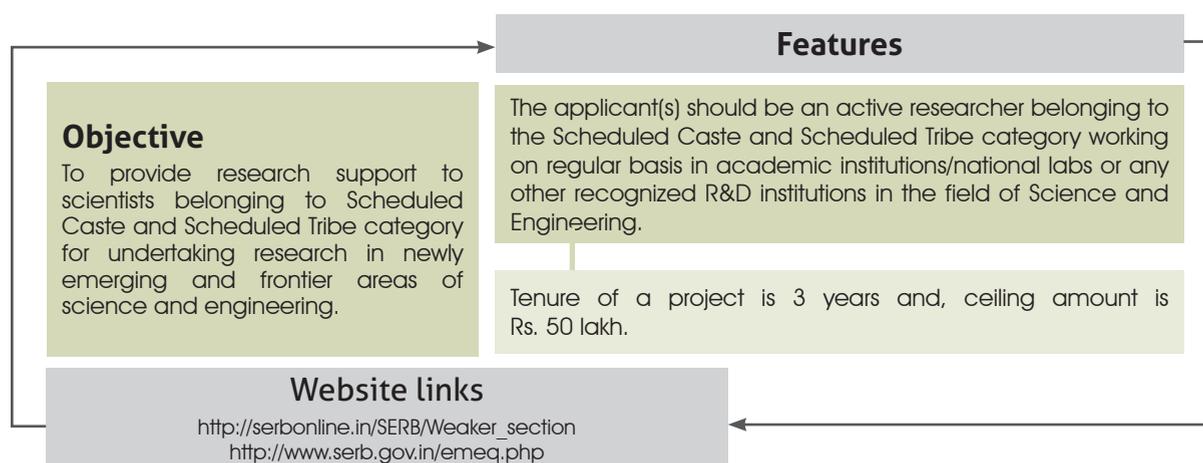
**Entangled and other nonclassical states and their applications in the field of quantum computation and communication:** The possibilities of generation of nonclassical states in the experimentally achievable physical systems and the applications of such states in quantum information processing was studied. In the last year (2018-19), in addition to the physical systems investigated earlier, a team from JP Engineering College had reported the

existence of nonclassical states (e.g., squeezed state, entangled state, antibunched state) in the physical systems like hyper Raman Processes, engineered quantum states, Optomechanical systems were reported. Extending the ideas developed in the first part of this project, dynamics of nonclassical feature is also studied in a PT symmetric system of coupled cavities with special attention toward Quantum Zeno and Anti-Zeno effects. Applications of the

nonclassical features observed in these works have been reported in the context of quantum communication in published paper related to Quantum Teleportation. Specifically, an optimal protocol for teleportation was designed and the same was implemented using IBM's cloud-based

quantum computer. A very rigorous review, describing the present status and future scopes of applied quantum optics were also published, and the same is expected to provide roadmap for the future research.

### ►► 3.2 Empowerment and Equity Opportunities for Excellence in Science (EMEQ)



Empowerment and Equity Opportunities for Excellence in Science (EMEQ) Scheme provides research support to scientists belonging to weaker sections of the society for undertaking research in newly emerging and frontier areas of Science and Engineering and involve them in the

National Science and Technology development process.

A total of 1485 proposals were received in the reporting period and 248 proposals were supported for funding (Table 3.2).

**Table 3.2 :** Area-wise sanctioned projects under EMEQ Scheme during 2018-2019.

S. No.	Broad Area (No. of projects sanctioned)	Sub Area	Number of Projects Sanctioned
1.	Chemical Sciences (39)	Inorganic Chemistry	9
		Organic Chemistry	17
		Physical Chemistry	13
2.	Physical Sciences (16)	Condensed Matter Physics & Materials Science	12
		Laser, Optics, Atomic and Molecular Physics	2
		Plasma, High Energy, Nuclear Physics, Astronomy & Astrophysics and Nonlinear Dynamics	2
3.	Life Sciences (96)	Animal Sciences	20
		Plant Sciences	28
		Health Sciences	31
		Biophysics, Biochemistry, Molecular Biology and Microbiology	17

S. No.	Broad Area (No. of projects sanctioned)	Sub Area	Number of Projects Sanctioned
4.	Engineering Sciences (81)	Chemical Engineering	13
		Electrical, Electronics & Computer	39
		Mining, Mineral & Materials	2
		Mechanical & Manufacturing Engineering and Robotics	22
		Civil & Environmental Engineering	5
5.	Earth & Atmospheric Sciences (11)	Earth Sciences	8
		Atmospheric Sciences	3
6.	Mathematical Sciences (5)	Mathematical Sciences	5

## Research Highlights

**Fabrication of Flexible Piezoelectric Energy Harvester for Developing the Self-Powering System:** Investigator successfully fabricated all-organic piezoelectric nanogenerator (OPNG) based on multilayer assembled electrospun PVDF nanofiber mats where vapor-phase polymerized PEDOT-coated PVDF nanofibers are assembled as electrodes and neat PVDF nanofibers are utilized

as an active component. In the right panel, few mechanical energy harvesting performance related results are shown. It indicates that even from toy the mechanical energy is possible to harvest. The output voltage and power density as function of external load is shown in the Figure 3.37 and 3.38. The 66% piezoelectric energy harvesting efficiency has been reported in this work.

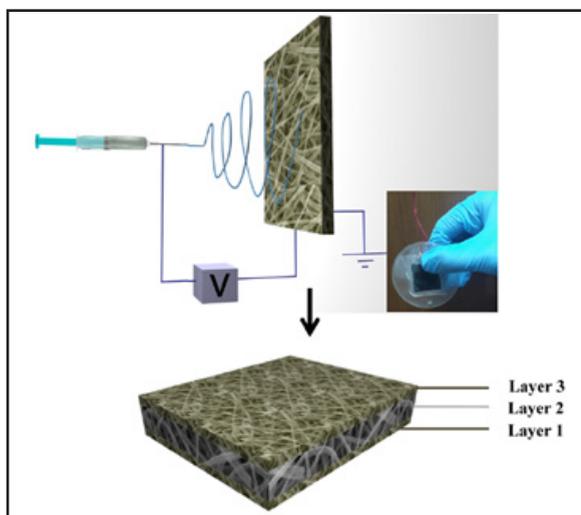


Figure 3.37 : The schematic of continuous electrospinning process for OPNG fabrication.

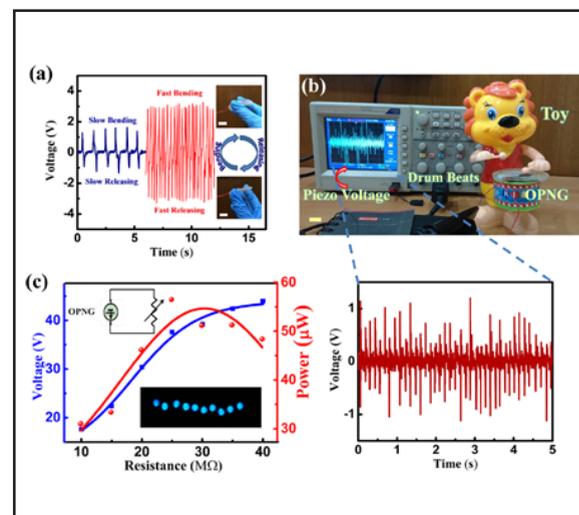
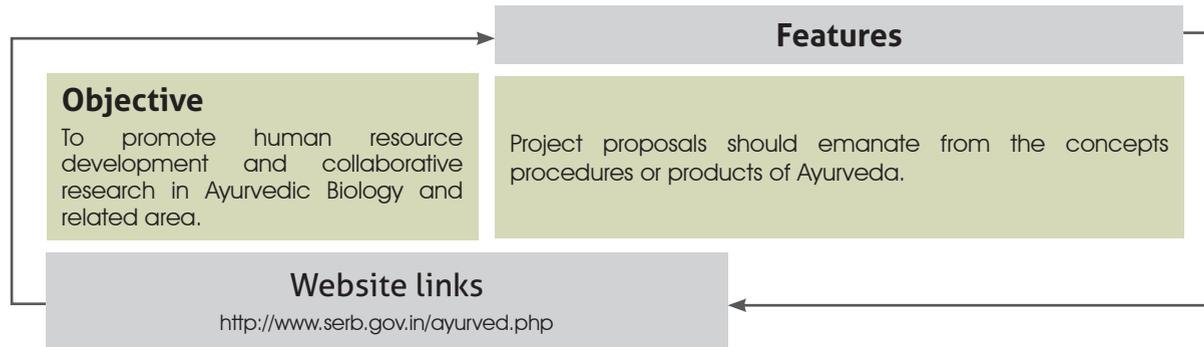


Figure 3.38 : Sensitivity of OPNG. (a) Relative changes in the output voltage signal vs time for monitoring different types of bending. The top and bottom insets show photographs of the device during bending and releasing, respectively. Scale bar, 1 cm. (b) Photograph demonstrates the voltage response for the impact of drumbeats of a toy. Scale bar, 3 cm. Enlarged marked area is shown below. (c) Dependences of the output voltage and instantaneous power on variable external load resistance with schematic circuit diagram in the inset. The inset shows the glowing array of LEDs by direct finger touch without external power source.

### ▶▶ 3.3 Ayurvedic Biology (AB)



Ayurveda transcends the practice of medicine and is identified with India's traditional system of medicine in vogue since the Buddhist era. It continues to serve 70% of India's rural population. AB Programme is designed to highlight scientific underpinnings of concepts, procedures and

products of Ayurveda in terms of modern sciences such as Molecular biology, Immunology and Chemistry. One project on Rasayana and Degenerative diseases was supported in the reporting period.

### Research Highlights

**Evaluating the potentials of Ayurvedic Amalaki Rasayana and Rasa-Sindoor in suppressing Alzheimer's and Parkinson's Disease in Mouse Models:** Metabolic and Molecular Studies: Neurodegeneration is one of the geriatric diseases which affects the aged people. Neurodegenerative diseases such as Parkinson's, Alzheimer's and Huntington's diseases are the

most common neurodegenerative diseases which is characterized by progressive loss of memory and cognitive dysfunction. Ayurvedic formulations are claimed to facilitate "healthy ageing" and thus have the potential to alleviate the suffering from neurodegenerative diseases (Figure 3.39).

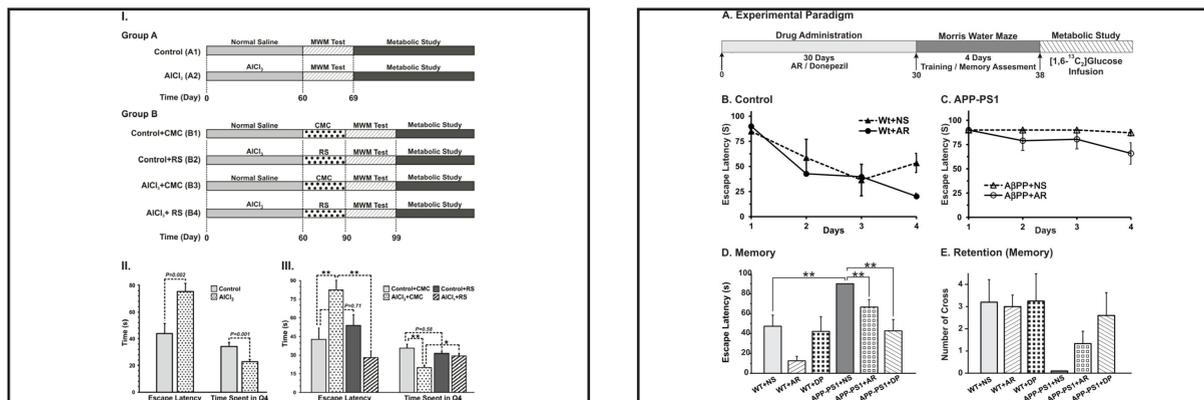


Figure 3.39: Neurodegenerative potential of drug.

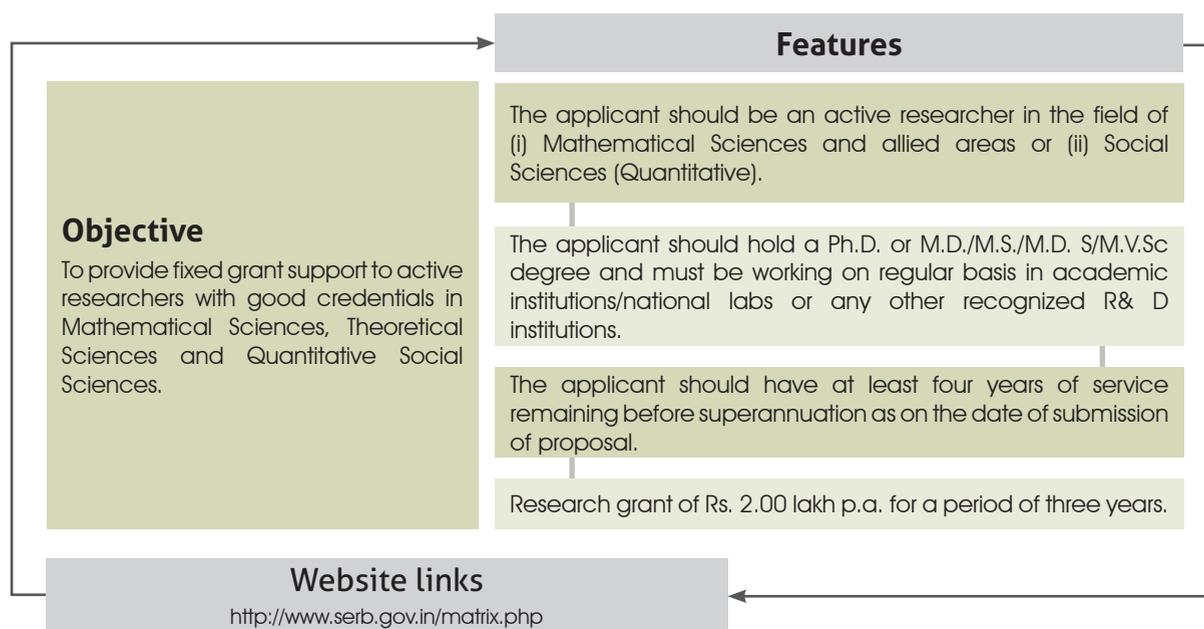
Although, Ayurvedic medicine has been widely practiced for several thousand years, very few systematic studies have been carried out to understand the Ayurvedic formulations and practices in terms of contemporary science. In the current project two Ayurvedic formulations, Amalaki Rasayana (herbal derivative) and Rasa Sindoor (Bhasma) had been used to evaluate their efficacy and as well as molecular mechanism against neurodegenerative disease models.

Intervention of Bhasma improved the memory and neuronal metabolism in  $\text{AlCl}_3$  treated mice suggesting that Bhasma may be useful for the management of memory and cognitive function in the geriatric people who are affected with Parkinson's disease. The double transgenic  $\text{A}\beta\text{PP-PS1}$  exhibit impaired memory and energy metabolism of excitatory and inhibitory neurons. Intervention with Amalaki Rasayana has improved the memory and neurometabolic

activity in AD mice nearly comparable to that of donepezil (allopathic) treated AD mice. These data suggest that AR has good potential to improve cognitive functions in AD. The current study clearly depicted that Intervention of Rasa Sindoor and Amalaki Rasayana improved

memory as well as the energetics of excitatory and inhibitory neurotransmission in chemical and genetic models of Alzheimer's disease. Hence, Rasa Sindoor and Amalaki Rasayana have strong potential to manage memory and cognitive functions in AD condition.

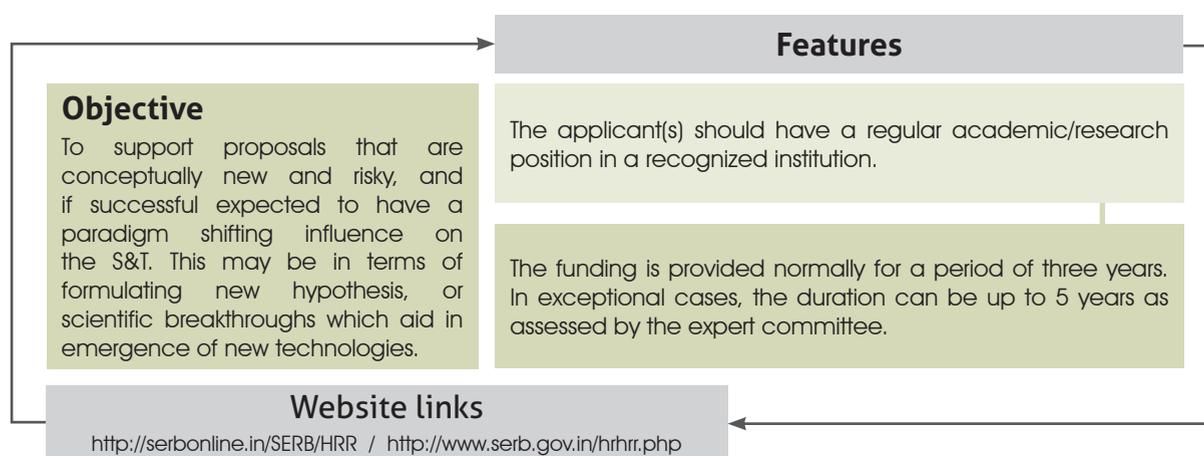
### ▶▶ 3.4 Mathematical Research Impact-Centric Support (MATRICS)



The main attribute of this scheme would be submission of a proposal in the form of concept note. The funding provided would cater to the specific needs of Mathematical/Theoretical

Sciences research. A total of 1853 proposals were received, and the committee recommended 133 proposals.

### ▶▶ 3.5 High Risk - High Reward (HRHR)



During the financial year 2018-19, a total of 223 proposals were received and only 1 was

supported under the discipline of Earth & Atmospheric Sciences.

Summary of the project supported under HRHR is given below:

Title of the project	Institution
Rodent-based biochronology and paleoecology of the Neogene Terrestrial sequences of Kutch and Kathiawar, Gujarat	Panjab University, Chandigarh-160014

#### Salient Features

Compartmentalization of miRNA biogenesis steps in mammalian cells microRNAs are short regulatory RNAs in metazoan cells. Regulation of miRNA activity and abundance is evident in human cells where availability of target messages can influence miRNA biogenesis by augmenting the Dicer1 dependent processing of precursors to mature microRNAs. The Investigator's group identified how the subcellular compartmentalization of the components of miRNA processing and effector machineries determines *de novo* miRNA biogenesis in human cells. The importance of Ago2-Dicer1 complex formation on late endosomes and its subsequent inter-organellar trafficking for the controlled biogenesis of miRNPs exclusively happening on the polysomes attached with the endoplasmic reticulum was observed during the study. The process is energy driven and dependent on mitochondrial tethering of endoplasmic reticulum and its interaction with endosomes. In cells with depolarized mitochondria, miRNA-biogenesis gets impaired that results in lowering of *de novo* formed mature miRNA levels and accumulation of miRNA-free Ago2 on endosomes that fails to interact with Dicer1 and gets trafficked back to endoplasmic reticulum associated polysomes for *de novo* miRNA loading. Thus, mitochondria by sensing the cellular context regulates the subcellular Ago2 trafficking that acts as a rate-limiting step in miRNA biogenesis process in mammalian cells (Figure 3.40).

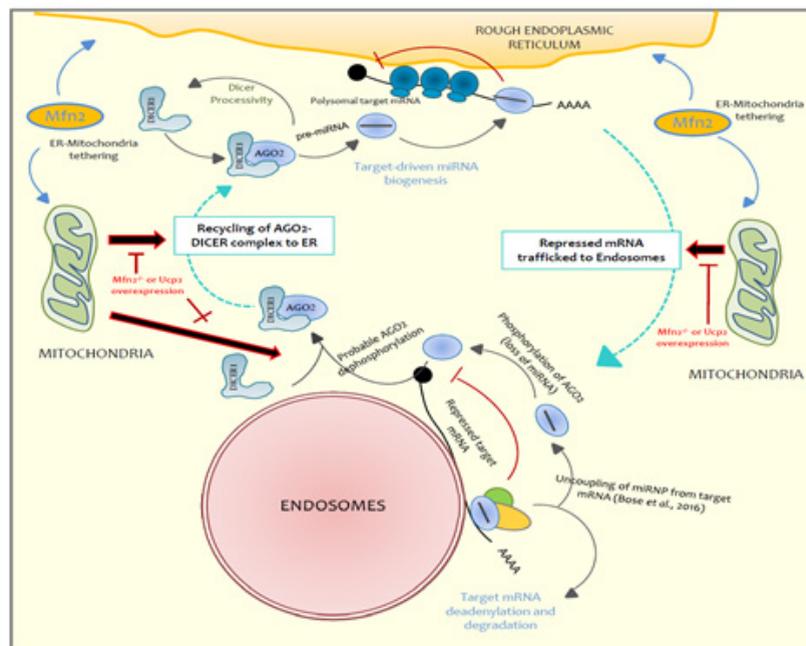
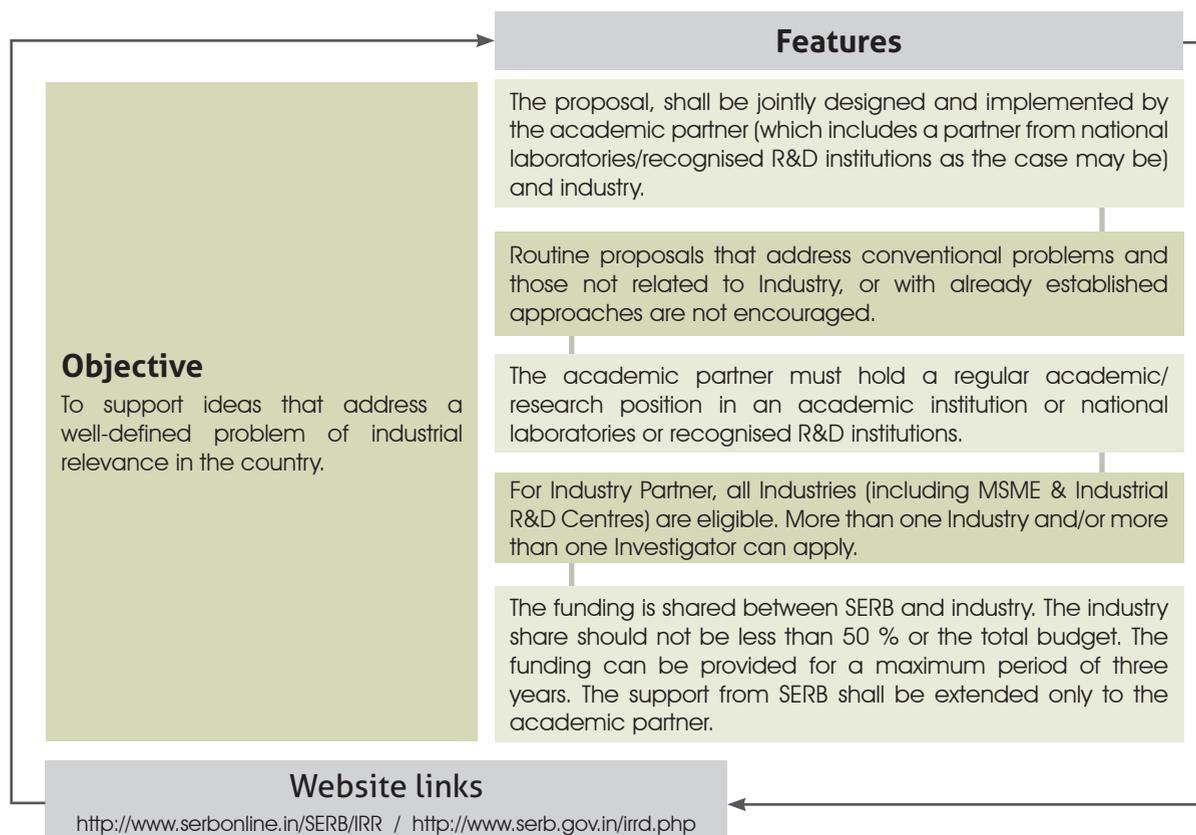


Figure 3.40: LegendA model of Ago2 recycling determined by mitochondria-controlled interaction for the Ago2-miRNA complex formation on the polysomes attached to rER.

### ▶▶ 3.6 Industry Relevant R&D (IRRD)



Industry Relevant R&D (IRRD) scheme was launched in the year 2015-16 with the objective to utilize the expertise available in academic institutions and national laboratories to solve industry specific problems for the larger benefit of society. IRRD supports joint proposals by

academic and industry partner. A total of 24 proposals were received out of which 04 proposals were recommended. In the reporting year two projects have been funded in partnership with Industry.

Research highlights from one of the funded properties is given below :

Title of the project	Institution
Development of Resin Formulation and Hybrid Materials for 3D printing	Principal Scientist, Polymer Science and Engineering National Chemical Laboratory Pune, Maharashtra-411008
<p><b>Salient Features:</b>            The project aims to develop flexible resin materials and resin formulation with improved mechanical properties and to develop hybrid materials for 3D printing where one of the objectives of the proposal was to develop UV curable polymer composite resin formulations that was amenable to 3D printing. To meet this objective the PI along with its Industry Partner has initiated surface functionalization of metal nanoparticles which were to be incorporated into polymerizable resin mixtures. The aim behind it was to maximize the loading of the non-organic composite material so to develop high strength 3 D printed materials.</p>	



Figure 3.41: A solus 3D printer has been procured under this project and installed.

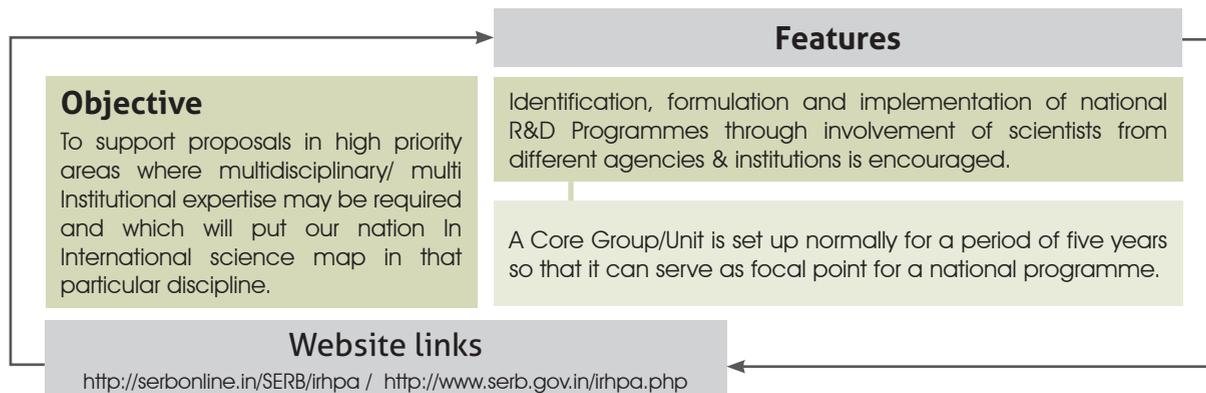


Figure 3.42 a : A Photograph of 3D printed objects using commercial resin



Figure 3.42 b : A Photograph of 3D printed objects using Indigenously developed formulations.

### ►► 3.7 Intensification of Research in High Priority Area (IRHPA)



Summary of some of the major ongoing IRHPA Projects is given below:

Title of the project	Institution
Rotavator Blade Development	CSIR-CMERI Centre of Excellence for Farm Machinery, Ludhiana-141006
<p><b>Salient Features</b></p> <p>The most frequently changing component of the rotavator is the rotavator blade, which is typically having L, C and J shape. CMERI, Ludhiana in collaboration with PAU, Ludhiana &amp; GBPUA&amp;T, Pantnagar developed and tested casted blades of Austempered Ductile Iron (ADI) with optimized material composition (Figure 3.43). The wear pattern of ADI rotavator blades, having L shape, were studied by measuring the loss of weight of each selected blade during set time interval of 10 hours for the total operational time of 100 h. The wear pattern was also established by observing the reduction in width and thickness of selected rotavator blades at different locations on the blade. The exhaustive field tests along with the analysis of blades shown that the current manufacturing process of rotavator blades can be replaced with the new ADI technology for rotavator Blades. Also, the ADI blades have minimum wear and long duration due to the work hardening of cutting surfaces.</p>	
 <p>Figure 3.43 : Rotavator Blades at the bottom depicts the operation time.</p>	

Title of the project	Institution
Virtual reality-based solution for effective neuroanatomy teaching	Centre for IT in Education, International Institute of Information Technology, Hyderabad- 500032
<p><b>Salient Features</b></p> <p>The proposal aims to establish the feasibility of leveraging volume images, their 3-D visualization and projection for teaching anatomy in classrooms. Human anatomy is a basic subject taught in the (first year) medical curriculum at the undergraduate level. It is generally taught using drawings and lectures to cover theory and practical with dissection of cadavers in labs. The course aims to give first-hand knowledge of the human body, its parts and spatial configuration of various structures. Practical teaching largely relies on models, charts and labelled parts of cadavers preserved in formalin (to overcome shortage of cadavers) which results incomplete understanding of the subject for the students potentially leading to under trained doctors. Spurred by a severe shortage of cadavers and medical ethics, much of teaching in leading universities around the world is leaning towards the use of technology as a solution. Virtual reality (VR) is at the heart of such teaching methods. However, most of this caters to learning by small groups or by individuals.</p>	

The proposal proposes the use of 3D visualisation for modernizing the teaching of anatomy for a *large* (~ 100) class of students. Choosing the brain as a target organ, the proposal proposes to develop a graphical model and use structural MR images of the brain to render and visualise the brain for teaching neuroanatomy. Modelling and representing the anatomy of the brain in a rich and layered approach enables rich graphical visualization of the brain for instruction. This is useful in teaching various systems of interest in neuroanatomy, visualise user-chosen cuts (cross-sections) and even enables navigation through the organ. A novel solution by adapting the 3D projection used in movie theatres to project the 3D rendered brain model to enhance the teaching in theory classes and facilitate a 3D visualisation experience for the students with the aid simple inexpensive eyewear is proposed, which may be useful for developing- 1) A novel solution to modernize the teaching of anatomy in classrooms complete with a 3-D viewing experience for the students and 2) Teaching in Medical & Dental Colleges, Nursing colleges, Colleges teaching Allied Health Sciences (Graduate & Post graduate programme in Neurology, Radiology & Medical imaging technology and other allied health science subjects).

Title of the project	Institution
Petrogenesis and Rare Earth Element potential of Kamthai and Amba Dongar carbonatites	Department of Geology and Geophysics, IIT Kharagpur, West Bengal-721302

#### Salient Features

Along with the body of substantial textural evidence (Figure 3.44), the major and trace element data of the minerals in the carbonatites at Kamthai, Rajasthan and Amba Dongar, Gujarat, indicate fluid assisted REE mobilization from the primary phases. Increase in pH due to the fluid-rock interaction was inferred to be the cause of REE precipitation in both the cases. However, evidence suggest a hydroxyl dominated minor sulfur-bearing fluid was the transporting medium at Kamthai, while a Cl<sup>-</sup>-poor, SO<sub>4</sub><sup>2-</sup>-bearing and fluorine-rich fluid transported the REEs at Amba Dongar. While, increase in pH at Kamthai was a consequence of non-redox transformation of magnetite to hematite [ $\text{Fe}_3\text{O}_4$  (magnetite) +  $2\text{H}^+ \rightarrow \text{Fe}_2\text{O}_3$  (hematite) +  $\text{H}_2\text{O}$ ], at Amba Dongar the same were achieved by interaction with the carbonate minerals in the host itself. Further, removal of sulfur by formation of barite also have aided and abetted the REE precipitation process at Amba Dongar which was operable only at alkaline pH.

The societal implication of this study is the identification of fluid-assisted appropriate alteration, which is mandatory for concentration of the high-tech rare earth metals in carbonatites as these metals have enormous industrial applications (in catalytic converters, permanent magnets, rechargeable batteries, technical ceramics, mobile devices, and various medical diagnostic machines).

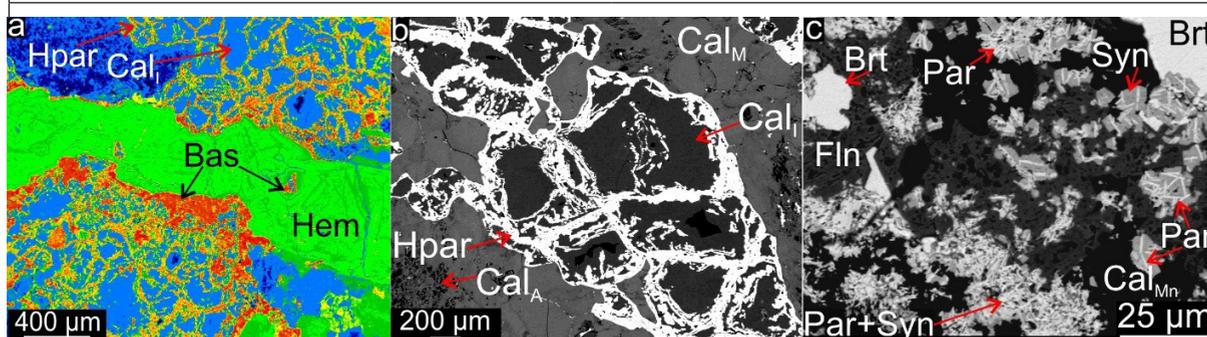


Figure 3.44: Representative (textural evidence) False colour composite (FCC) and grey scale Back scattered Electron (BSE) images of the Kamthai (a and b) and Amba Dongar (c) carbonatites. Replacement of hematite (Hem) by bastnäsite (Bas) at the immediate vicinity and by hydroxylparisite (Hpar) slightly away from it (a); box-work intergrowth of magmatic Calcite (CalM), altered Calcite (CalA) and intergrown Calcite (CalI), and hydroxylparisite (b); syntactic intergrown parisite (Ce) (Par; thin bright lamellae) within synchysite (Ce) (Syn; grey) that are intergrown with florencite (Ce) (Fln) and barite (Brt) (c).

Title of the project	Institution
Studies on the Stratosphere Troposphere Coupling Processes over the Monsoon Region using Stratosphere Troposphere (ST) Radar at Cochin	Advanced Centre for Atmospheric Radar Research, Cochin University of Science & Technology, Cochin- 682022

**Salient Features**

Stratosphere Troposphere (ST) wind profiler radar project funded to the Cochin University of Science and Technology (CUSAT) has been installed and successfully functioning and being operated at 205 MHz frequency (Figure 3.45). This National facility was inaugurated by Union Hon'ble Minister, Dr. Harsh Vardhan in July 2017. Besides being the first radar in the world operated at this frequency, it is also the first wind profiler radar in the near equatorial site set up to study and predict the variability of monsoon, extreme weather events like severe droughts and floods, and the regional climate change effect over the Indian Peninsular region. This most sophisticated and indigenously developed ST wind profiler radar provides a cost effective and high precision technology data of atmosphere starting from 315 m and up to 20 km in all weather conditions.

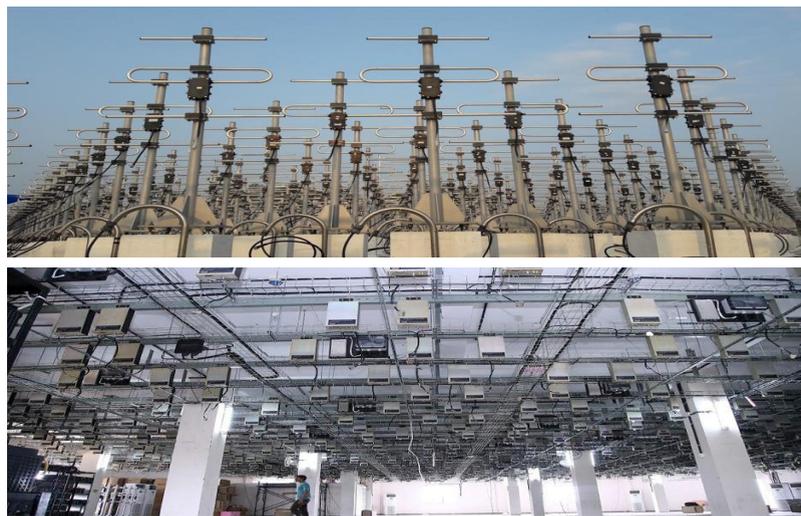


Figure 3.45: Display of Antenna Array at the Rooftop and TR Modules hung below at CUSAT, Cochin.

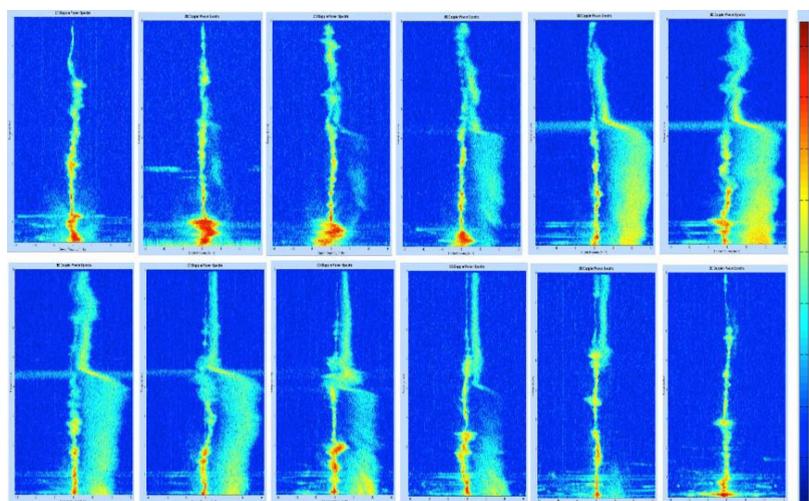


Figure 3.46: ST Radar Observations of Rain Formation and its Progress in the Atmosphere.

Since Cochin is in the Gateway of Indian Summer Monsoon, numerous unknown features on the onset, active and break phases of the Indian summer monsoon circulation can be detected using the high-resolution wind profiler radar. This is expected to be a National Facility to be utilized widely by the national agencies for operational purposes as well as scientific studies by academic and research institutions. With the 205 MHz radar measurements, it is possible to clearly demarcate the clear air portion from the precipitation portion as shown in the Figure 3.46. In addition, the rain starting from an altitude of 5 km but failing to reach the surface can also be seen. This shows the ability of this radar in discerning different layers of rain bearing clouds.

Title of the project	Institution
Atmospheric Studies in the Geophysically sensitive Tropical to Sub-tropical transition region with ST Radar Facilities at Calcutta University	Institute of Radio Physics and Electronics, University of Calcutta, Kolkata-700073.

**Salient Features**

The ST Radar project at University of Calcutta is at advance stage of implementation. This indigenously developed state-of-the-art 53 MHz VHF ST Radar is being established by Institute of Radio Physics and Electronics, University of Calcutta at Ionosphere Field Station, Haringhata of the University. The ST Radar at Ionosphere Field Station is the only radar at this frequency (53MHz) in the entire Eastern and North-Eastern India as well as South-East Asian longitude sector. This radar is situated at the verge of the transition region between the tropics and subtropics, and near the northern crest of the Equatorial Ionization Anomaly (EIA). During 2018-19, observations using a Pilot array have been done and initial results presented at various meetings and conferences, both national and international. During this period, extensive tests on the final deliverable radar hardware have been conducted. Liaison has been established with RMC Kolkata, IMD for mutual collaboration and future use of the high-resolution ST radar data. Presently, validation of the wind speed and direction calculated from the Pilot array are being done with IMD measurements from Kolkata (Figure 3.47).

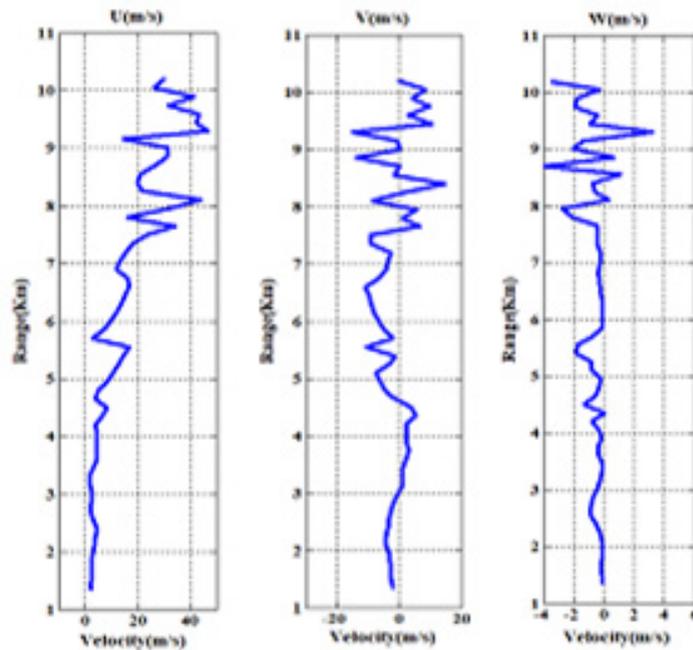


Figure 3.47: Computation of Wind Velocities (UWV) Date: November 23, 2018.

Title of the project	Institution
Setting up of ST Radar System at ARIES, Nainital, Uttarakhand	Aryabhata Research Institute of Observational Science (ARIES) Nainital, Uttarakhand- 263002

**Salient Features**

Aryabhata Research Institute of observational Science (ARIES) has installed Stratosphere Troposphere Radar (ASTRAD) at a relatively lower frequency. This Radar has been operated nearly 500 hrs. with seven clusters and captured wind data up to a height about 13 km. Observed wind pattern from the system is consistent with the general wind patterns over this region. Wind observations from radar have been compared with the observations made using balloon-borne radiosonde, which showed reasonably good agreement (Figure 3.48).

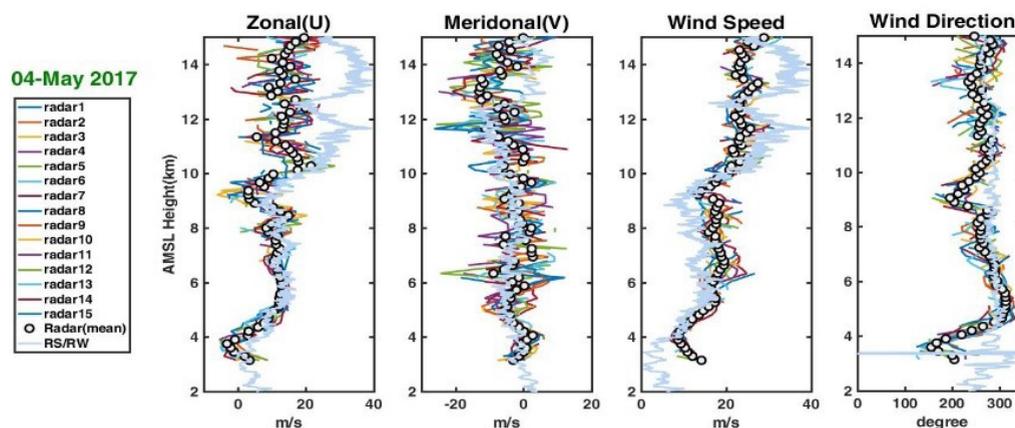


Figure 3.48: A comparison between winds from ARIES ST Radar and balloon-borne radiosonde observations on 4 May 2017.

Temporal variations in Zonal and Meridional wind components, wind speed and wind direction obtained were using ARIES software. Higher winds could be seen at greater altitude region (Figure 3.49).

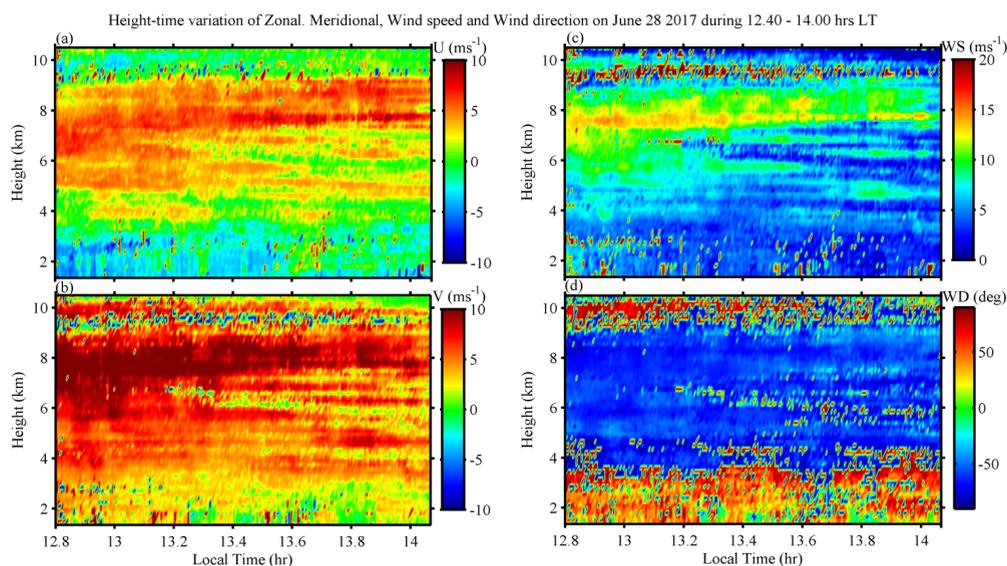
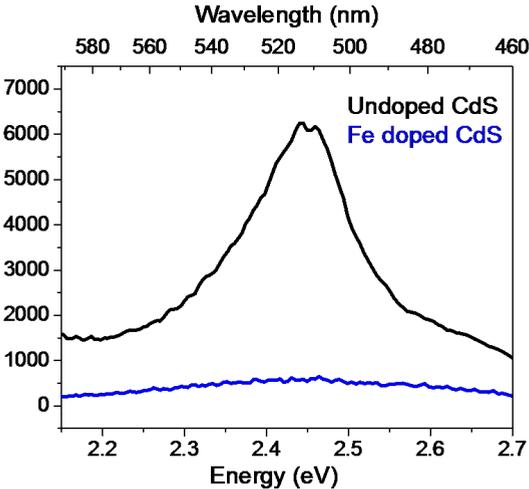


Figure 3.49: Temporal variations (local noon) in vertical (up to about 11 km) winds (Zonal, Meridional, speed and direction) analyzed using ARIES software for June 28, 2017.

Title of the project	Institution
Low temperature, spatio-temporal spectroscopy of nanocrystals and multifunctional nanoassemblies.	Indian Institute of Science, Bengaluru 560012
<p><b>Salient Features</b></p> <p>In this project spontaneous lifetime evolution in nanocrystals has been studied. The temporal evolution of radiative rates in certain families of nanocrystals was observed and studied. While radiative rate is a fixed observable in most systems, the identification of temporal evolution of radiative rate is extremely surprising. Procedures and techniques were developed in order to ascertain and confirm temporal rate evolution.</p> <p>Efficient nanocrystal catalysts for the photoreduction of solubilized carbon-dioxide to formate have also been developed in this project. These CuAlS<sub>2</sub>/ZnS materials enable the conversion of bicarbonate to formate at an unprecedented solar to chemical energy conversion efficiency of 20%.</p> <p>The outcomes from the Transient Absorption Studies to Probe the Excitation and De-excitation Pathways in Fe doped CdS Quantum Dots (QDs) are as follows:</p> <ul style="list-style-type: none"> <li>➤ Quenching of luminescence in II-VI QDs by Fe dopants have been extensively observed in literature, origin remains unexplored.</li> <li>➤ No dopant related emission is observed in PL spectra.</li> <li>➤ Band edge (BE) is also quenched upon doping with Fe as seen in the Figure 3.50.</li> </ul> <div style="text-align: center;">  </div> <p>Figure 3.50: Quenched band edge upon doping of Fe</p> <p>Transient absorption studies were undertaken to understand excited state dynamics and based on the spectra obtained as seen in Figure 3.51, and it has been observed that-</p> <ul style="list-style-type: none"> <li>➤ There is an instantaneous rise in undoped CdS</li> <li>➤ BE decays and stabilises in a few picoseconds. Excitonic processes are insensitive to the surface.</li> <li>➤ Fe quenches the BE instantaneously.</li> </ul> <p>However, upon expansion, it was observed that-</p> <ul style="list-style-type: none"> <li>➤ Slow rise of CdS as compared to Fe doped CdS.</li> <li>➤ CdS decays in a few picoseconds in presence of Fe.</li> <li>➤ CdS gets excited and de-excited much faster when Fe is present.</li> </ul>	

These can help in understanding the mechanism of electron capture within the QDs.

Additionally, the limitation of Purcell effect in the nano regime has also been investigated. The Purcell effect has been the basis for several decades in understanding enhancement of photonic efficiency and decay rates of emitters through their coupling to cavity modes and metal nanostructures. Using monolayer thin films of semiconductor quantum dots embedded with tiny gold nanoparticles it was observed that the giant radiative enhancements of quantum dot assemblies with extremely small metal nanoparticles and emitter-particle separations  $R$  of a few nanometers, where Purcell effect would lead to either no enhancements or quenching. It has also invoked a new regime of radiative enhancements to explain the experimental data and correctly predict the emergence of strong coupling below certain,  $R$ , as observed in experiments.

The room temperature tuning of excitonic lifetime in pristine and hole doped monolayer MoS<sub>2</sub> based field effect transistor (FET) devices by systematically controlling the free carrier density have also been reported. In pristine MoS<sub>2</sub> devices, with intrinsic electron doping, an exciton dominant regime with an exciton lifetime of 3 ns was observed, when doped electrostatically with holes was seen.

The PI also explored decay rates of semiconductor quantum dots (QDs) coupled to plasmonic lattices. By varying concentration of the QDs the PI was able to tune the system from weak to strong coupling regime. It was observed that the significant enhancements of decay rates in the weak coupling regime when QDs couple to the lattice modes as well as strong enhancement in single photon emission rates.

There is an enormous diversity in reported values of the excitonic binding energy of hybrid perovskites halides, such as MAPbI<sub>3</sub>. The origin of this disparity in reported values, identifying its source to the dynamic generation of surface defects due to the evacuation process necessary for carrying out photoluminescence experiments in the usual way have also been investigated. This phenomenon makes it impossible to probe the true temperature dependent PL properties necessary to evaluate the excitonic binding energy of any material. The use of sub-bandgap excitation and 2-photon absorption to induce PL throughout the bulk of the sample avoids this problem, leading to the correct estimation of excitonic binding energies in all these systems has been shown.

Further the PI has shown how one may design specifically surface-protected extended defects inside quantum dots to provide highly efficient and tunable PL that are also free of self-absorption, thereby proving these systems to be near-ideal emitters.

Total 7 publications in various journals have been generated from this project for the financial year 2018-19.

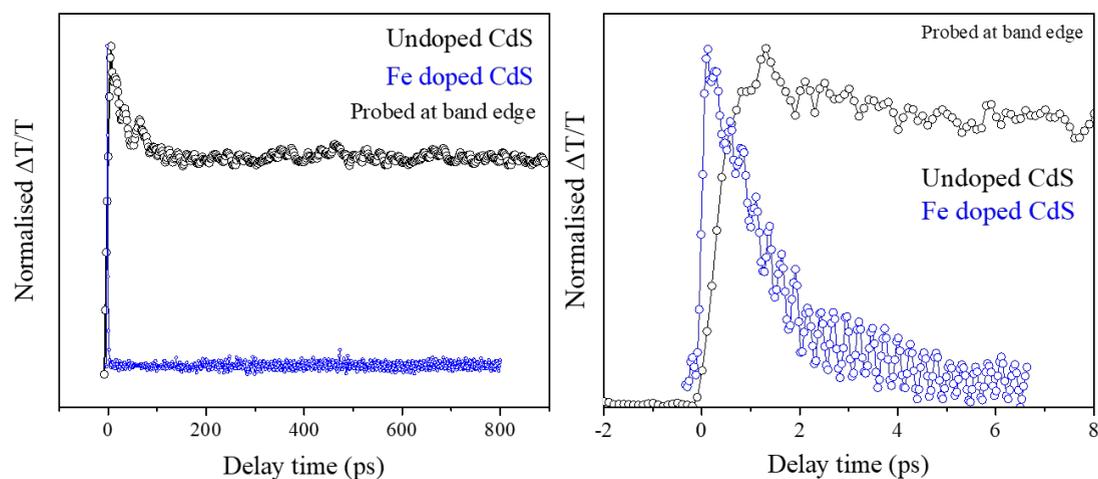


Figure 3.51: Transient absorption data of Fe doped CdS and undoped CdS quantum dots.

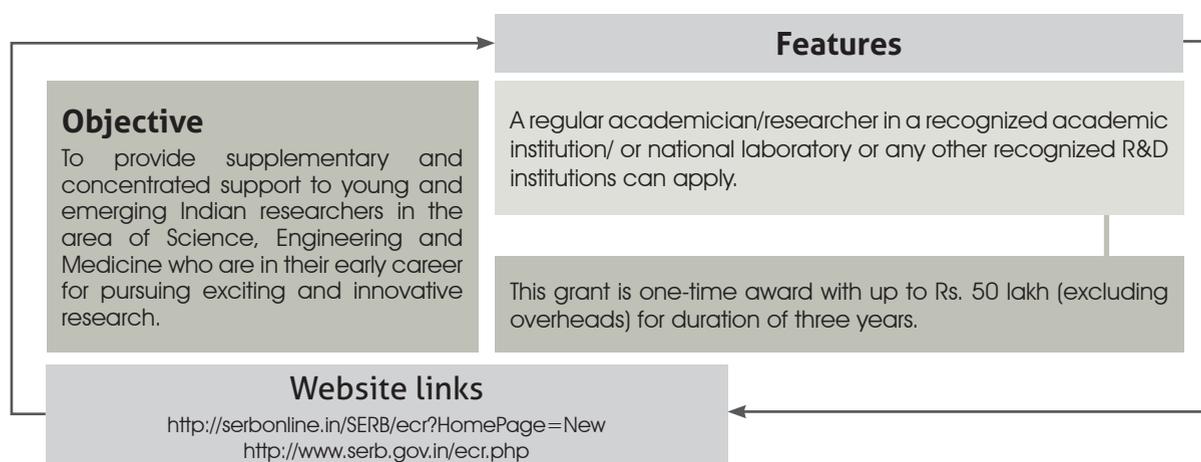
## 4 FOSTERING THE YOUNG RESEARCHERS

Early independence of young scientists is one of the prime priorities of the Board. The Board had designed and implemented innovative schemes to attract and nurture budding Indian scientists.

The Start-up Grant is an important element in the career of a young scientist. The Young Scientist Scheme (YSS) (erstwhile) has been restructured into two parts – **National Post-Doctoral Fellowship (N-PDF)** and the **Early Career Research Award (ECRA)**. The N-PDF aims to provide opportunities for young PhDs to avail post-doctoral level

research in academic institutions and research laboratories of the country. The ECRA provides start up research grants to young scientist working in regular capacity in an institute. The erstwhile YSS continue to be in existence w.r.t ongoing projects in most of the disciplines.

### ►► 4.1 Early Career Research Award (ECRA)



A national call for proposals was solicited in July 2018. The number proposals received under

different disciplines and the number of awards offered are listed in Table 4.1

**Table 4.1:** The number of ECRA awards offered in the reporting period.

PAC	Total Proposal Received	Number of Proposal Approved
Chemical Sciences	443	48
Earth and Atmospheric Sciences	96	18
Engineering Sciences	1129	159
Life Sciences	875	143
Physical & Mathematical Sciences	354	35
<b>Total</b>	<b>2897</b>	<b>403</b>

### 4.1.1 Chemical Sciences

A total of 74 projects were awarded under different sub disciplines as given in Figure 4.1 :

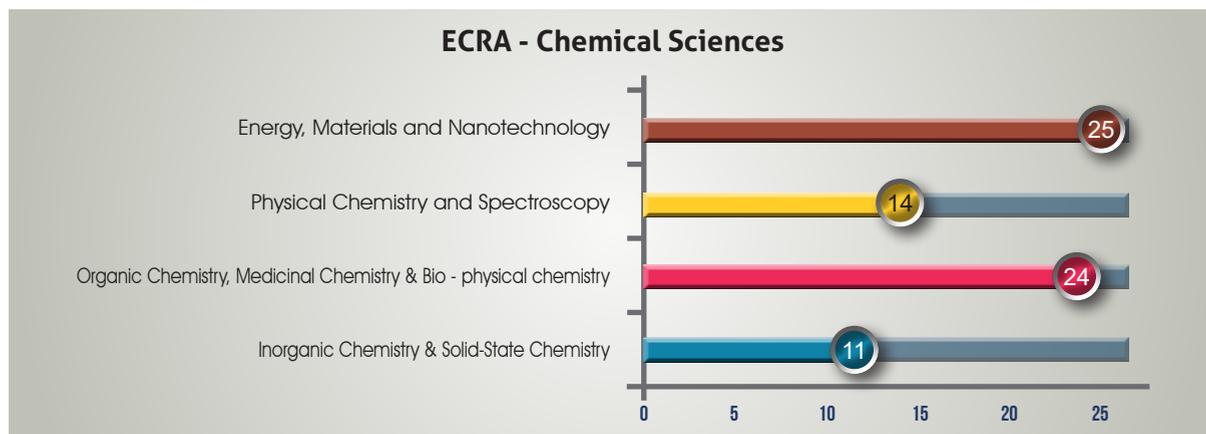


Figure 4.1: Projects supported in Chemical Sciences.

### 4.1.2 Earth and Atmosphere Sciences

A total of 38 projects were awarded under different sub disciplines as given in Figure 4.2 :

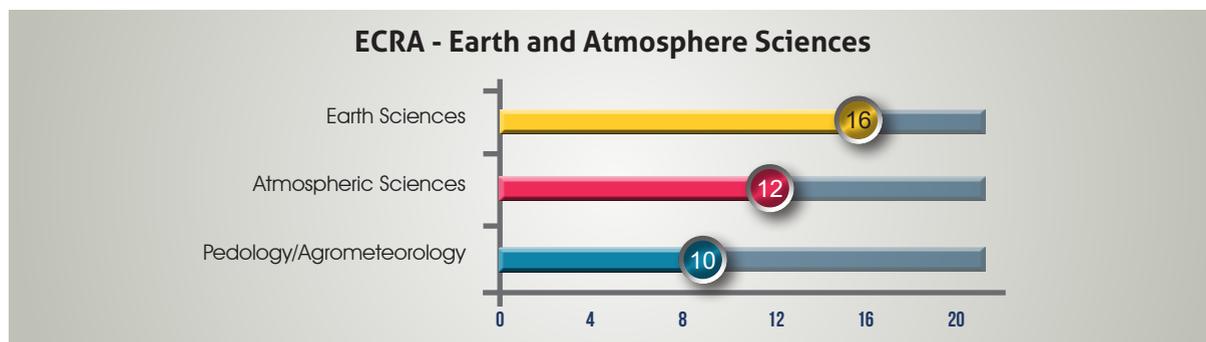


Figure 4.2: Projects supported in Earth and Atmospheric Sciences.

### 4.1.3 Engineering Sciences

A total of 169 projects were awarded under different sub disciplines as given in Figure 4.3 :

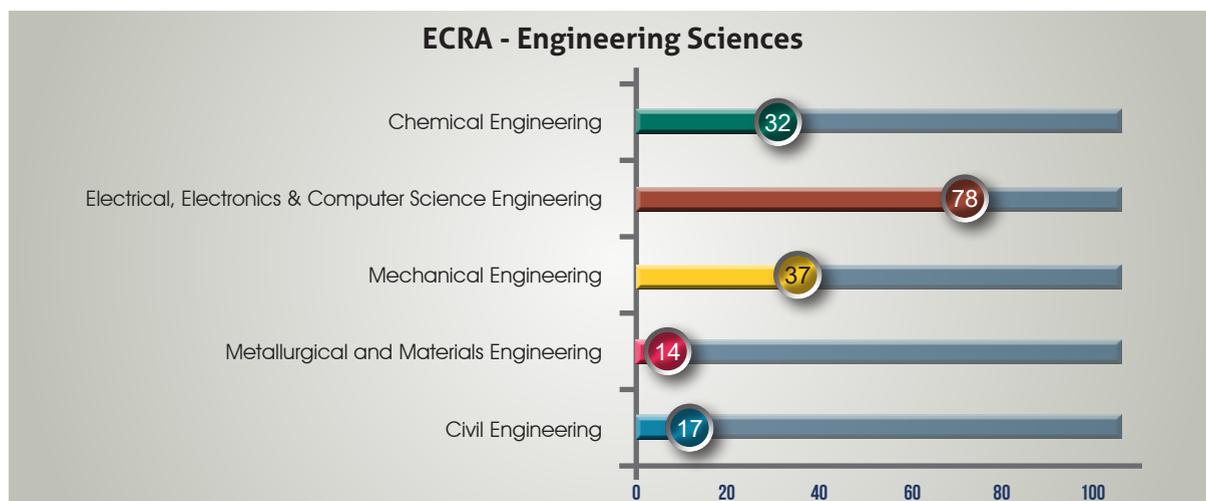


Figure 4.3: Projects supported in Engineering Sciences.

### 4.1.4 Life Sciences

A total of 224 projects were awarded under different sub disciplines as given in Figure 4.4 :

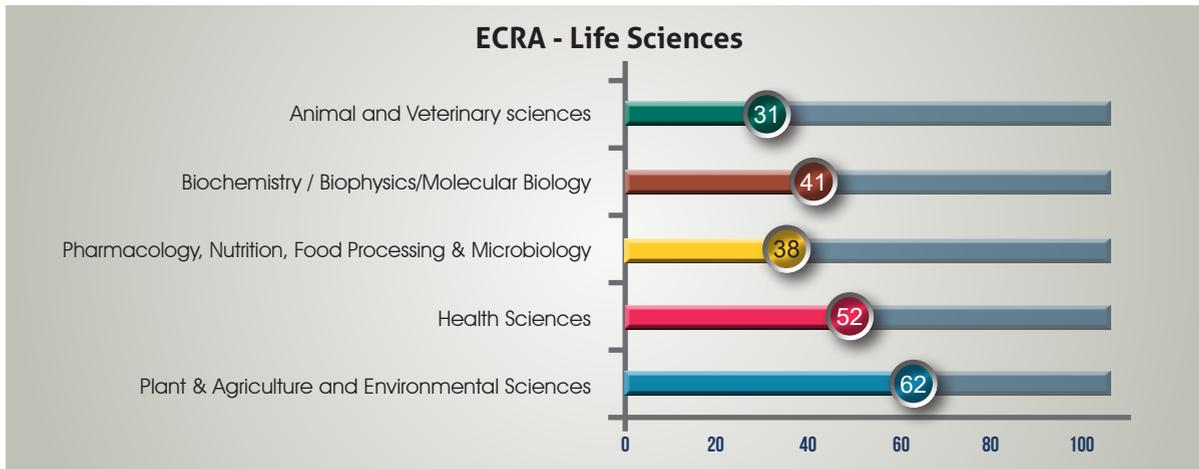


Figure 4.4: Projects supported in Life Sciences.

### 4.1.5 Physical and Mathematical sciences

A total of 117 projects were awarded under different sub disciplines as given in Figure 4.5 :

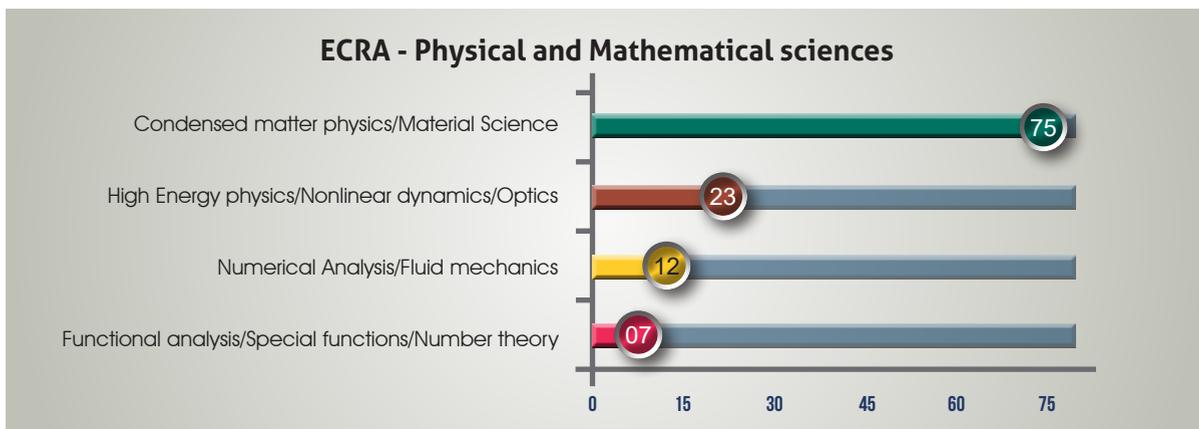
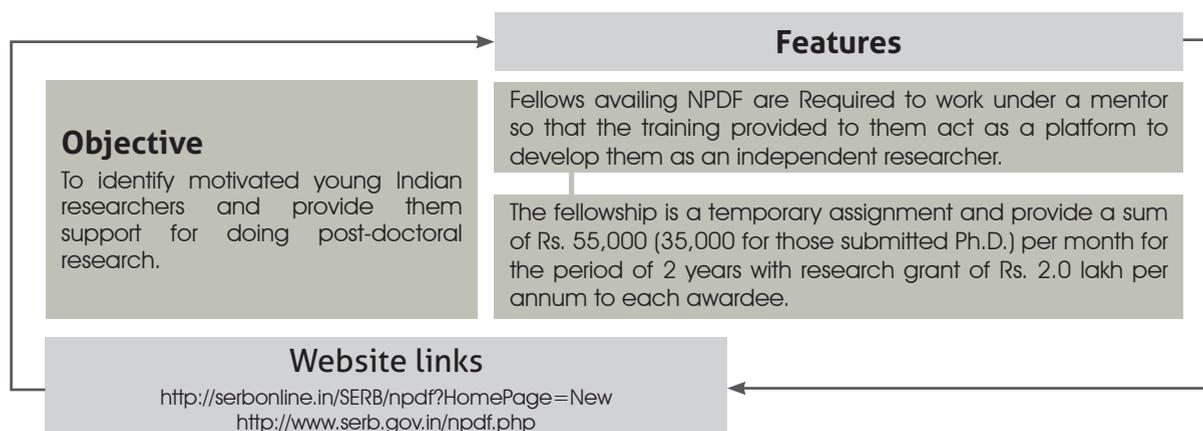


Figure 4.5: Projects supported in Physical and Mathematical Sciences.

## ►► 4.2 National Post-Doctoral Fellowship



A call for applications was solicited in April 2018. The number of applications received in different disciplines and the number of fellowship offered are given in Table 4.2

**Table 4.2 :** The number of N-PDF awards offered during the reporting period.

PAC	Total Proposal Received	Number of Fellowships Awarded
Chemical Sciences	1007	80
Earth and Atmospheric Sciences	270	38
Engineering Sciences	498	56
Life Sciences	2025	154
Physical & Mathematical Sciences	690	56
Total	4490	384

### 4.2.1 Chemical Sciences

A total of 45 fellowships were awarded under different sub disciplines as given in Figure 4.6 :

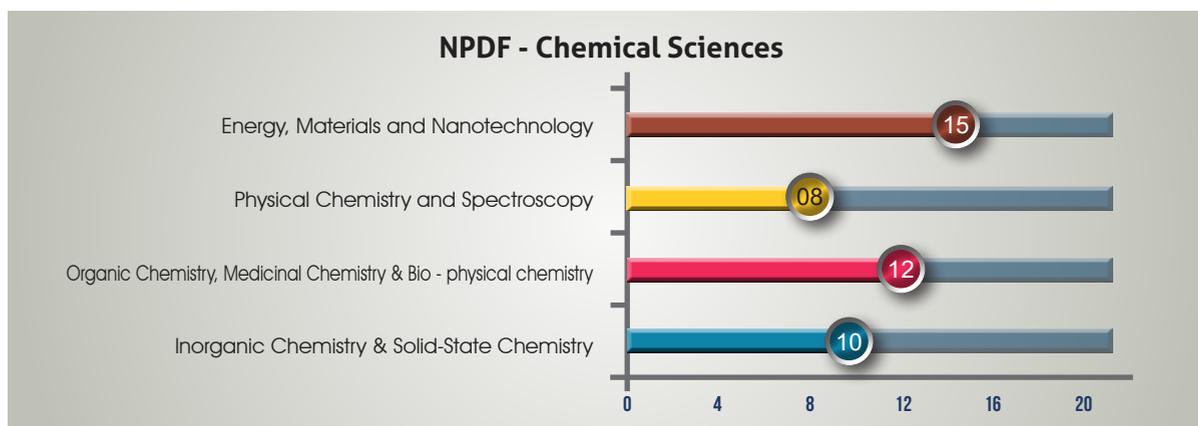


Figure 4.6: Fellowships awarded in Chemical Sciences.

### 4.2.2 Earth and Atmospheric Sciences

A total of 15 fellowships were awarded under different sub disciplines as given in Figure 4.7 :

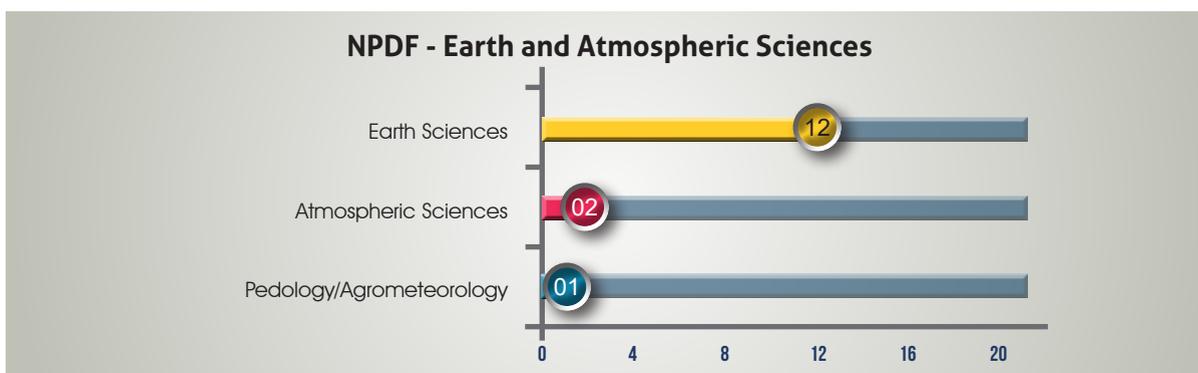


Figure 4.7: Fellowships awarded in Earth and Atmospheric Sciences.

### 4.2.3 Engineering Sciences

A total of 32 fellowships were awarded under different sub disciplines as given in Figure 4.8 :

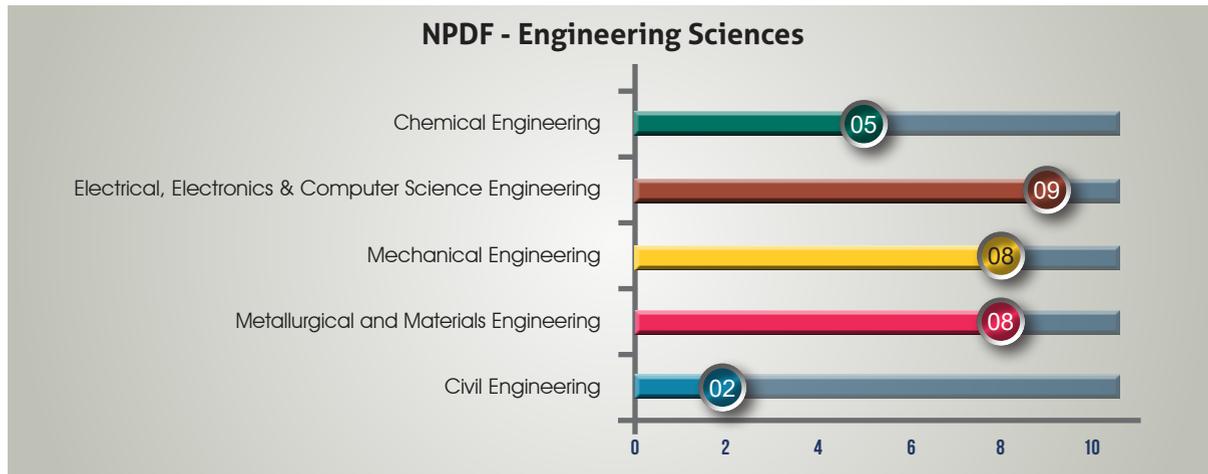


Figure 4.8: Fellowships awarded in Engineering Sciences.

### 4.2.4 Life Sciences

A total of 412 fellowships were awarded under different sub disciplines as given in Figure 4.9 :

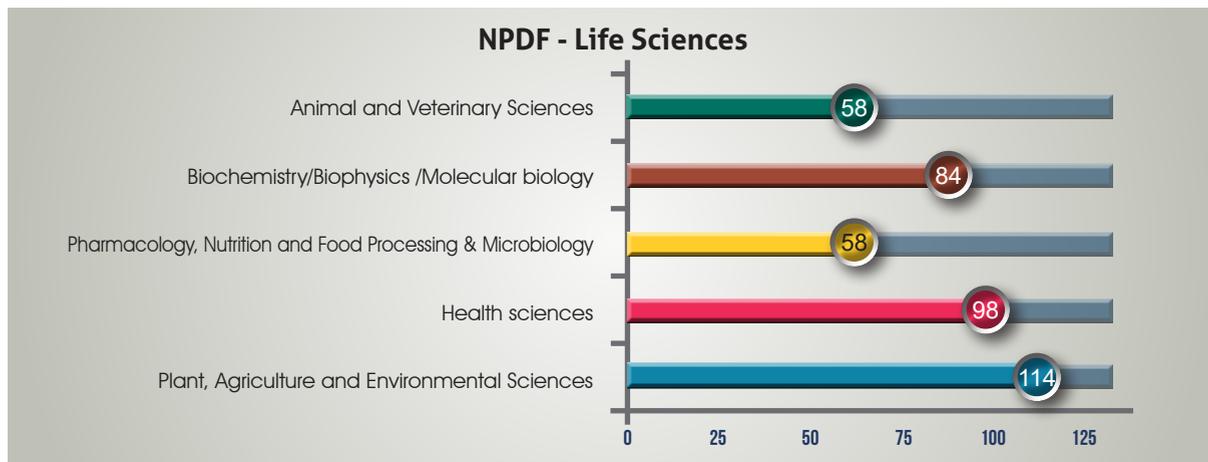


Figure 4.9: Fellowships awarded in Life Sciences.

### 4.2.5 Physical and Mathematical Sciences

A total of 66 fellowships were awarded under different sub disciplines as given in Figure 4.10 :

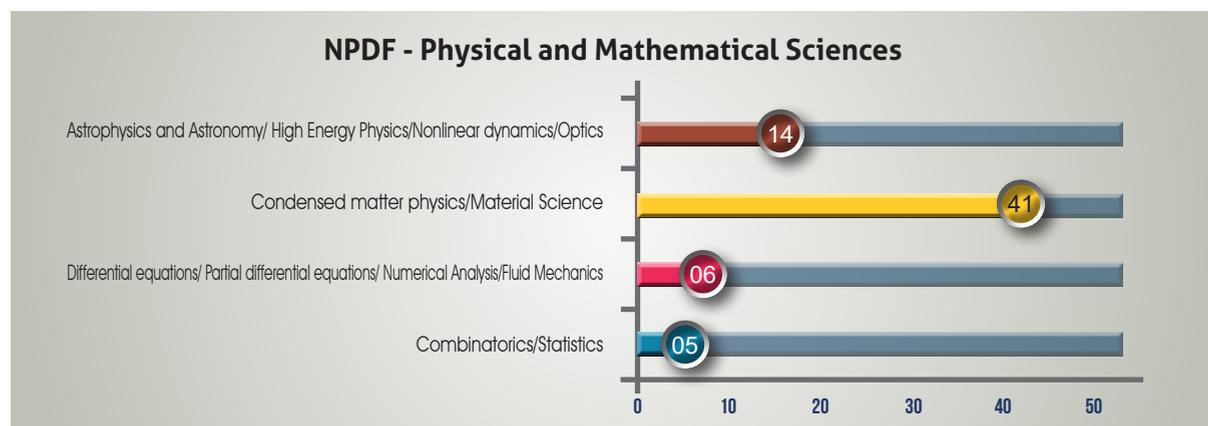


Figure 4.10: Projects supported in Physical and Mathematical Sciences.

## ►► 4.3 Significant Research Highlights from YSS/ECRA/NPDF Projects

Many young researchers are supported under the programs, NPDF and ECRA every year. For the purpose of brevity, only one research from

each discipline of YSS/ ECRA/NPDF have been included.

### 4.3.1 Chemical Sciences

#### Development of First Row-Transition Metal Catalysts for Catalytic Asymmetric Reductive Functionalization Reactions:

Catalysis is a key technology for making molecules for pharmaceutical and chemical industries. The advancement of organometallic catalysis is mainly pursued using noble 4d and 5d transition metals. However, use of these metals is not sustainable, especially in homogeneous catalysis, for a large number of reasons. Considering these and global emphasis on sustainable development of chemical synthesis, it is highly desirable to replace the 4<sup>th</sup> and 5<sup>th</sup> row-transition-metals with 3<sup>rd</sup> row metals which are abundant, cheap, and less toxic. A researcher at IISER – Kolkata developed catalysts with Earth's abundant first row-transition metals such as Manganese, Iron, Cobalt, Nickel, etc. and applied them for reductive functionalization reactions. Emphasis was given on the possibility that in contrast to their heavier congeners, the first row-transition metal catalysts can provide novel reactivity and selectivity and enable the development of new processes.

As a first step, Cobalt catalysts were made with mono-dentate *N*-heterocyclic carbene, tri-

dentate pincer type CNC, and NNN-ligands. These catalysts were found to be active for the hydrogenation and hydroboration of alkenes. A novel manganese catalyst was prepared using readily available bench stable NNN-pincer ligand. The NNN-Mn catalyst was found to catalyse olefination of methyl substituted heteroaromatic compounds using alcohols as the olefinating agent. The product olefins were obtained in very high yields and excellent stereoselectivities (Figure 4.11). Importantly, the by-product hydrogen could potentially be used as an energy source. In this case, the manganese catalyst showed novel catalytic activity than their higher congener. The same manganese catalyst was found to be active for the alkylation's of ketones using primary alcohol as the alkylating agent. A manganese catalyst, derived from a bidentate NN-hydrazone ligand, was found to catalyze alkylations of alkyl nitriles with primary alcohol as the alkylating agent. Direct olefination of alkylsulfones was performed using a pincer complex of manganese. The highly functionalized vinyl sulfones were obtained in high yields and excellent stereo-selectivity. Selective reduction of carboxylic acids was performed using a PNP-Mn pincer complex.

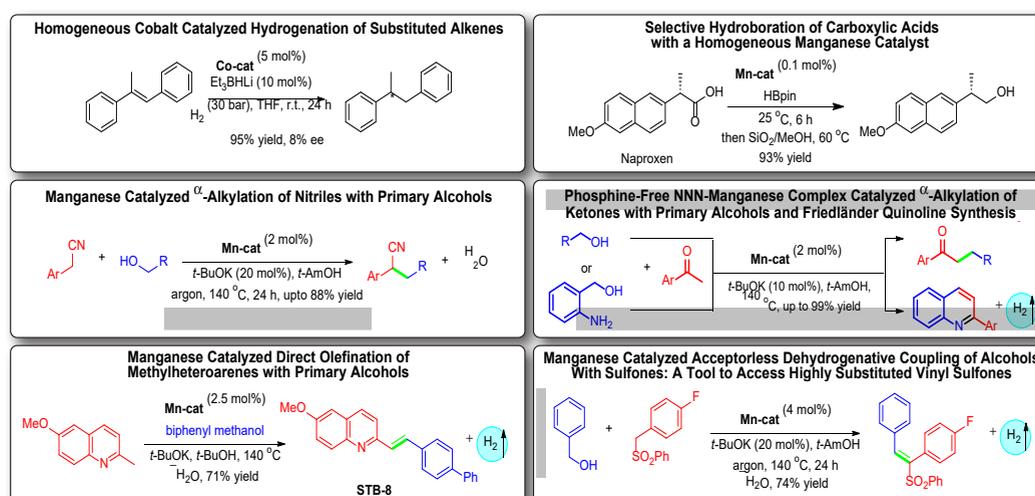


Figure 4.11: Co, Mn catalysed Catalytic Asymmetric Reductive Functionalization Reactions.

The catalysts developed with 3<sup>rd</sup>-row-transitional metals were found to be highly efficient for

catalyzing many reductive-functionalization reactions under milder reaction condition with high

selectivity. The products are interesting in terms of biological as well as material applications. The developed protocols are sustainable and highly

environmentally benign. Most often by-products are water and hydrogen. The produced hydrogen can potentially be utilized.

### 4.3.2 Earth and Atmospheric Sciences

**Precipitation Susceptibility of Clouds to Aerosols in the Indian Monsoon Region:** Indian monsoon has been found to change its pattern (duration and intensity of extreme events) in the warming climate. Elucidating the causal pathway for these changes to greenhouse gas feedback and aerosols are critically important in order to predict the future climate. However, large discrepancy amongst the climate models to mimic the

monsoon cloud distribution accurately continues to be the main challenge in resolving this issue. Partly, lack of a comprehensive observation-based cloud 3D structure is responsible for the limitation of robust evaluation of climate models. Especially in case of multi-layer clouds, evaluation of vertical cloud structure will prove to be very beneficial with the use of active remote sensing satellite data (Figure 4.12).

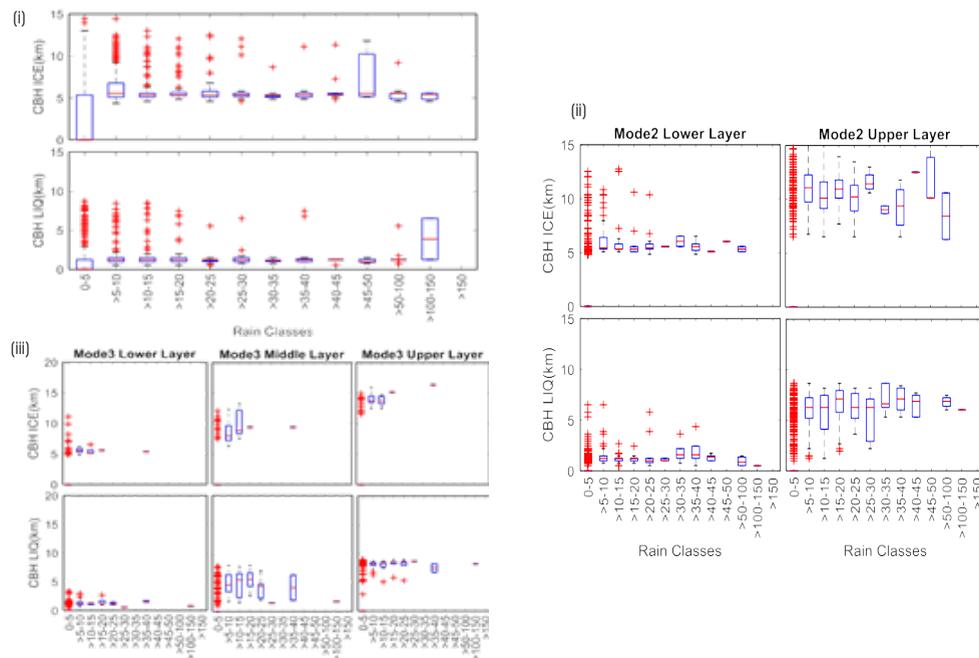


Figure 4.12: Cloud Base height as a function of precipitation for (i) single layer ice and liquid cloud, (ii) Double layer ice and liquid cloud, (iii) Triple layer ice and liquid cloud.

Characteristics of cloud macro and microphysical parameters were studied using CloudSat data for the mean summer monsoon (June-July-August) season in Indian subcontinent (latitude 5° - 40° North and 65° - 100° East). It was observed that the cloud fraction from CloudSat data for individual cloud types were Cumulus, Stratus-Stratocumulus, Nimbostratus, Altostratus, Altocumulus, Deep-convective and Cirrus are 4.7%, 11.7%, 2.2%, 5.5%, 4.8%, 1.5%, and 5% respectively. Changes in cloud vertical structure and associated microphysical properties (effective radius and water path for water and ice clouds) were analyzed as a function of rainfall intensity in the Indian landmass. The rainfall characteristics over the region for the decade

mentioned are analyzed using IMD high resolution (0.25° X 0.25°) gridded precipitation data. Cloud data from active radar measurement from CloudSat CPR (2007-2016) and Precipitation data from Indian Meteorological Department (IMD) was used for the study.

It was found from the studies till date that the macro and microphysical cloud parameters in ISM region showed strong dependence on precipitation intensity. From the altitudinal distribution of ice water content and liquid water content, the multi-layered cloud structure and cloud overlap can be identified. In ice and liquid cloud maximum three layers were observed. The dependence of cloud top height and base

height on precipitation has been seen to be more pronounced in multi-layered structure than for single layered cloud occurrence.

The present analysis provides an observational framework to quantify precipitation susceptibility of monsoon clouds for the Indian

summer monsoon. The strategic knowledge in terms of process understanding would facilitate refinement of weather and climate models through better representation of precipitating and non-precipitating clouds in the Indian monsoon region.

### 4.3.3 Engineering Sciences

**Design of quick healing, multi-material Orthopaedic screws for femur and tibia fracture:** Femur and tibia contribute as the largest bones in human body and fracture in these areas involves fixation of plates with orthopaedic screws. The screws used for the fixation of plates and fracture was made of single material mostly metallic in nature and was designed based on ASTM and ISO standards [Figure 4.13 (a) and (b)]. The issues with the existing screws were that they were functionally rigid, which results in longitudinal compression of the bone during daily activities. This induces pain in the implanted area. Materials like bio-glass was used as replacement for the metallic screws because of its quick healing properties but its functionally rigid characteristic acts as a hindrance towards its usage as a medium for fixation at orthopaedic implants. The novel idea is to design and fabricate a

multi-material screw with outer body made of biocompatible material and inner body with bio-metallic material acting as a reinforcement for the outer body in terms of both functional rigidity and compressive forces. The outer body is designed based on ASTM standards for cortical screws (HA-type) with self-taping and self-drilling threads. The inner body being a reinforcement structure provides a provision to be retracted from the assembly once the bone has healed or the plate must be removed. Custom made grippers were used to affix the bones into the UTM through 6 mm slots using orthopaedic drill bits [Figure 4.14 (a)]. The design was formulated in SolidWorks® 2017 [Figure 4.14 (a) and (b)] and manufactured. The manufacturing is carried out using Stratasys Object 3.0 on bio compatible material MED610 (Figure 4.15) and [Figure 4. 16 (a), (b)].

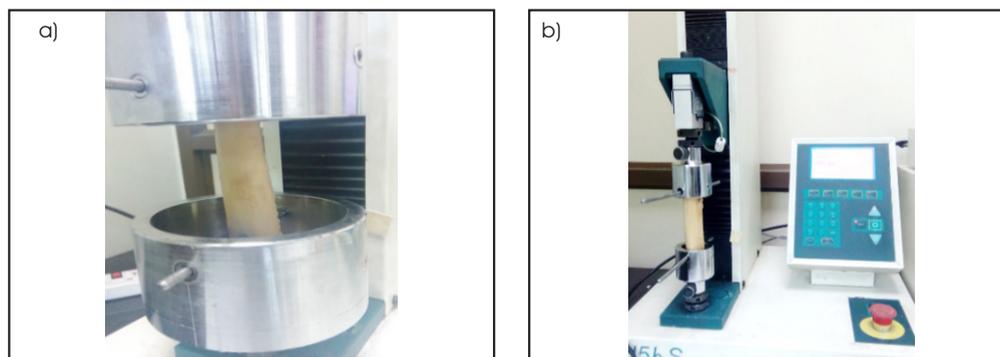


Figure 4.13: a) Grippers for fixing femur bone; b) Tensile testing setup.

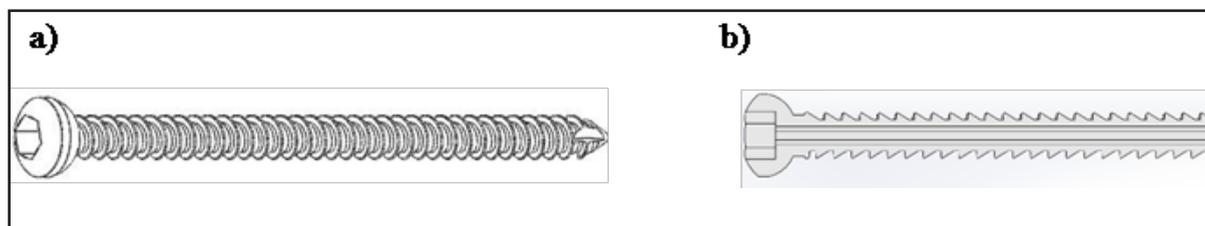


Figure 4.14: a) Cortical screw (HA 4.5); b) Section view of designed cortical screw

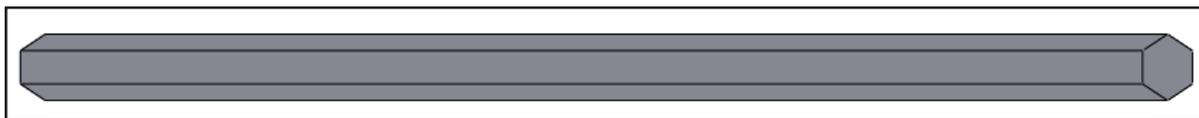


Figure 4.15: Isometric view of inner key.

The condyle fracture in femur was first placed in proper alignment for fixation of screw. Subsequently, 4 mm drills were made on the condyle using 4mm orthopaedic drill bit to

facilitate the screw. Being self-taping in nature, both the screws were inserted using a handheld screwdriver [Figure 4.16 (a) and Figure 4.16 (b)].

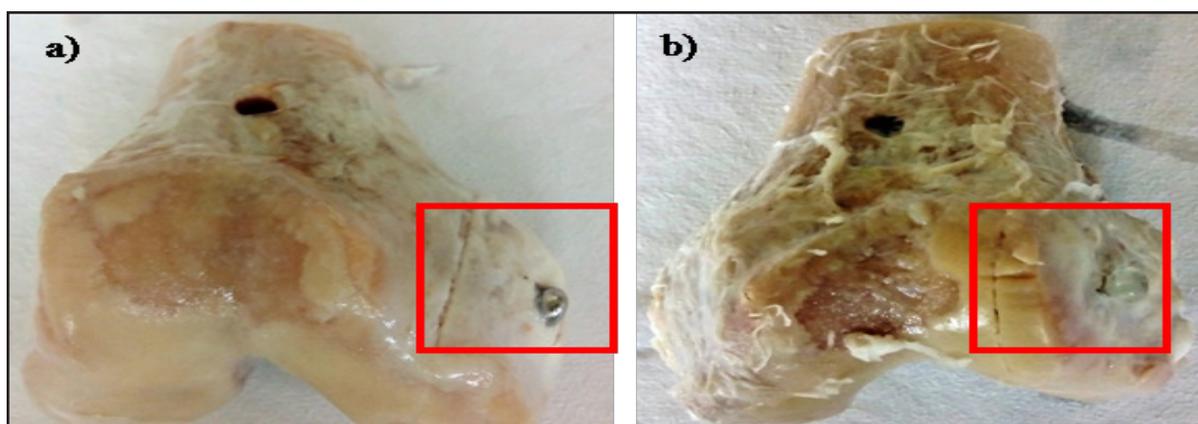


Figure 4.16: (a) Metallic screw insert; (b) Polymeric screw insert. The red rectangle illustrates the propagated crack in condyle of femur bone and both metallic and polymeric screw insertion.

Through this, a multi-material screw for femoral and tibial fracture was designed which provides quick healing property for the bones as the outer body is made of bio-absorbable polymer. It also minimizes the loading on the bone during

dynamic activity like walking, running, jumping etc. due to softer outer material. The inner rod provides structural integrity to the assembly and hence the stiffness is increased compared to bio-absorbable polymeric screws.

#### 4.3.4 Life Sciences

**i) UPLC and ESI-MS analysis of metabolites of *Rauvolfia tetraphylla* L. and their spatial localization using desorption electrospray ionization (DESI) mass spectrometric imaging:** *Rauvolfia tetraphylla* L. (family Apocynaceae), often referred to as the wild snakeroot plant, is an important medicinal plant and produces a number of indole alkaloids in its seeds and roots. In this study, the spatial localization of the various indole alkaloids in developing fruits and plants of *R. tetraphylla* were examined using desorption electrospray ionization mass spectrometry imaging (DESI-MSI). A semi-quantitative analysis of the various indole alkaloids was performed using UPLC-ESI/MS. DESI-MS images showed that the distribution of ajmalicine, yohimbine, demethyl serpentine and mitoridine are largely localized in

the fruit coat while that for ajmaline is restricted to mesocarp of the fruit. At a whole plant level, the ESI-MS intensities of many of the ions were highest in the roots and lesser in the shoot region. Within the root tissue, except sarpagine and ajmalicine, all other indole alkaloids occurred in the epidermal and cortex tissues. In leaves, only serpentine, ajmalicine, reserpiline and yohimbine were present. Serpentine was restricted to the petiolar region of leaves. Principal component analysis based on the presence of the indole alkaloids, clearly separated the four tissues (stem, leaves, root and fruits) into distinct clusters. The DESI-MSI results indicated a clear tissue localization of the various indole alkaloids, in fruits, leaves and roots of *R. tetraphylla* (Figure 4.17;4.18).

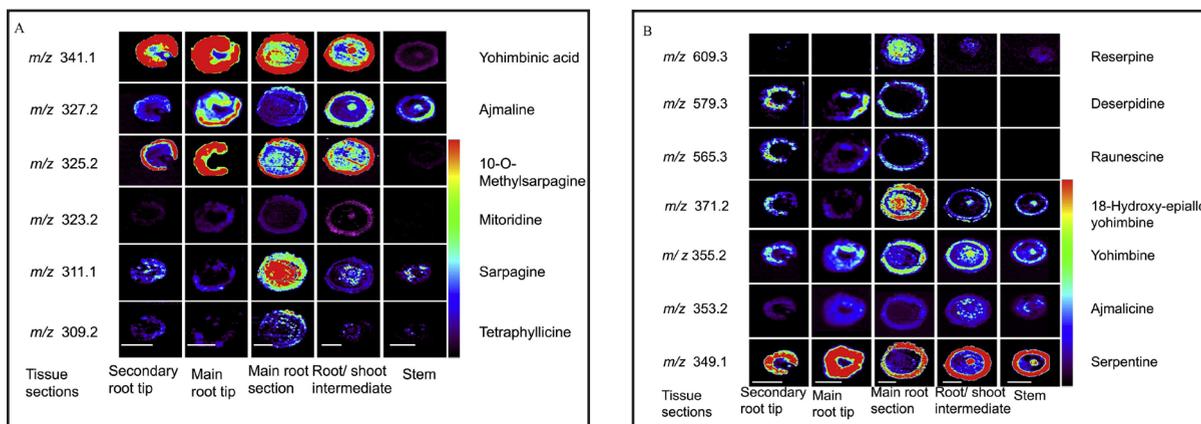


Figure 4.17: DESI MS images showing the indole alkaloid distribution in root and stem sections of *R. tetraphylla*. Scale bars correspond to 5 mm and apply to all the images of a row.

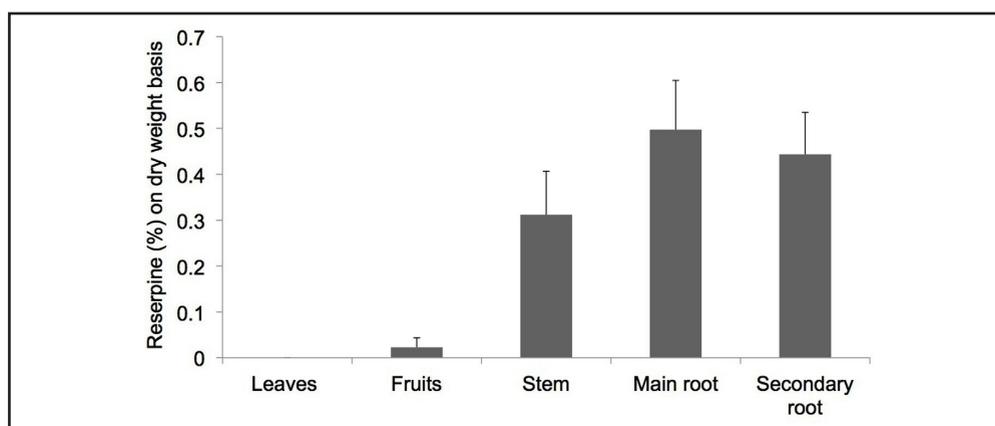


Figure 4.18: Reserpine content (on dry weight basis) in different parts of *R. tetraphylla* plant. Error bars indicates standard deviation.

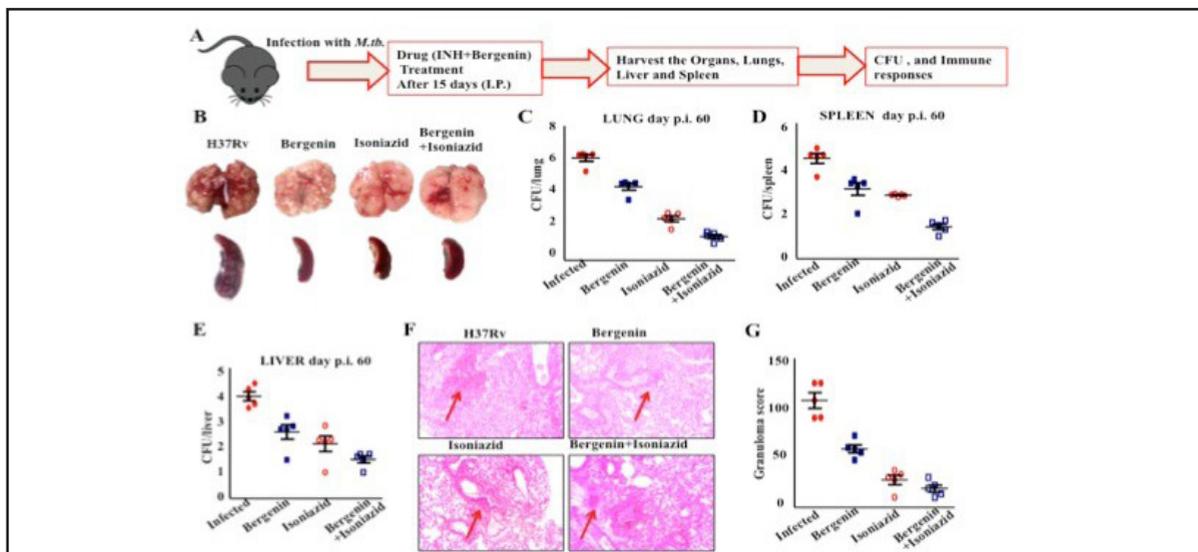
ii) **A novel strategy for immunotherapy of tuberculosis that avoids generation of drug resistant variants (MDF and XDR) and hepatotoxicity** : Isoniazid treatment dramatically reduces *Mycobacterium tuberculosis* (*M.tb*) antigen specific immune responses and induces apoptosis in activated T helper cells and also increases the vulnerability of TB reactivation and reinfection, thus present TB treatment is associated with immune impairment responses. It has been well established that interferon gamma (IFN- $\gamma$ ) secreting T-helper 1 (Th1) cells play a central role in host resistance to *M.tb* infection while Th2 and T-reg cells are associated with pathogenesis. However, chemotherapy in tuberculosis dampens the T-cell response rendering the host more vulnerable to other infectious diseases. Therefore, an adjunct therapy with the inclusion of immunomodulators along with conventional antibiotic treatment regimens was proposed. The use of immunomodulators could prevent the loss of antigen specific T-cell responses commonly observed during DOTS treatment resulting in

restoration of immune memory required to counter Tuberculosis reactivation and reinfection.

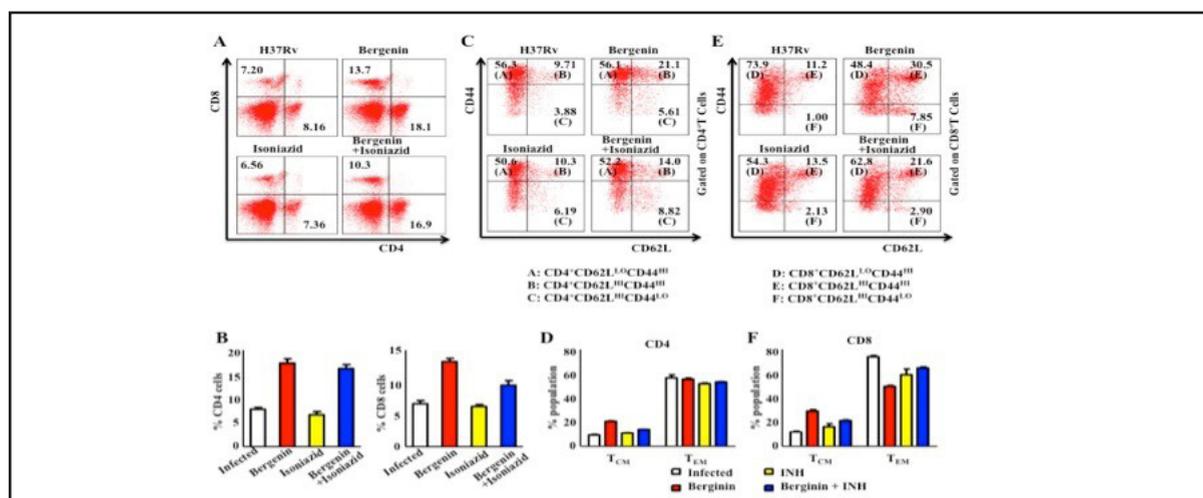
It is hypothesized that bergenin could be used in adjunct therapy with ATT (anti-tuberculosis therapy) reducing major risks and adverse effects associated with ATT. To check this group of C57BL/6 mice were infected with low dose of H37Rv strains of *M.tb* via aerosol route. The treatment regimen was started 15 days post infection. The treatment regimen consisted of combined therapy with bergenin and isoniazid for one group and other two groups receiving Bergenin and isoniazid individually along with untreated mice making up our control group. Organs were harvested from infected animals after 30 and 45 days of treatment to determine the bacterial burden and immune responses (Figure 4.19A). The gross picture of the lungs and spleen showed reduced number of granulomatic lesions and necrosis in the mice co-treated with Bergenin and Isoniazid simultaneously than other groups (Figure 4.19B). The administration of Bergenin

along with isoniazid also resulted in reduced bacterial burden in lungs (Figure 4.19C), livers (Figure 4.19D) and spleens (Figure 4.19E) of the mice. Mice receiving Bergenin and Isoniazid in combination showed more than 4 log decrease in bacterial burden when compared to the mice receiving Bergenin and Isoniazid individually. It was also observed more than 1 log decrease in bacterial burden in mice receiving bergenin in comparison to untreated animals. Also reduced numbers of granulomas in lungs from these mice were observed against the ones harvested from infected controls (Figure 4.19 F&G). Bergenin lacks direct anti-mycobacterial activity and indirectly kills M.tb in infected macrophages by inducing the secretion of NO and TNF- $\alpha$ . These data suggest that Bergenin could be used as an adjunct therapy along with ATT for better results against pulmonary tuberculosis. Combination therapy enhances immunity against M.tb. It was observed that Bergenin treatment enhanced the prevalence of CD4+ and CD8+ T cells in the spleen of the mice than untreated infected control (Figure 4.20A&B). Furthermore, Isoniazid treatment dampens the cellular immune responses as evident from comparatively reduced number

of CD4+ and CD8+ T cells. These data were agreement with previously reported suppression of antigen-specific cytokine responses during isoniazid therapy in murine model of tuberculosis. Moreover, co-treatment with Bergenin and isoniazid restores the Isoniazid induced suppression of immune responses (Figure 4.20 A&B). Properties of these T cell subsets of CD62L and CD197/CCR7 expression were analysed. It was found that co-treatment enriched the TCM cell pool (CD4+CD62LhiCD44hi) compared with the TEM cell pool (CD4+CD62LloCD44hi) in the spleen (Figure 4.20 C&D) of infected mice. Similarly, co-therapy induced CD8+ TCM (CD8+CD62LloCD44hi) cells over CD8+ TEM (CD8+CD62LhiCD44hi) cells (Figure 4.20 E&F). These data suggest that Bergenin could be used to potentiate the vaccine efficacy of BCG by inducing central memory T cell population, which is the main precursor of memory T cells that can provide long lasting protection against pathogens. Collectively these data suggest that co-treatment with Bergenin and Isoniazid induces faster and stronger recall responses upon subsequent infection, owing to their larger pool of TCM cells in spleen.



**Figure 4.19:** Adjunct therapy with Bergenin and Isoniazid protects mice against Tuberculosis. (A) Schematic diagram to show the groups of native C57BL/6 mice challenged with H37RV strains of M.tb via the aerosol route with a low dose inoculum of  $\sim 110$  CFU/ mice. After 15 days these mice were treated with Bergenin and isoniazid for 45 days. Mice were sacrificed at various time points and lungs were harvested for the estimation of bacterial burden. (B) Gross picture to show the profile of lungs and spleen of infected and treated mice. (C) CFU from lung. (D) Spleen (E) Liver homogenates of the different groups of mice. (F) Lungs from the different groups of mice were harvested, preserved in 4% paraformaldehyde, sectioned and stained with Hematoxylin and Eosin (H&E) and AFB. (G) Bar diagram to show the number in infected and treated mice.



**Figure 4.20:** Combined therapy with Bergenin and isoniazid induces host protected T cell responses. **A & B:** FACS data to show the percentage of CD4<sup>+</sup> and CD8<sup>+</sup> T cell in the spleen of different groups of mice infected with H37Rv strain of M.tb and treated with bergenin and isoniazid. **C & D:** Profiling of memory immune responses (i.e T naive CD4<sup>+</sup> CD62L<sup>hi</sup>, CD44<sup>lo</sup>, TEM CD4<sup>+</sup>, CD62L<sup>lo</sup>, CD44<sup>lo</sup>) of CD4<sup>+</sup> T cell isolated from spleen of infected and treated mice. **E & F:** Profiling of memory immune responses (i.e T naive -CD8<sup>+</sup>CD2L<sup>hi</sup>, CD44<sup>lo</sup>, Tcm CD8<sup>+</sup> CD2L<sup>hi</sup>, CD44<sup>hi</sup>, TEM CD8<sup>+</sup> CD62L<sup>lo</sup> CD44<sup>hi</sup>) of CD8<sup>+</sup> T cells isolated from spleen of infected and treated mice.

### 4.3.5 Physical and Mathematical sciences

#### Hydrothermally synthesized GO/TiO<sub>2</sub> nanocomposite for photocatalytic application:

In this project, high quality TiO<sub>2</sub> thin films was synthesised using hydrothermal method. A uniform deposition of TiO<sub>2</sub> thin films onto glass substrate was obtained. X-ray diffraction patterns of TiO<sub>2</sub> thin films are deposited at different deposition temperatures; 140, 160 and 180°C and annealed at 450°C. The matching of observed and standard values using the JCPDS card No. 01-075-1537 confirms the tetragonal crystal structure of TiO<sub>2</sub> thin films. Preferred orientation observed along (101) plane for all films were observed along with some weak reflections such as (004), (200), (105). The reason for comparatively lower peak intensities is due to the lower film thickness and formation of amorphous plus nanocrystalline phase in thin films. As the substrate temperature increases, the crystallinity of the films increases and peaks at 450°C. Further increase in deposition temperature leads to decrease in peak intensity.

According to factor group analysis, anatase TiO<sub>2</sub> has five Raman active modes (3Eg+2B1g). The Raman spectrum shows five Raman peaks at 142 cm<sup>-1</sup> (Eg), 197 cm<sup>-1</sup> (Eg), 397 cm<sup>-1</sup> (B1g) and 519 cm<sup>-1</sup> (B1g), which confirms the formation of anatase phase of TiO<sub>2</sub> (Figure 4.21). Anatase phase shows higher degradation efficiency as

compared to rutile and brookite phase. From the SEM images it has been observed that substrate surface was covered with nano granules and at some places agglomeration of grains were observed. Such morphology increases the surface area of the films, which was helpful for redox reactions and therefore photocatalytic degradation. The band gap energy of films deposited at 140°C is 3.34 eV, at 160°C is 3.43 eV & at 180°C is 3.39 eV. This value of band gap energy was slightly greater than the value of energy reported for single crystal TiO<sub>2</sub>, and comparable with earlier reported values for spray deposited TiO<sub>2</sub> thin films. The observed difference in the band gap energy was due to stoichiometric differences in the TiO<sub>2</sub> films deposited at various substrate temperatures.

Graphene oxide and its composite with TiO<sub>2</sub> was deposited as next step. XRD pattern of graphene oxide shows the diffraction peak at 10.35° which indicates the formation of graphene. From the SEM images it is seen that Ti ions were merged into the flex of graphene oxide, which result into compact and dense morphology of GO/TiO<sub>2</sub> (Figure 4.22 and 4.23) was observed. Insertion of Ti ions into graphene oxide converts nanoflex morphology into the dense and compact morphology.

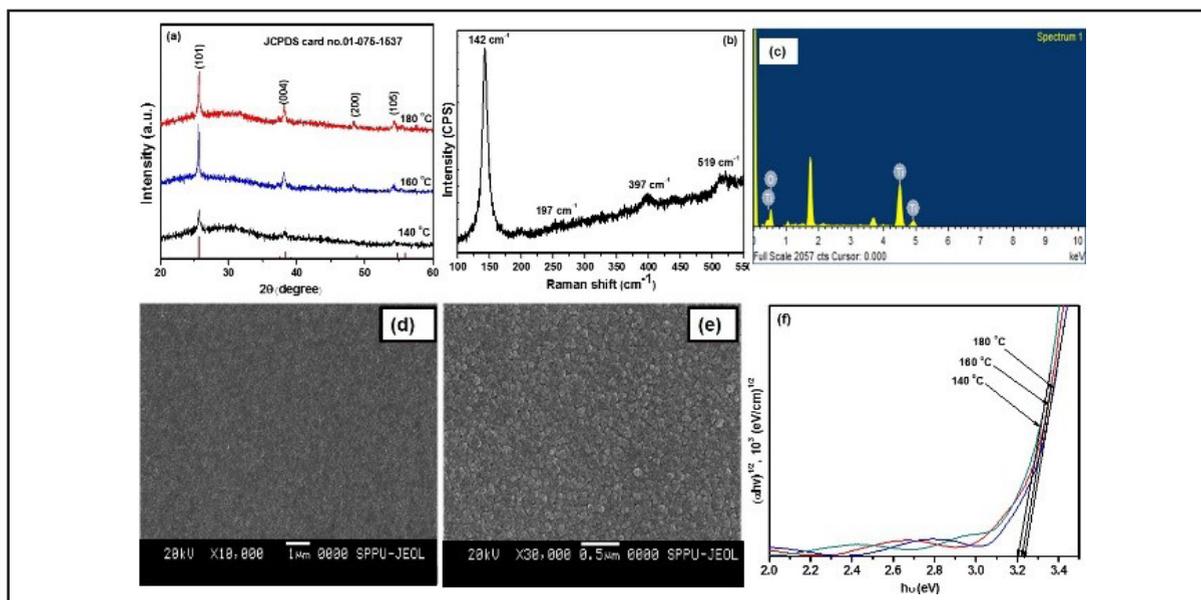


Figure 4.21: (a) X-ray diffraction patterns of TiO<sub>2</sub> thin films deposited at different deposition temperatures 140°C, 160°C and 180°C and annealed at 450°C (b) Raman spectra of the typical TiO<sub>2</sub> thin films deposited at optimized deposition conditions. (c) EDAX pattern of TiO<sub>2</sub> thin films. (d-e) SEM images of TiO<sub>2</sub> thin films deposited at 160°C deposition temperature and at different magnification. (f) plots of  $(\alpha h\nu)^2$  Vs  $h\nu$  for TiO<sub>2</sub> thin films deposited at different deposition temperatures.

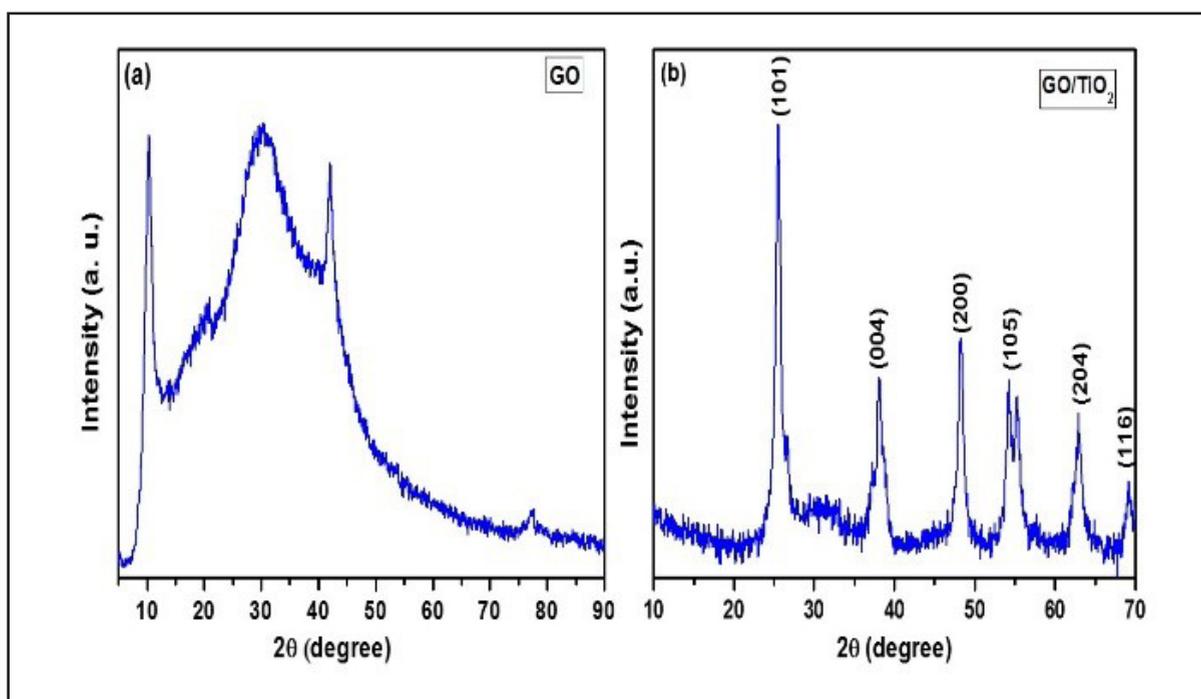


Figure 4.22: (a) shows XRD pattern of graphene oxide, the diffraction peak at 10.35° indicates the formation of graphene. (b) Diffraction pattern of GO/TiO<sub>2</sub> nanocomposite, the diffraction peaks of anatase TiO<sub>2</sub> at 26.5, 37.8, 47.9, 55, 62.4 and 68.3° corresponding to (1 0 1), (0 0 4), (2 0 0), (1 0 5), (2 0 4), and (1 1 6) planes respectively.

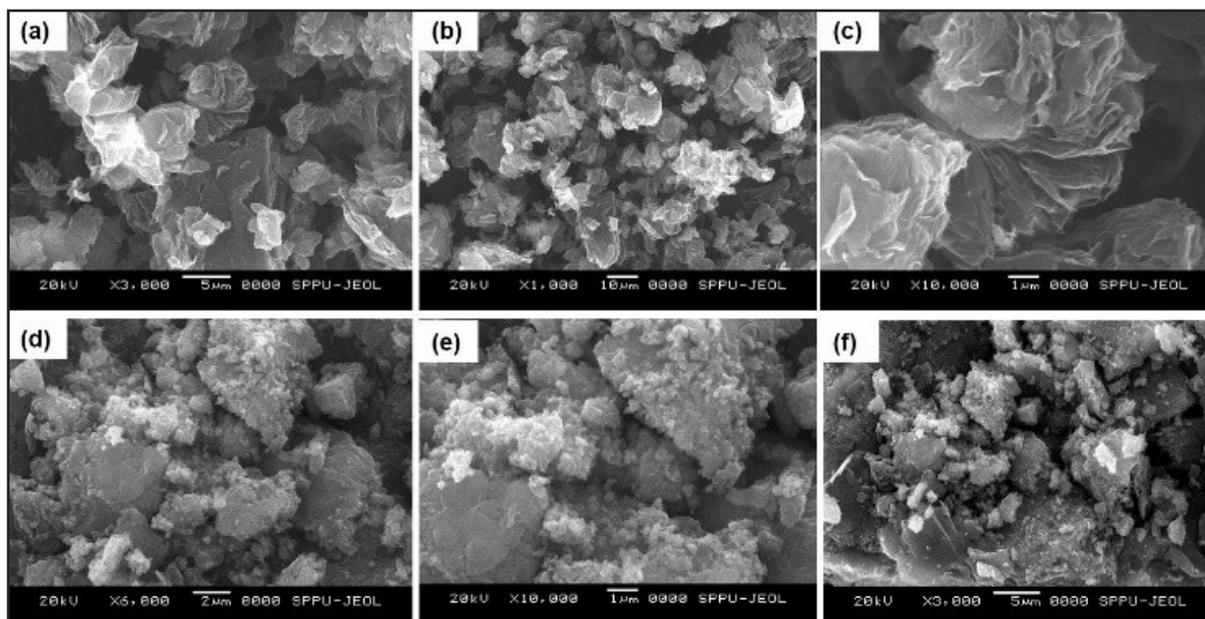


Figure 4.23: (a, b, c,) shows scanning electron micrographs of graphene oxide prepared by Hummers method. (d, e, f) shows SEM images of GO/TiO<sub>2</sub> composite at different magnification prepared by hydrothermal route.

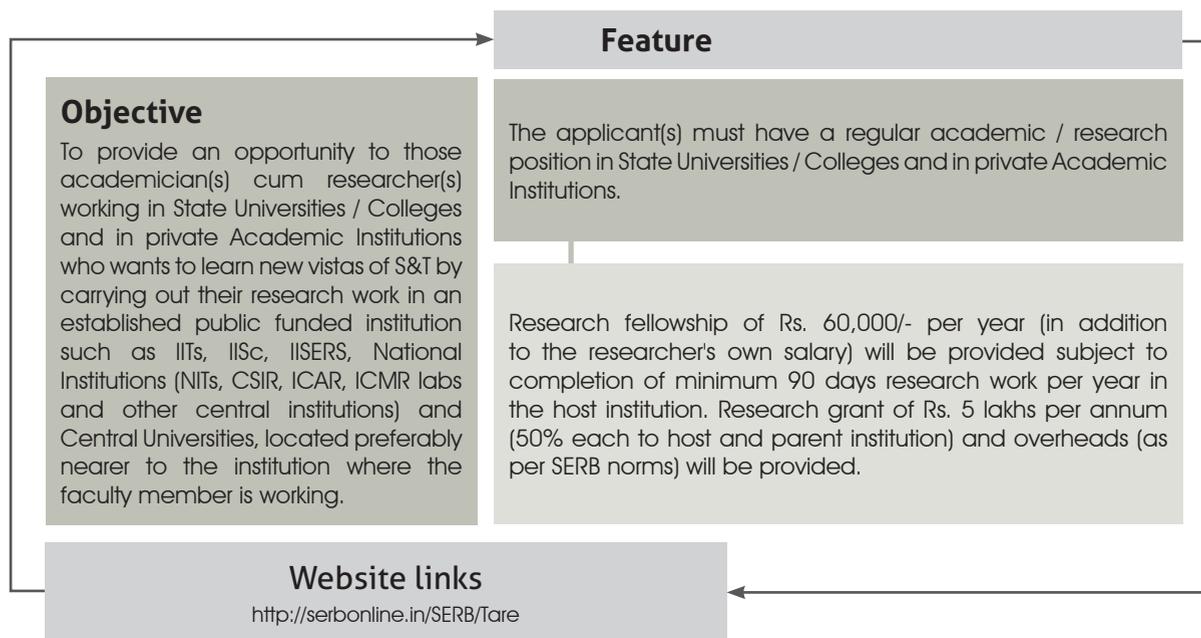
**Special Activity:** The first NPDF Conclave (Figure 4.24) was held on 25<sup>th</sup> July 2018 at National Institute of Plant Genome Research, New Delhi. Forty-one shortlisted fellows from the online poster competition gave the presentations in three parallel sessions viz. Chemical sciences, Engineering, Earth & Atmospheric Sciences, Physical & Mathematical Sciences and Life Sciences. Prof. Ashutosh Sharma, Secretary, DST distributed the merit certificate to the NPDF fellows and delivered the special address. Prof. Sharma invited the young researchers of the country to undertake the research programs addressing

the day today problems of the society and emphasized that the research without social implications will not be of great use to the human development. He also indicated that the NPDF programme is not an employment opportunity but a temporary platform to develop them as an independent researcher. The NPDF fellows were urged to evolve as a responsible citizen by involving themselves in the development of nation by exploring different ways and venturing into entrepreneurship and create employment opportunities.



Figure 4.24: Participants of the first NPDF conclave

## ►► 4.4 Teachers Associateship for Research Excellence (TARE)



A total of 959 applications across all subject areas were screened by the Screening Committee and shortlisted 332 application for further consideration by the Expert Committee. Expert Committee recommended 152 proposals for the TARE award. Projects in Chemical Sciences focused on topics such as hydrogen evolution reaction, efflux pump inhibitors, modification of two-dimensional nano-fluidic channel, Anhydro- and Dianhydro-Sugar Scaffolds among others. Earth and Atmospheric Sciences include topics such as 3D turbulence and horizontal porous beds. Anti-spoofing method, silicon photonic integrated circuit, efficient millimetre-

wave communication were the broad areas in which the projects on Engineering Sciences were recommended. In case of Life Sciences evolution of bitter taste, visceral Leishmaniasis, gallbladder cancer, HIV-1 are the interesting areas in which projects were recommended. Projects under Mathematical Sciences includes acyclic matrices, filippov system, and differential equation model of ecosystem. Physical Sciences include topics such as Driven Quantum Many Body Systems, Femtosecond Laser Induced Breakdown Spectroscopy, giant magnetocaloric materials (Table 4.3).

**Table 4.3 :** Projects supported in TARE Scheme

Name of respective disciplines	Approximate nos.
Chemical sciences	30
Earth and Atmospheric Sciences	06
Engineering Sciences	45
Life Sciences	40
Mathematical sciences	07
Physical sciences	24
<b>Total</b>	<b>152</b>

## ▶▶ 4.5 SERB Research Scientists (SRS) Scheme

Among many schemes that offer opportunities for young scientists to initiate research careers, INSPIRE Faculty Award (DST) and Ramanujan Fellowship (SERB) stand out in terms of impact and outreach. However, these schemes do not offer any extension of the fellowship, and support link is broken after the end of normal tenure of 5 years.

In 2018-19, a scheme called SERB Research Scientists (SRS) was initiated to provide a platform for sustainment of research careers of INSPIRE Faculty and Ramanujan Fellows for an additional period of three years. The scheme is open only

to INSPIRE Faculty and Ramanujan Fellows, wherein the applicants should have completed the tenure of INSPIRE Faculty Award/Ramanujan Fellowship or nearing its completion. Successful awardees can continue their research objectives from their present institution or opt to choose a different host institution that is suitable to the proposed research work.

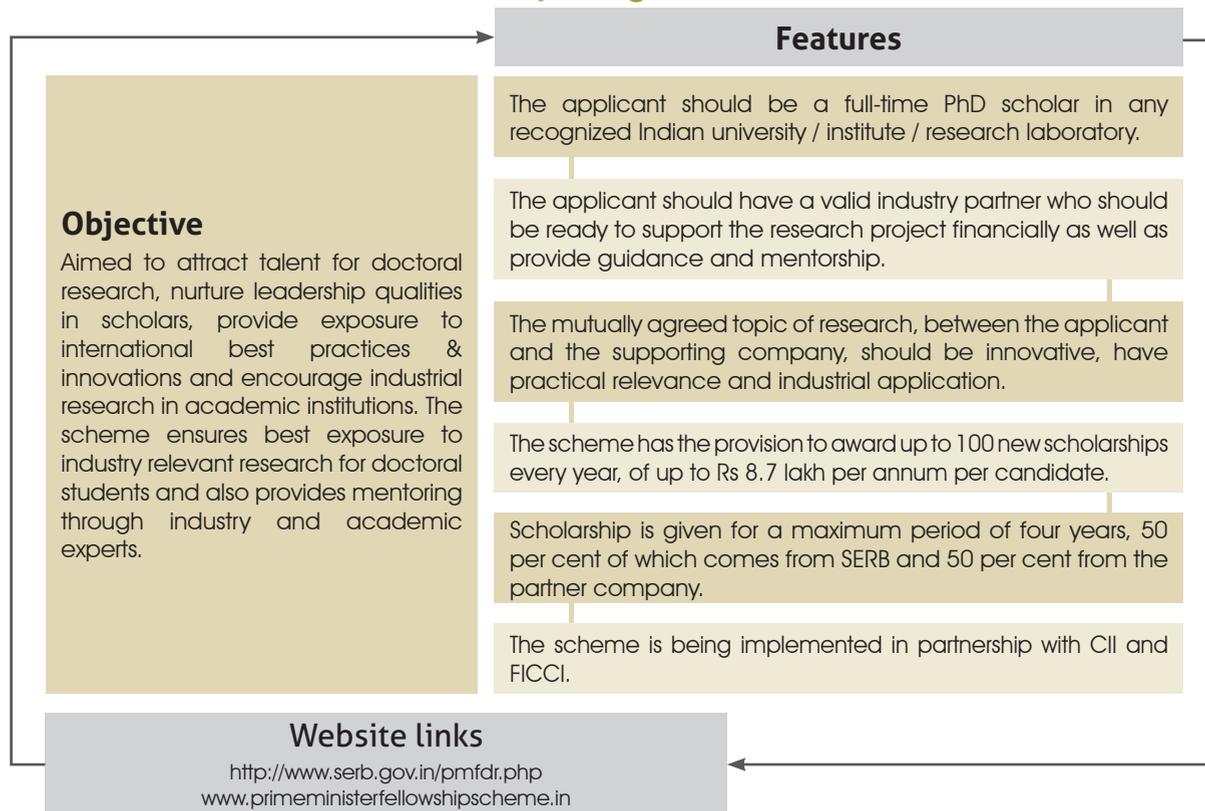
The scheme offers fellowship of Rs. 1.25 Lakhs per month along with research grants to a tune of Rs. 7 Lakh per annum. In the past year, 3 applicants were shortlisted in this scheme.

## 5 BUILDING RESEARCH NETWORKS

SERB with an aim on creating more opportunities for research collaboration and advanced training has developed several domestic and overseas research networks for various segments of research fraternity. This includes doctoral and postdoctoral training programmes, industry-oriented projects, sectoral intensive initiatives etc.

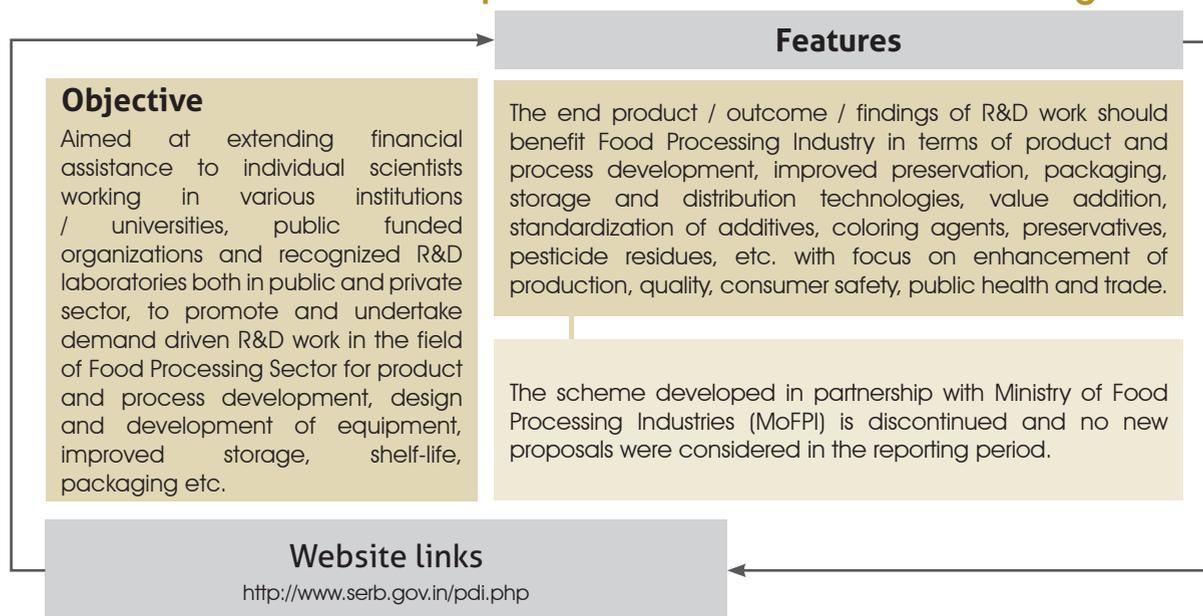
### ►► 5.1 National Collaborations

#### 5.1.1 Prime Minister’s Fellowship Programme for Doctoral Research



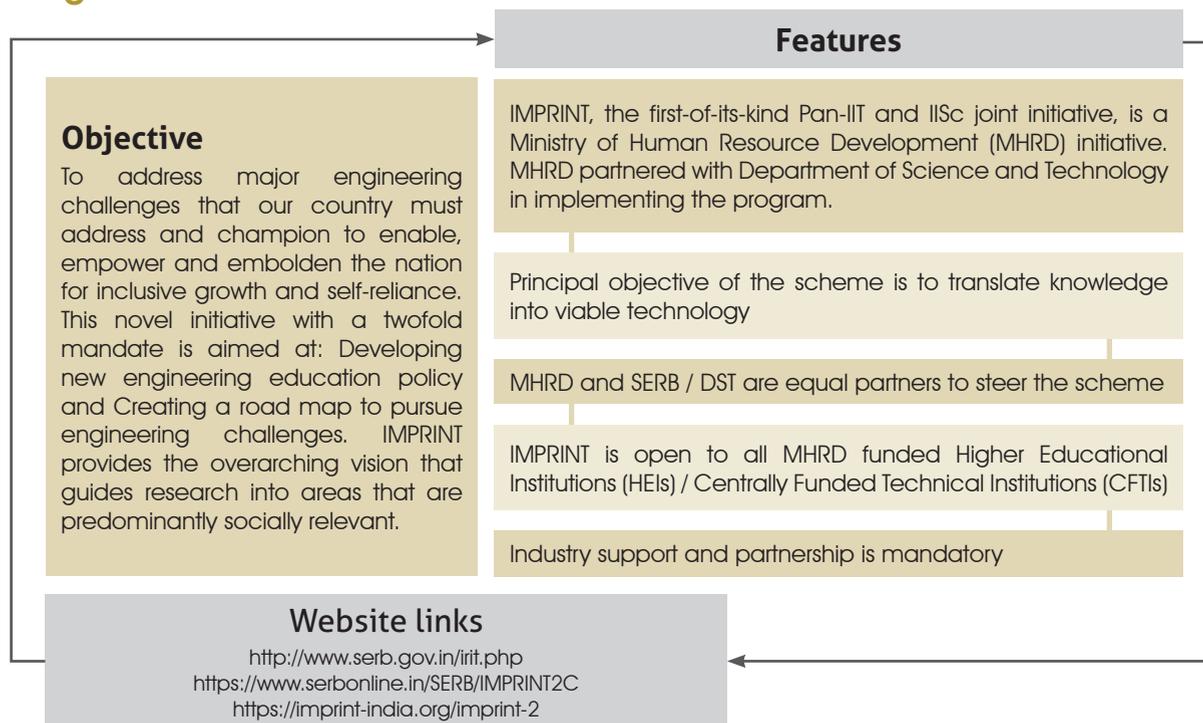
- i. A total of 37 Fellowships awarded in the reporting period.
- ii. In addition, 86 fellows are pursuing research under the scheme.
- iii. FICCI participated in “32nd International Conference on VLSI Design & 18th International Conference on Embedded Systems” to disseminate the Prime Minister’s (PM) fellowship scheme for doctoral research. The conference had also held a special session on PM fellowship scheme for doctoral research for its due publicity and wider dissemination.
- iv. SERB also joined with FICCI to organize three round table discussions with industries in the reporting period.

### 5.1.2 Research and Development Scheme on Food Processing



- i. A total of 21 publications in areas of milk & milk products, fruits & vegetables /spices /honey, tea /coffee, grains /rice & their products, packaging /storage /shelf life /preservation etc. emanated from the ongoing projects.
- ii. One patent by Sharma Rajan, Rajput Y S, Brath Priyae Gatuam & Mann Bimlesh: An indicator and the indicator impregnated strip for detection of neutralizers in milk, Patent application no. 201811030055 dated 10.08.2018 was filed.

### 5.1.3 IMPacting Research INnovation and Technology (IMPRINT) Programme



A unique national initiative called IMPacting Research, INnovation and Technology (IMPRINT) has been launched by the Ministry of Human Resource Development (MHRD), Government of India (GoI) to address all major engineering challenges relevant to India through an inclusive and sustainable mode of translational research steered by the top engineering institutions in the country. The President and Prime Minister inaugurated IMPRINT from Rashtrapati Bhavan on November 5, 2015. This is a first-of-its-kind Pan-IIT and IISc joint initiative to lay down a Research Roadmap to address major engineering and technology challenges in ten selected domains relevant to our country's needs. The scheme was intended to bring forth collaborative funding for the research projects that would end up creating products and patents. 10 technology domains have been identified under IMPRINT that could substantially impact the quality, safety and security of life both in urban and rural areas, namely: (1) Healthcare, (2) Energy, (3) Sustainable Habitat, (4) Nano Technology hardware, (5) Water resources and river systems, (6) Advanced materials, (7) Information and Communication Technology, (8) Manufacturing, (9) Security and Defence, and (10) Environmental Science and Climate change.

SERB/DST in partnership with MHRD on equal cost share basis, supported target-oriented projects mainly in the area of Advanced Materials and

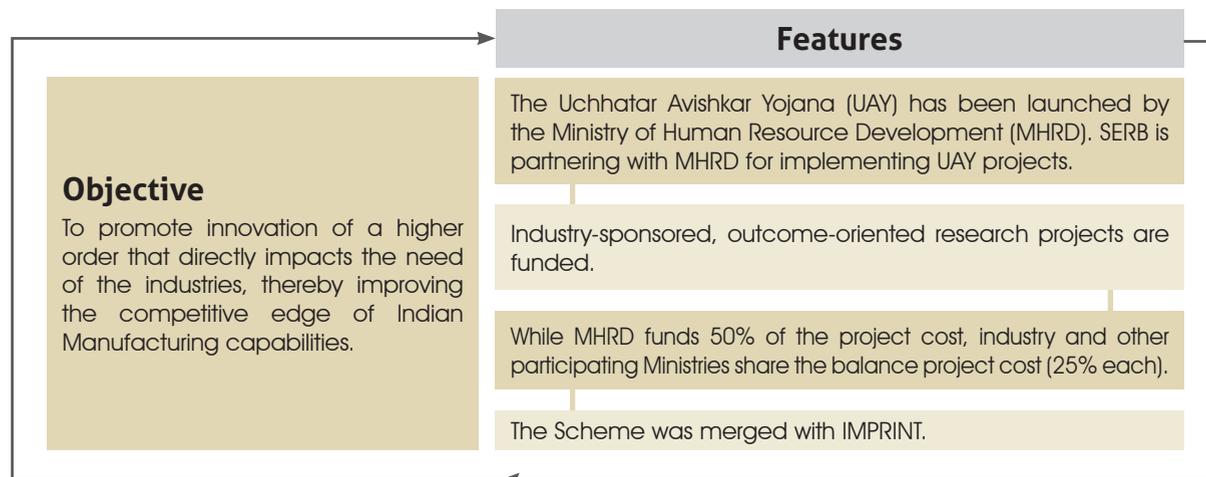
Nano-Material. SERB had been entrusted to steer these areas (IMPRINT-1).

Seeing the widespread enthusiasm and interest of the community, the next version of IMPRINT, IMPRINT-II with a revised strategy has been initiated by MHRD in partnership with SERB. The principal objective of IMPRINT-II is to address all major engineering challenges faced by the nation by translating knowledge into viable technology (product/process).

An announcement was made for inviting preliminary proposals on March 2018. A total no of 2145 proposals were received (IMPRINT – II A&B) out of which 126 proposals were recommended. Finally, 118 projects were sanctioned in 2018-19.

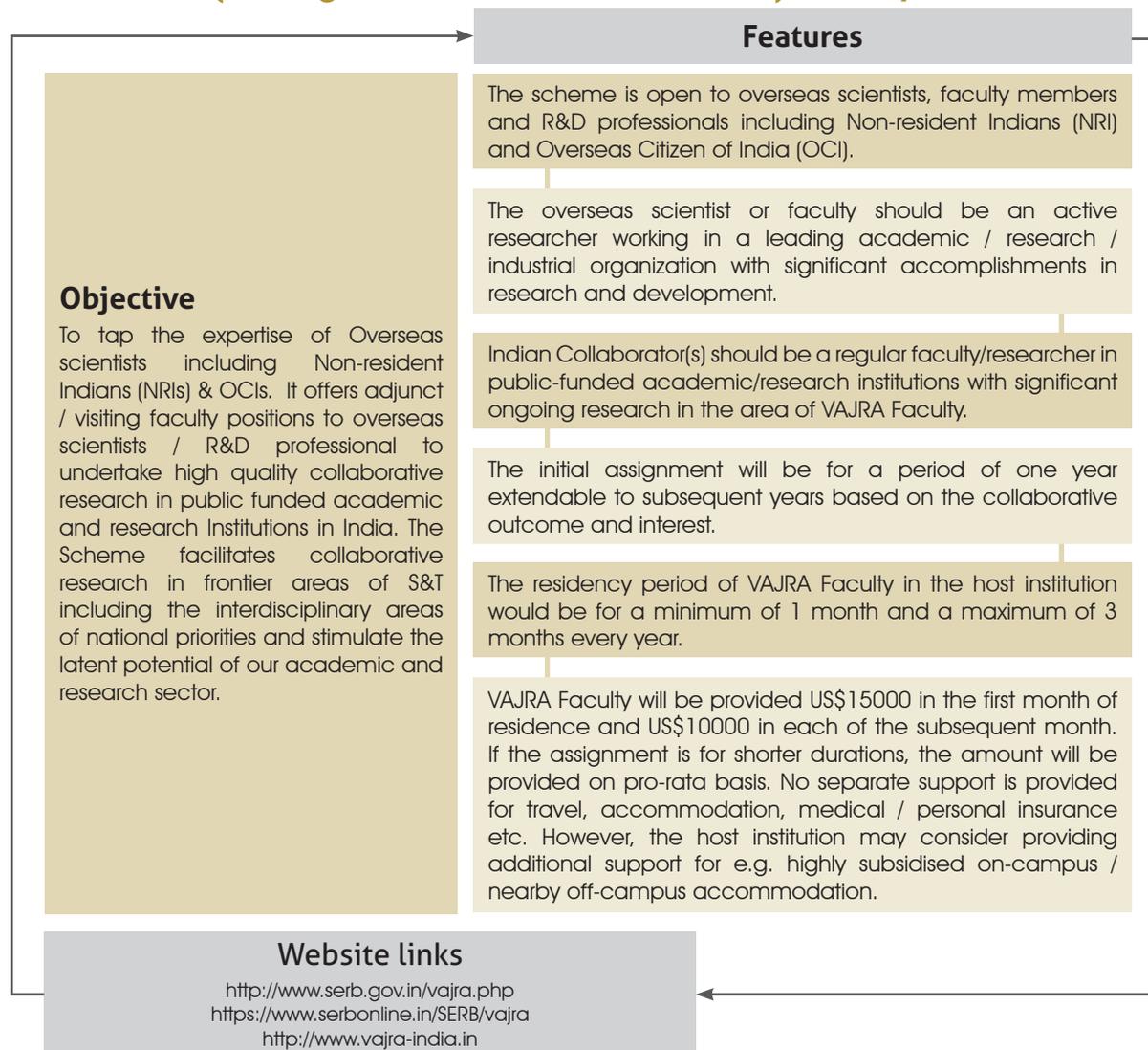
MHRD and DST launched the next round of IMPRINT II, called IMPRINT IIC (Societal Mission Projects) in Dec 2018 with an aim to seek proposals related to 20 very specific technology development themes of major societal relevance/benefit, selected from the areas identified by partner ministries. In these projects, at least 25% of the project cost should be supported by the Industry out of which at least 10 % of the project cost should be in cash. An announcement on IMPRINT-IIC.1 was made for inviting preliminary proposals in December 2018. A total of 499 proposals were received and after first screening 144 detailed proposals have been received.

### 5.1.4 Uchhatar Avishkar Yojana (UAY)



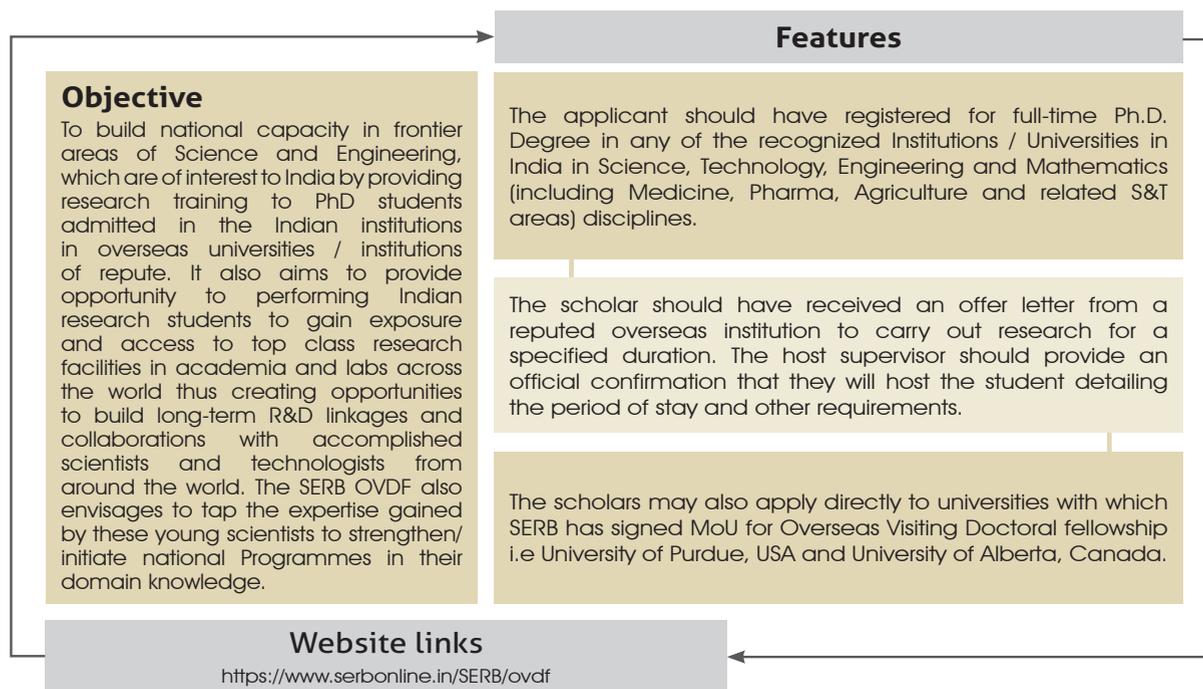
## ►► 5.2 International Collaborations

### 5.2.1 VAJRA (Visiting Advanced Joint Research) Faculty Scheme



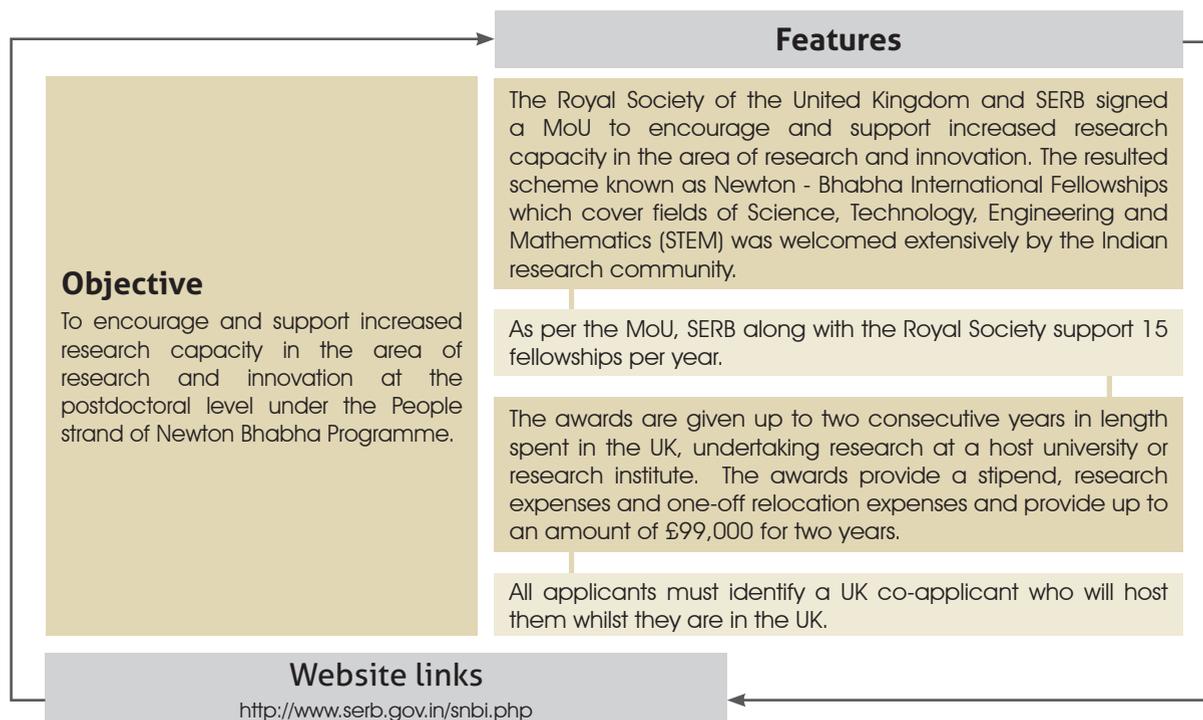
During the reporting period 8 accomplished scientists have been offered VAJRA Facultyship. From the earlier batch, 8 scientists had made their collaborative research visits.

### 5.2.2 SERB OVERSEAS VISITING DOCTORAL FELLOWSHIP



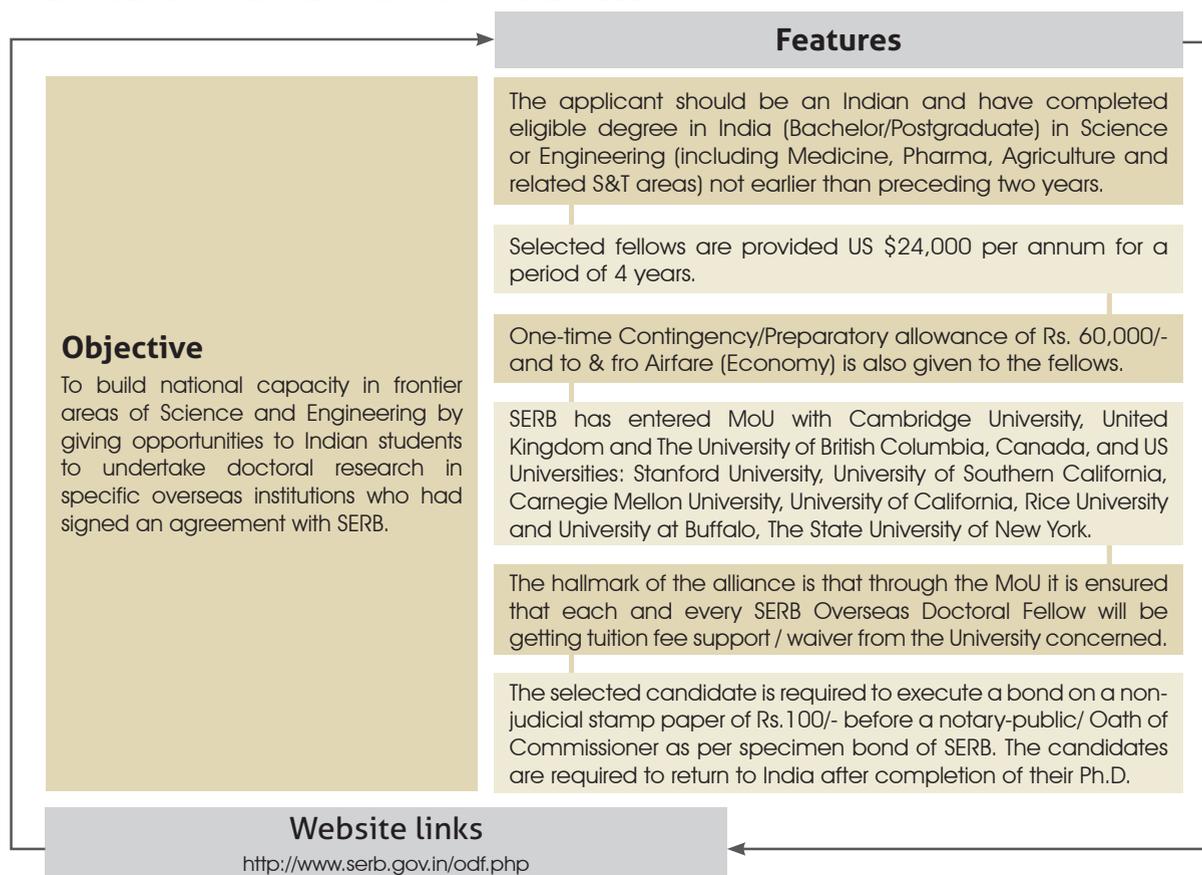
- i. The first call for application under the scheme was announced in the year 2018-19 and 40 researchers have been selected for the fellowship to pursue their short-term doctoral research in 24 different countries around the world under renowned guides of various Institutions/ Universities.
- ii. Under the SERB-Purdue University OVDF programme 25 students were selected.
- iii. Under the SERB-UAlberta OVDF scheme 10 students were selected.

### 5.2.3 SERB NEWTON - BHABHA INTERNATIONAL FELLOWSHIP



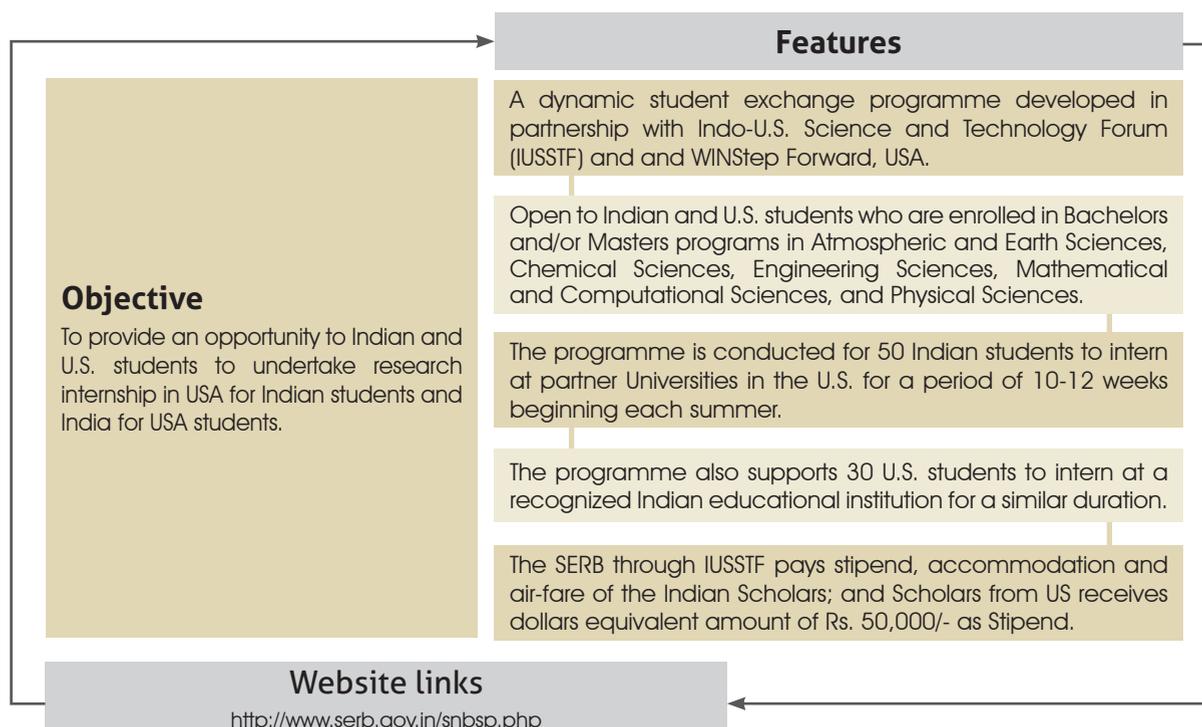
A total of 15 researchers have been offered the fellowship in the reporting period.

### 5.2.4 SERB OVERSEAS DOCTORAL FELLOWSHIP



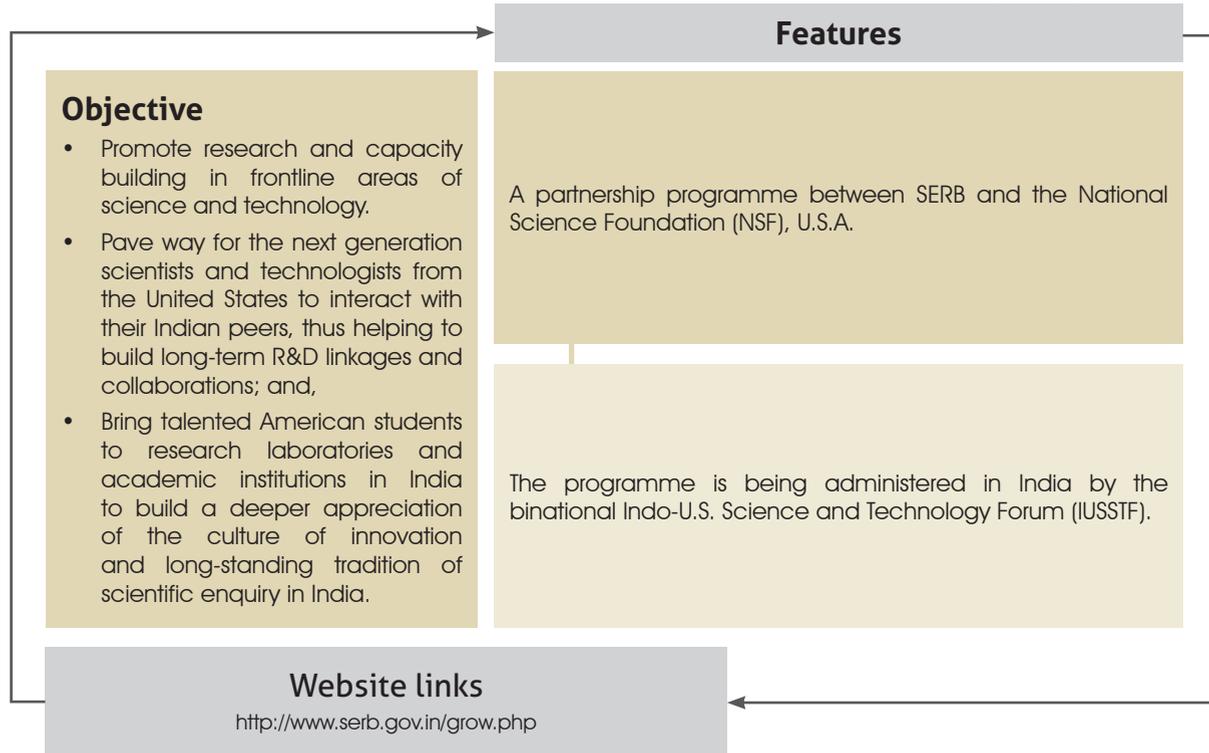
A total of 13 students have been awarded the fellowship in the reporting period.

### 5.2.5 S.N BOSE SCHOLAR PROGRAMME



Fifty (50) students have been offered Internship in the reporting period.

### 5.2.6 Graduate Research Opportunities Worldwide (GROW) Programme



Two NSF Graduate Research Fellows had undertaken the research visit in the reporting period.

### 5.2.7 Partnership for International Research and Education (PIRE)

PIRE is a highly prestigious international collaborative Programme of National Science Foundation (NSF) aimed to leverage the monetary resources of funding agencies as well as intellectual capabilities of research groups all over the world in front line areas of research and

education. India has joined the PIRE through a bilateral agreement between SERB and NSF.

One project being implemented at Indian Institute of Astrophysics, Bengaluru was completed in the reporting period.



## 6 STRENGTHENING LINKAGES WITH SOCIETY

Importance of connecting scientific research with society has been highlighted at various fora. While engaging in high quality research in academic and scientific institutions, it is pertinent to guide our researchers to undertake appropriate scientific activities to connect students, researchers and other stakeholders for training, mentoring etc. SERB on its part has adopted a Social Scientific Responsibility (SSR) Policy for its Programmes and Schemes.

### ▶▶ 6.1. Social Scientific Responsibility (SSR)

Scientific research continues to spur various technological advances and is one of the pivotal factors driving the economic growth of any nation. Science in India has witnessed rapid progress over the past several years and number of research institutions, scientific infrastructure and resources along with research output have increased significantly. Scientific resources and knowledge thus developed are an unprecedented wealth which when strategically tapped and channelized can create a huge impact on the research ecosystem of the nation. Hon'ble Prime Minister in the 104<sup>th</sup> Indian Science Congress at Tirupati emphasized "On the lines of Corporate Social Responsibility, the concept of Scientific Social Responsibility needs to be inculcated to connect our leading institutions to all stakeholders, including schools and colleges. We must create an environment for sharing of ideas and resources." Based on the above concept, SERB devised a Social Scientific Responsibility (SSR) policy, to imbibe a culture of social commitment among the SERB grantees. The policy intends to effectively utilize the R&D infrastructure and expertise of SERB grantees to benefit other S&T stakeholders especially the less-endowed researchers and the society.

SSR Initiative would focus on: (i) Infrastructure sharing (ii) Mentoring (iii) Fostering research culture (iv) Public outreach and knowledge dissemination and (v) Scientific Services. The activities associated with SSR under various categories are:

#### Infrastructure sharing

- Access to scientific facilities of SERB grantee

#### Mentoring/Training

- Mentorship of college/university faculty by SERB grantee
- Training on high end scientific skills and research facilities created at SERB grantee's lab/institution for other researchers
- Providing student internships

#### Fostering research culture

- Organize workshop to faculty members of nearby colleges
- Enabling school and college students to visit SERB grantee's lab/institution and interact with scientists/faculty to develop a scientific culture among school/college students
- SERB grantee delivering individual lectures to students in nearby colleges/schools for inculcating the scientific temper

#### Public outreach and knowledge dissemination

- Public lectures on science
- Popular articles in science journals such as Current Science, etc.
- Reports in newspapers, web articles, etc.

#### Scientific Services

- Peer review of research proposals submitted to SERB for funding, as and when assigned.

SERB SSR was implemented across most of the programs of SERB in the year 2018-19. According to the procedure, SSR activities need to be chosen by the SERB grantee after approval of project or fellowship. Depending on the activities chosen additional budget is provided to carry out the chosen activities. SERB grantees need to

undertake the proposed SSR activities during their project period.

The number of SERB grantees involved in SSR activities in a year would be more than 10000 and beneficiaries of the SSR efforts would be about 20000 researchers, 20000 faculty, 1000 students through internships, 20000 students through one-day visit to PI institution and about 1.5 lakh

students through individual lectures and millions of people through public outreach activities.

It is expected that the SERB SSR initiative would not only spread the benefits beyond the direct beneficiaries of SERB programs but also foster the development of rich research culture of integrated scientific and social commitments in the country.

### 6.1.1. Research Highlights of SSR

Few Highlights of SSR activity are given below:

1. A scientific outreach programme with a set of lectures and open discussion addressed to the class 9 and 11 students and some of the teachers of Jaduguda and Narwapahar Atomic Energy schools in Jharkhand (Figure 6.1) was organized on 23 and 24 January 2019 sponsored by a J C Bose fellow of SERB. About 480 students and 40 teachers

attended the lectures. The eminent speakers gave lectures basically to arouse the interest and curiosity about interplay between subatomic physics and astrophysics. After the lectures, there was a very exciting interactive session with the students and their teachers in which scientists interacted with them at each venue.



Figure 6.1: Scientific outreach programme at Jaduguda and Narwapahar.

2. SERB partially supported to organize the International Conference on Sustainable Solutions in Industrial Pollution Water and Wastewater Treatment held on November 10<sup>th</sup> to 11<sup>th</sup>, 2018. The international conference

was organized by the Department of Civil Engineering, Jamia Millia Islamia University in collaboration with the College of Engineering University of Toledo, USA. It mainly focussed on invited lectures by eminent resource persons

both from India and abroad. Dr. Rajendra Singh, Magsaysay award and Stockholm Water Prize winner delivered a key – note lecture on Sustainability of water resources.

About one hundred and seventy-five research papers were contributed by different researchers from India and abroad. Around 200 delegates including volunteers have attended the two days event.

- SERB partially supported to organize "6<sup>th</sup> International Conference on Issues and

Challenges in Doctoral Research" (Figure 6.2) August 25<sup>th</sup>, 2018 (Jointly organized by ITM University Gwalior, NIAS and Christ University, Bengaluru). The objective of the conference was to develop remedial strategies to address concerns and topics in order to promote and strengthen doctoral research in India. Some eminent speakers of different organization share their thoughts on overview of the grave crises and complexities confronting doctoral research.



Figure 6.2: 6<sup>th</sup> International conference on issues and challenges in doctoral research.

## ▶▶ 6.2. Themes and Missions

### 6.2.1 Themes

Many of the programmes of SERB connect the National Missions of the Government of India. Keeping in view of the current scenario of S&T in the country, all the supported proposals under different schemes of SERB have been categorized into 10 different themes (Figure 6.3).

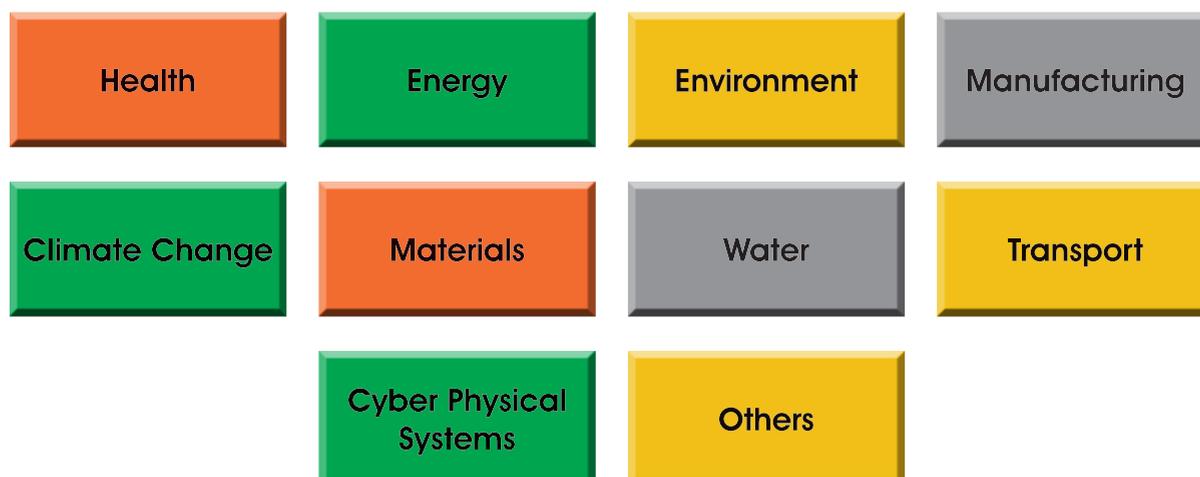


Figure 6.3: Classification of different themes

During the year, it has been observed in terms of cost, Health sector received highest investment under different schemes like CRG/EMR, ECR, EMEQ followed by Materials (Figure 6.4)

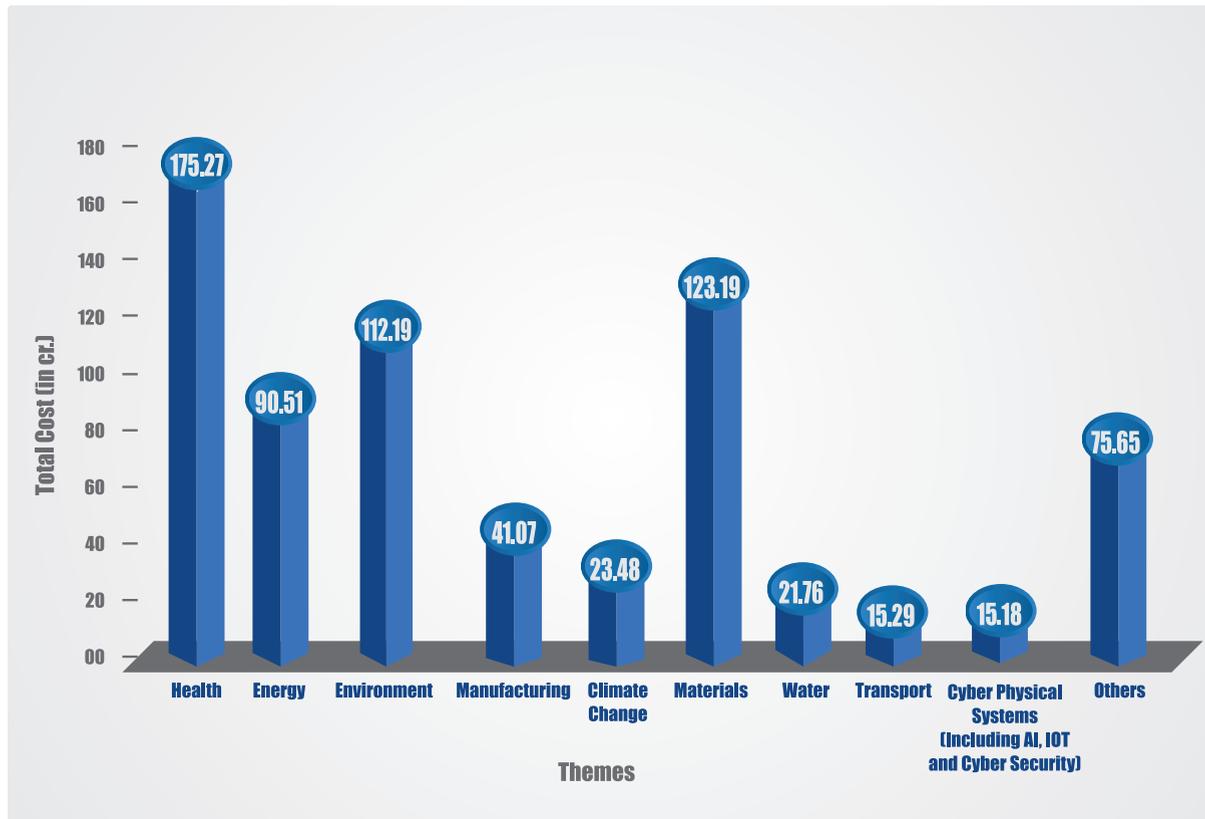


Figure 6.4: Theme wise investment under CRG/EMR, ECR, EMEQ schemes.

### 6.2.2. Missions

Considering the importance of National Missions, the supported proposals have also been classified into mission wise as per Government of India directive (Figure 6.7).

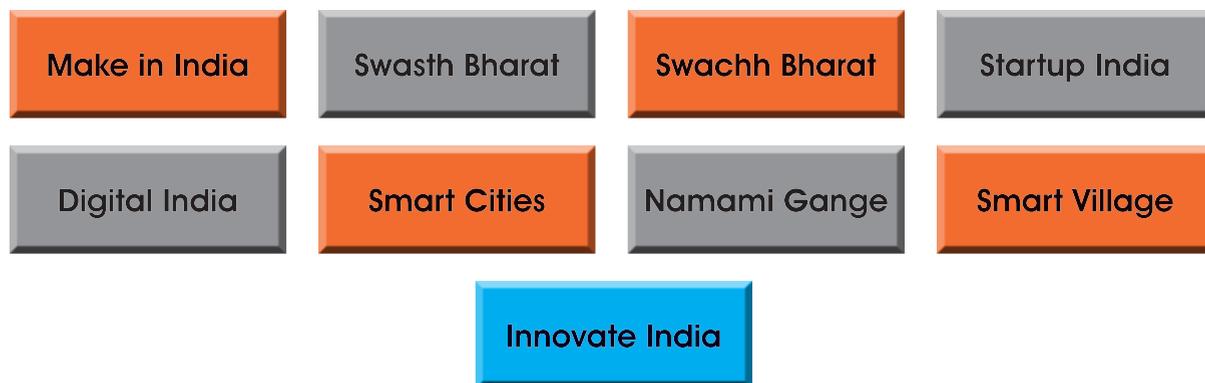


Figure 6.5 : Classification of different missions.

During the year, it has been observed in terms of cost, Make in India mission received highest investment under the schemes namely CRG/EMR, ECR, EMEQ followed by Swasth Bharath (Figure 6.6):

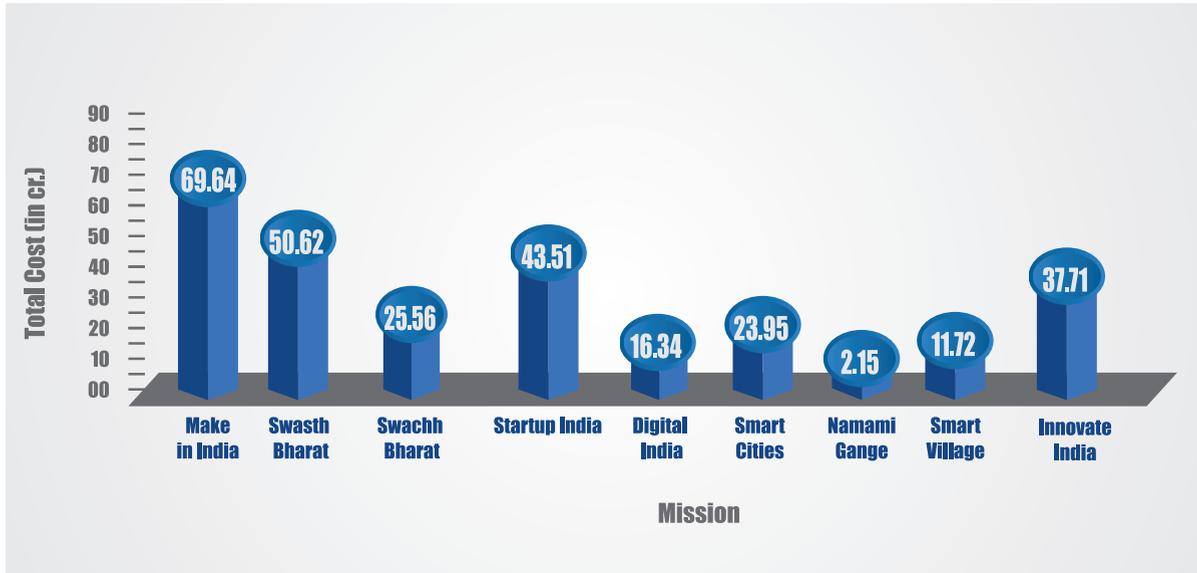


Figure 6.6: Mission wise investment under CRG/EMR, ECR, EMEQ schemes.



# 7 AWARD & RECOGNITIONS

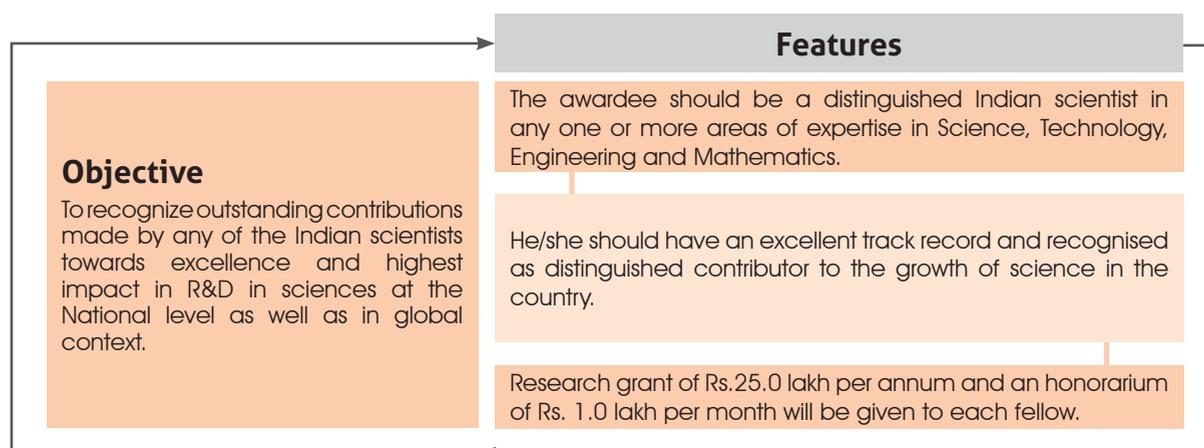
Recognition through several fellowships and awards for the brilliant young scientists and active superannuated scientists, professors and engineers for their extraordinary contributions in the field of Science and Technology is one of the important activities of SERB. The objective is to motivate the scientists to aspire for excellence in scientific R & D.

## ▶▶ 7.1 Year of Science Chair Professorship (YoSCP)

The Year 2012 is recorded as the Year of Science in commemoration of the outstanding scientific contribution emanating from Indian Science since the last 100 years. The beginning of Year of Science Chair Professorship (YoSCP) can be traced back and related to this cause in the year 2012 to recognise outstanding Indian Scientists.

The award is given initially for a period of 5 years and is extendable through assessment based on the performance evaluation.

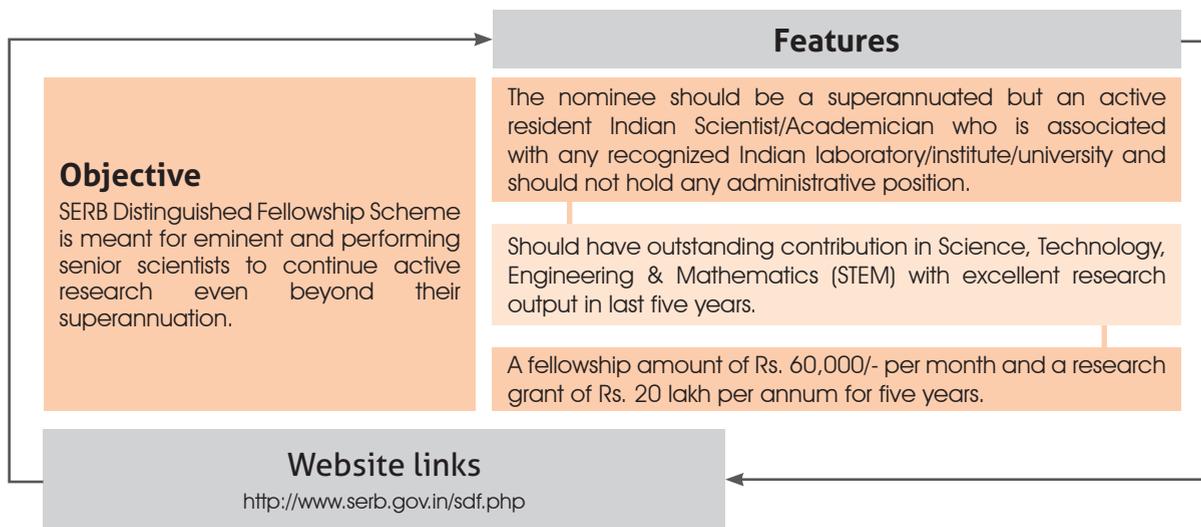
A total of six (06) ongoing and two (02) new awards were supported during the reporting period.



## ▶▶ 7.2 SERB Distinguished Fellowship

Many active senior scientists who are passionate about research find it extremely difficult to continue their research after superannuation and forced to stop doing research against their choice. The great amount of knowledge and more importantly the experience that they have accumulated over many years, which may be considered as a non-replaceable treasure, can

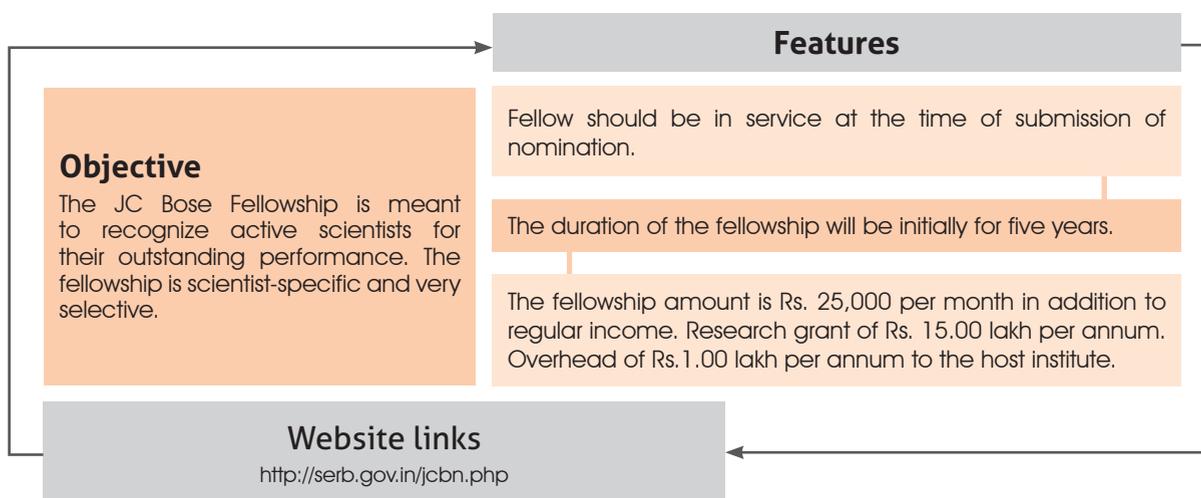
be lost if some avenues are not made available to them. In order to support research of eminent scientists who do not hold any administrative roles and functions but are active and performing, SERB has instituted Distinguished Fellowship Award. Eleven (11) new fellows were supported for this prestigious fellowship during the year 2018-19.



### 7.3 J C Bose Fellowship

J C Bose Fellowship is instituted to recognize active scientists and engineers for their outstanding performance and contributions. These fellowships are scientist-specific, very selective and are open to Indian nationals residing in India, with upper age limit of 68 years. The value of the fellowship is Rs. 25,000/- per month in addition

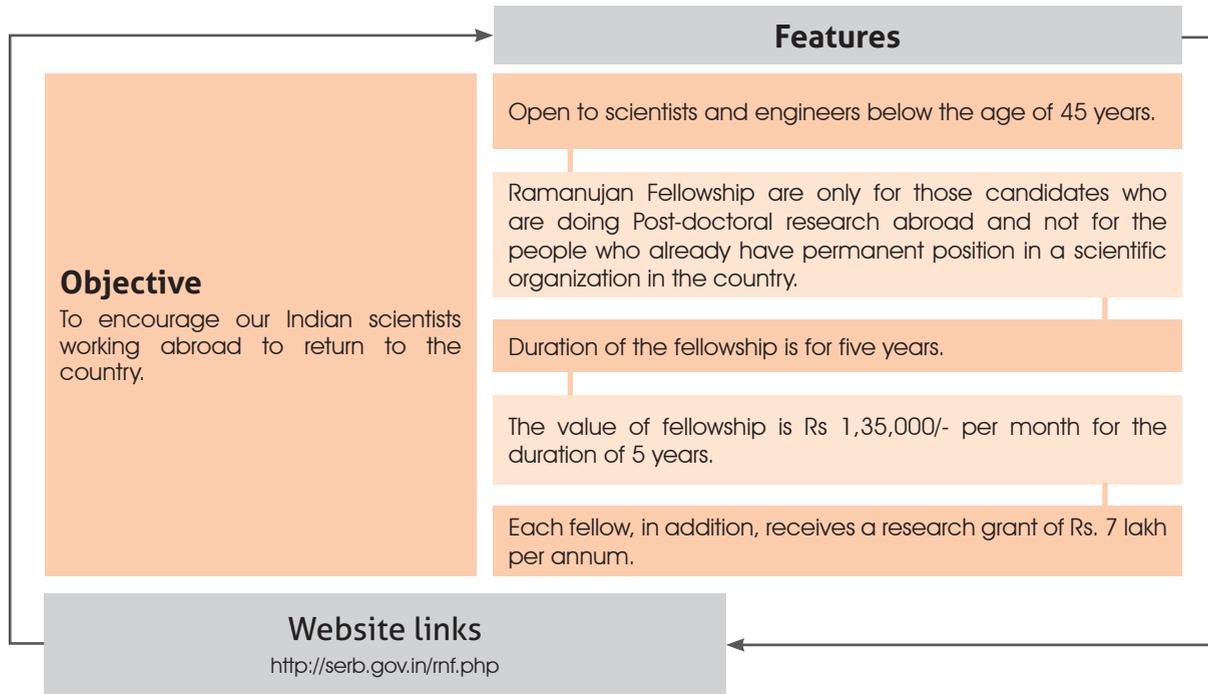
to the fellow's regular income. Rs. 15 lakhs per annum is provided as research grant for a period of 5 years. During this year, a total of 59 fellows were awarded with J C Bose fellowship. The scientific contributions of the fellows have been well recognized all over the globe.



### 7.4 Ramanujan Fellowship

Ramanujan Fellowship is meant for brilliant scientists and engineers from all over the world to return to the country and take up scientific research positions in India. During the year, a total of 46 fellows were awarded with Ramanujan

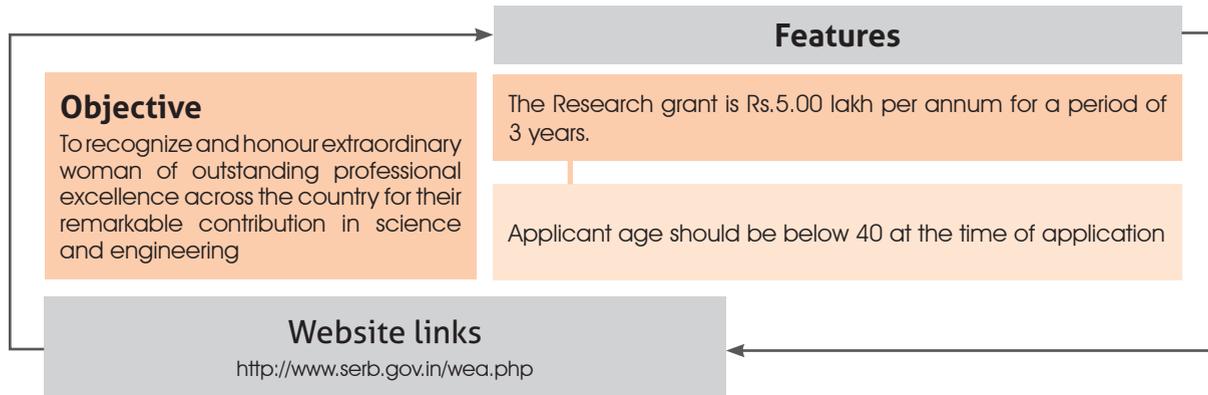
fellowship. The awarded fellows have published several research articles on their scientific investigation in peer reviewed reputed journals of high impact factor.



### ►► 7.5 SERB Women Excellence Award

SERB Women Excellence Award is a one-time award given to women scientists below 40 years of age, and who have received recognition from the any of the National Academics in science, engineering and medical.

This year 16 applications were received out of which 8 were awarded.

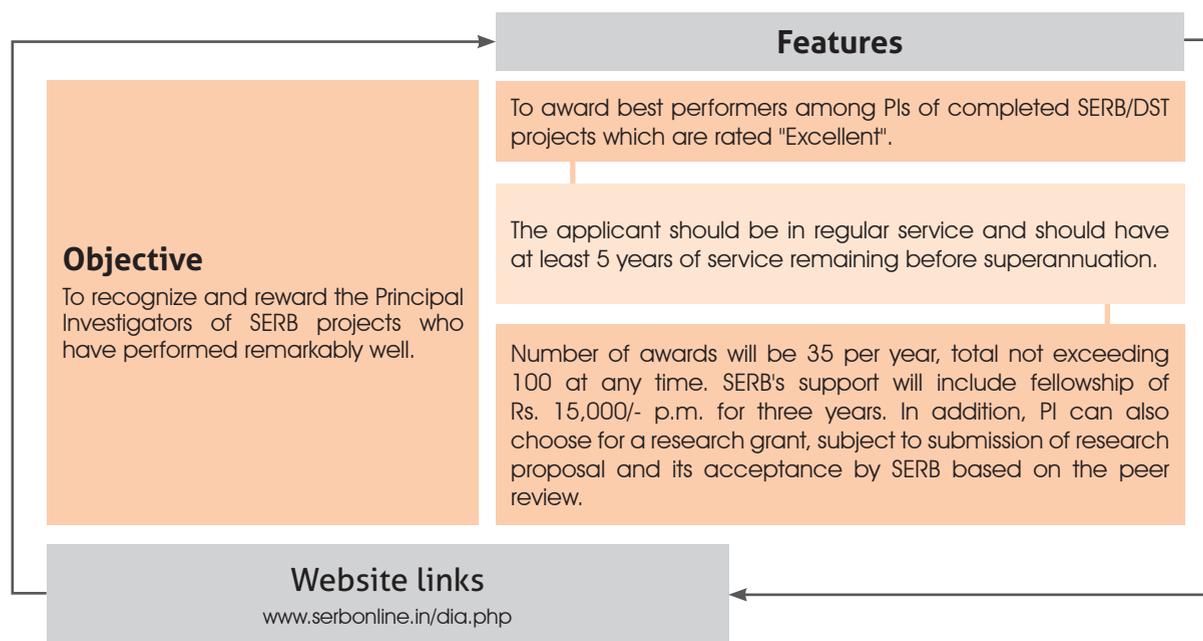


## ▶▶ 7.6 SERB Distinguished Investigator Award (SERB-DIA)

SERB Distinguished Investigator Award (SERB-DIA) Scheme was initiated to award best performers among PIs of completed, "Excellent-rated" individual centric SERB/DST projects based on project outcome. In the first-year, Core Research Grant (CRG) projects completed in previous year and rated 'Excellent' were considered for the award. Invitations were sent to 40 PIs who were

eligible to submit the application online for DIA.

DIA Selection Committee selected 12 awardees of which 9 opted for Fellowship along with the project and 3 opted for Fellowship only. In the year 2018-19, 6 PIs were awarded only DIA Fellowship and 6 were awarded Fellowship along with the project.

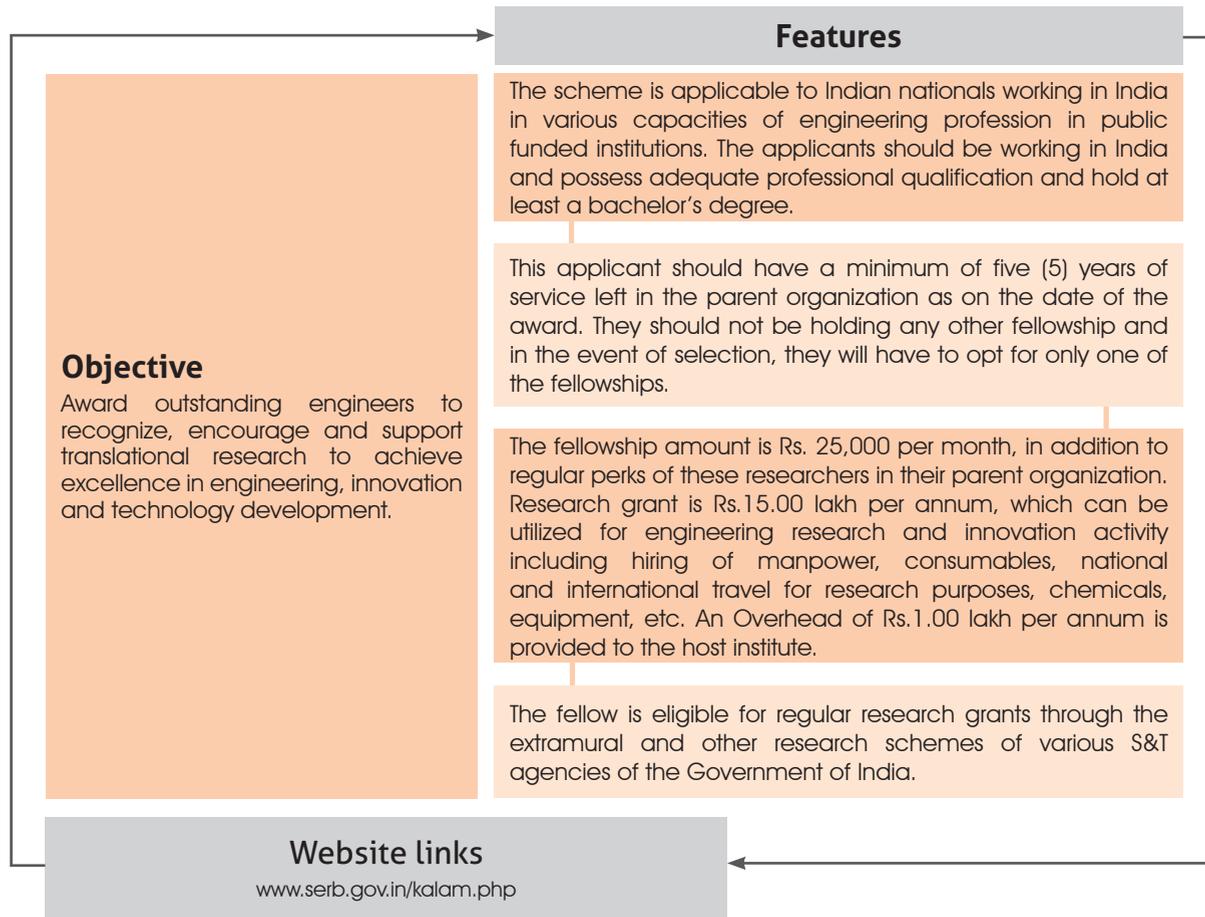


## ▶▶ 7.7 Abdul Kalam Technology Innovation National Fellowship (AKTIN)

Abdul Kalam Technology Innovation National Fellowship was launched by SERB to recognize, encourage and support translational research by Indian Nationals. Indian National Academy of Engineering (INAE) will co-ordinate and award Abdul Kalam Technology Innovation National Fellowships to outstanding engineers to recognize encourage and support translational research by individuals to achieve excellence in engineering, innovation and technology development in

association with SERB. All areas of engineering, innovation and technology will be covered by this fellowship. The duration of the fellowship will be initially for three years. The nominations can be sent by the Heads of the Institutions/ organizations, Presidents/ fellows of National science/ engineering academies, SS Bhatnagar Awardees and JC Bose awardees and the same will be accepted throughout the year. Maximum of 10 Fellowships will be awarded per year.

In FY 2018-2019, 8 new projects and 6 ongoing projects were supported under Abdul Kalam Technology Innovation National Fellowships.



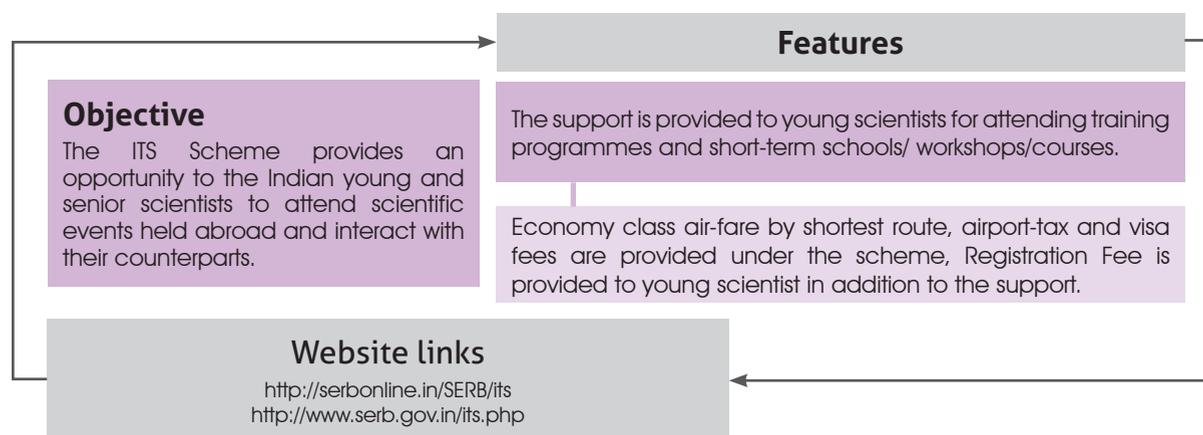


## 8

## SUPPORT FOR SCIENCE &amp; TECH. EVENTS

“Support for Science & Technology Events (SSTE)” provides support to two major components namely, International Travel Support Scheme (ITS) and Seminar Symposia (SS), for the events pertaining to science and technology.

### ►► 8.1 International Travel Support (ITS) Scheme



In the financial year (2018-19), 6385 applications were received to attend the Conference/ Workshop (ITS Scheme) from all the States/ UTs across the country in various fields of Science and Technology. Out of 6385 applications, 1937

applications were recommended for financial support to present their research findings (Table 8.1). Among them 1404 were Young Scientists and 533 were Senior Scientists.

**Table 8.1.** Recommended number of applications during year 2018-19:

S.No.	Items	Conference/Workshop
1.	Application Received	6385
2.	Application Recommended	1937

The participants were supported to attend various conferences in various subjects/disciplines which were held at different countries across the world, among them the top ten countries are United States of America (652), United Kingdom (82), France (100), Germany (95), Italy (99), Spain (75), Singapore (35), Japan (105), Canada (72), Australia (44) and China (59). The important events supported under the Scheme are: American Society for Microbiology (ASM) 2018 (20), SPIE

International Symposium 2018 (19), Gordon Research Conferences & Seminar (45), 2018 MRS Spring Meeting & Exhibit (09), COSPAR Assembly 2018 (19), 43rd International Conference on Coordination Chemistry (11), Cell Symposium 2018 (12), 43rd International Conference on Coordination Chemistry (11), European Materials Research Society-2018 (09), 2019 MRS Spring Meeting & Exhibit (09), Asia Oceania Geosciences Society 2018 (07)

**Table 8.2.** Subject- wise summary of received & recommended ITS Applications (2018-19):

Sr. No.	Name of discipline	Applications		Recommended Category		Gender	
		Received	Recommended	Senior Scientists (>35 Years)	Young Scientist (<35 Years)	M	F
1.	Engineering Sciences	1889	536	138	398	430	106
2.	Life Sciences	2361	659	196	463	379	280
3.	Chemical Sciences	538	180	60	120	127	53
4.	Physical Sciences	845	344	67	277	239	105
5.	Earth & Atmospheric Sciences	434	153	46	107	106	47
6.	Mathematical Sciences	318	65	26	39	48	17
	<b>Grand Total</b>	<b>6385</b>	<b>1937</b>	<b>533</b>	<b>1404</b>	<b>1329</b>	<b>608</b>

Institute-wise summary of Received vs. Recommended Applications are given below (Figure 8.1) :

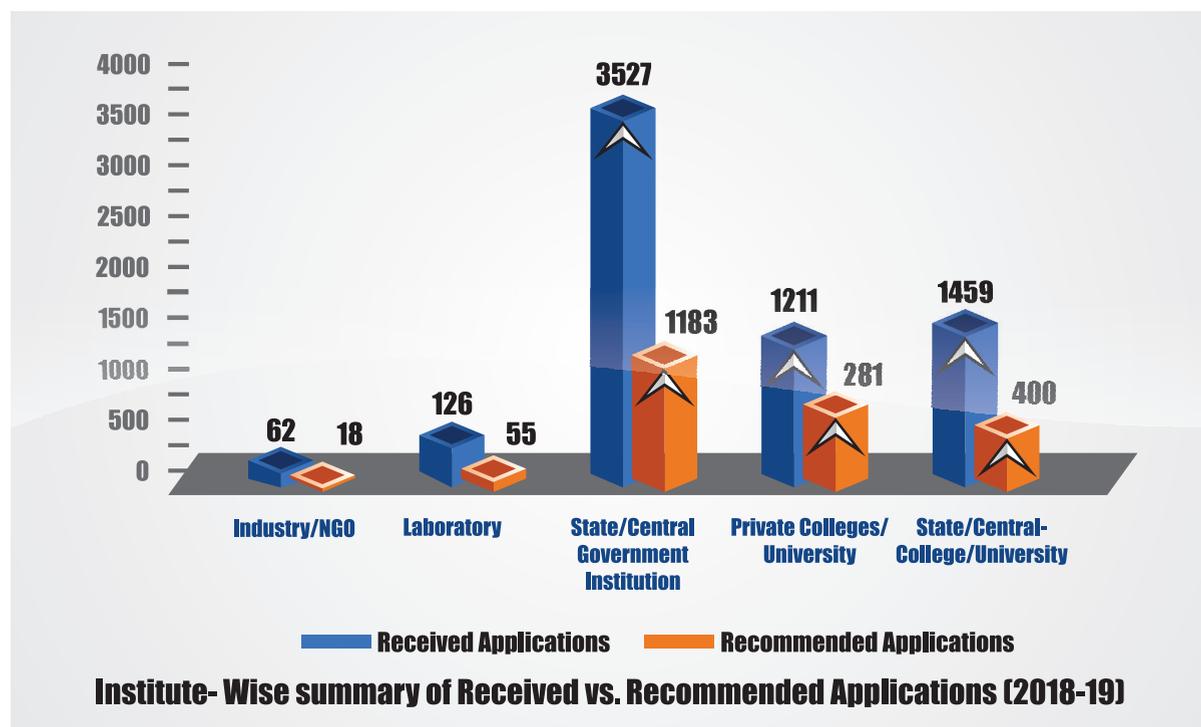
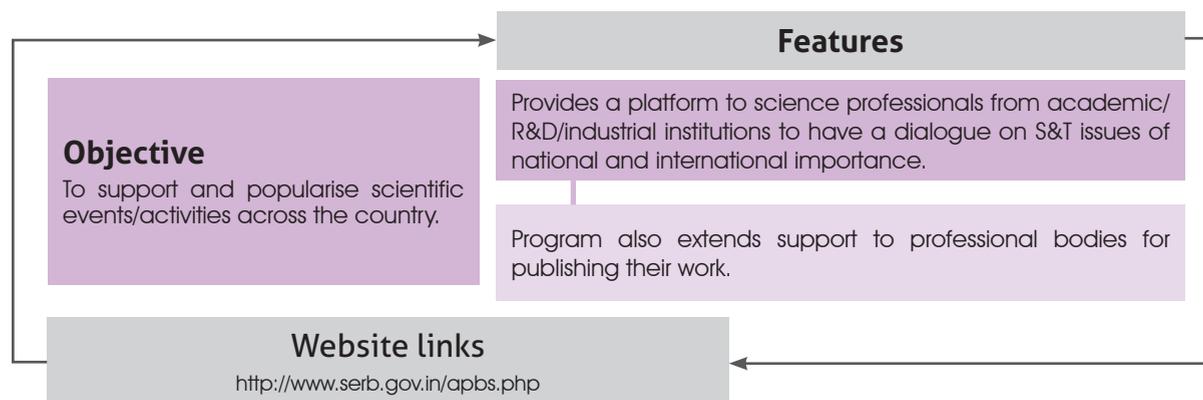


Figure 8.1 : Institute-Wise summary of Received vs. Recommended Applications (2018-19) in ITS.

## ▶▶ 8.2 Assistance to Professional Bodies & Seminars/Symposia



In the financial year (2018-19), **1547** applications under seminar / symposia were received for partial financial support from institutions/organisations across the country in various fields of Science and Technology. In addition to this, partial financial

support was extended to fourteen (14) Professional Bodies / Institutes / Societies for publication of Journals (Table 8.3). Out of 1547 applications, **464** applications in different subjects/disciplines were recommended for support (Table 8.4).

**Table 8.3.** Number of applications supported during year 2018-19:

S. No.	Items	Seminar / Symposia	Professional Bodies
1.	Application Received	1547	26
2.	Application Recommended	464	14
3.	Total Expenditure	7.44 Cr	18 Lac

**Table 8.4.** : Subject-wise summary of received & recommended applications under Seminar/ Symposia:

S. No.	Broad Subject Area	Received	Recommended	Approval Rate
1.	Chemical Sciences	74	37	50.00
2.	Earth Sciences	64	31	48.44
3.	Engineering Science	699	136	19.46
4.	Life Science	373	145	38.87
5.	Mathematical Science	115	35	30.43
6.	Other	197	65	32.99
7.	Physical Sciences	25	15	60.00
	Grand Total	1547	464	29.99



## 9

## PATENTS AND PUBLICATIONS

The patents and publications arising out from some of the funded projects during the year are provided in this chapter.

### ▶▶ 9.1 Patents Filed/Granted

Number of patents filled in 2018-19	
Country	Number of patents filled
INDIA	89
USA	5
<b>Total</b>	<b>94</b>

### ▶▶ 9.2 Publications

A list of publications under different schemes are detailed below:

Scheme	SCI	Non-SCI	Total
CRG	1902	530	2432
ECRA	668	589	1257
EMEQ	134	129	263
MATRICES	38	6	44
N-PDF	883	397	1280
Seminar/Symposia	7	78	85
<b>Total</b>	<b>3632</b>	<b>1729</b>	<b>5361</b>



## 10 ADMINISTRATION

The Administration continued to provide support and necessary administrative decisions for smooth functioning of the Board to meet desired results and meeting the targets.

### ►► 10.1 Administration and Recruitment

Dr. Rajiv Sharma, Scientist 'G' and Head of Technology Mission Division, DST was having additional charge of the post of Secretary (SERB) w.e.f. 01.03.2017 (F/N). Consequent upon his retirement on attaining the age of superannuation, w.e.f. 31.07.2019, Dr. Rajiv Kumar Tayal, Scientist 'G' and Executive Director, Indo-US Forum, DST was assigned the additional charge of the post of Secretary (SERB) w.e.f. 01.08.2019 (F/N).

The meeting of the Search-cum-Selection Committee for selection to the post of Secretary (SERB) was held on 17.01.2019. The Appointments Committee of Cabinet (ACC) on 10.03.2019, has approved the appointment of Prof. Sandeep

Verma, IIT Kanpur as Secretary (SERB) for a tenure of 3 years. Department of Science and Technology (DST) and SERB are in the process of appointing Prof. Sandeep Verma as Secretary (SERB).

Two posts of Scientist-G within the sanctioned strength which are lying vacant for more than two years, fell under the category "deemed abolished". A proposal was forwarded to DST for seeking approval of Ministry of Finance for revival of these two posts on 6th March 2018. Approval Department of Expenditure, Ministry of Finance has since been received. Necessary recruitment action for filling up of these posts is being taken.

### ►► 10.2 Implementation of Official Language

The SERB, since its inception has been implementing the guidelines issued by the Department of Official Language, Ministry of Home Affairs. Hindi Fortnight was celebrated in SERB from 14 to 28 September 2018. Various activities were organized for the staff/officers, both Hindi speaking and Non-Hindi speaking

to promote the official language. At the end of the Hindi Fortnight, a closing ceremony was held under the Chairmanship of Secretary, SERB, wherein the senior officers and staff of SERB were present in large number. The winners were awarded cash prizes, certificates and Hindi books by Secretary, SERB (Figure 10.1).



Figure 10.1: Hindi Pakhwara organized by SERB during the year.

Further, four Hindi workshops were also conducted on 25.06.2018, 20.09.2018, 20.12.2018 and 29.03.2019 to enhance the knowledge of the officers/staff for the maximum use of Hindi language in official work. Quarterly meetings of

Official Language Implementation Committee were held regularly to review the progress of the use of Hindi language in SERB and the quarterly reports were sent to DST as per schedule.

### ▶▶ 10.3 Audited Annual Statement Of Accounts

As per the provisions laid down in Section 13 of the Science & Engineering Research Board (SERB) Act, 2008, the Annual Accounts of the Board are required to be maintained in the prescribed formats and audited by the Comptroller and Auditor General of India (C&AG) or by their

appointed auditors annually. Accordingly, the Annual Accounts for the Financial Year 2018-19 have been prepared and audited by a team of Auditors from C&AG. The duly audited Financial Statements and Annual Accounts for the Financial Year 2018-19 are form part of this Annual Report.

### ▶▶ 10.4 Right To Information Act, 2005 (RTI)

Ninety-seven (97) RTI applications were received during the Financial Year 2018-19 including eighteen (18) received as transfer from DST. Out of the total 97 RTI applications, two (2) applications were transferred to other departments and appropriate information was provided to the rest of the applicants under RTI Act, 2005. Thirteen

(13) appeals were also received during the year and disposed-off by the appellate authority. A total fee of Rs.1416/- (Rupees one thousand four hundred sixteen only) was received by SERB for providing information under RTI Act, 2005, during the period.

### ▶▶ 10.5 Vigilance Awareness Week

The Vigilance Awareness Week was observed by SERB during the period from 29.10.2018 to 03.11.2018 with the theme "Eradicate Corruption-Build a New India (भ्रष्टाचार मिटाओ- नया भारत बनाओ)". All Officers/Staff of SERB assembled in the

Conference Room on 29th October 2018 to take the integrity pledge, to abide by the principles of honesty and integrity to fight against corruption (Figure 10.2).



Figure 10.2: Vigilance Awareness week commemorated in SERB during the year.

### ▶▶ 10.6 Internal Compliance Committee (ICC) of SERB

ICC Committee of SERB was constituted in the year 2017. As per guidelines given in the Act 2013, the committee meets regularly and

discussion on the issues are held. Constitution of the committee, guidelines and the related information are given in the website.

# **FINANCIAL STATEMENTS**

**FY 2018-19**



Amount in Rs.

## Balance Sheet as at 31.03.2019

	Schedule	Current Year	Previous Year
<b>CORPUS / CAPITAL FUND AND LIABILITIES</b>			
Corpus / Capital Fund	Schedule 1	885,542,810.65	586,896,443.46
Reserves and Surplus	Schedule 2	-	-
Earmarked / Endowment Funds	Schedule 3A, 3B, 3C, 3D & 3E	56,065,019.50	170,249,246.00
Secured Loans and Borrowings	Schedule 4	-	-
Unsecured Loans and Borrowings	Schedule 5	-	-
Deferred Credit Liabilities	Schedule 6	-	-
Current Liabilities and Provisions	Schedule 7	46,776,077.00	45,425,773.00
<b>Total</b>		<b>988,383,907.15</b>	<b>802,571,462.46</b>
<b>ASSETS</b>			
Fixed Assets (Net)	Schedule 8	59,771,314.00	38,948,994.00
Investments-From Earmarked / Endowment Funds	Schedule 9	-	-
Investments-Others	Schedule 10	-	-
Current Assets, Loans, Advances etc.	Schedule 11	928,612,593.15	763,622,468.46
Miscellaneous Expenditure (to the extent not written off or adjusted)			
<b>Total</b>		<b>988,383,907.15</b>	<b>802,571,462.46</b>
Significant Accounting Policies	Schedule 26		
Contingent Liabilities and Notes to Accounts	Schedule 27		

For Science and Engineering Research Board



Secretary

SERB



Director-Finance

SERB

Date: 27<sup>th</sup> June 2019.

Place : New Delhi

Amount in Rs.

## Income &amp; Expenditure Account for the Year Ended on 31.03.2019

	Schedule	Current Year	Previous Year
<b>Income</b>			
Income from Sales / Services	Schedule 12	-	-
Grants / Subsidies *	Schedule 13	9,964,627,195.00	7,975,894,650.00
Fees / Subscriptions	Schedule 14	-	-
Income from Investments	Schedule 15	-	-
Income from Royalty, Publication etc	Schedule 16	-	-
Interest Earned	Schedule 17	89,110,506.99	60,131,427.90
Other Income	Schedule 18	14,573,229.00	12,852,590.00
Increased/(Decrease) in stock of Finished Goods and Works-in-Progress	Schedule 19	-	-
<b>Total (A)</b>		<b>10,068,310,930.99</b>	<b>8,048,878,667.90</b>
<b>Expenditure</b>			
Establishment Expenses	Schedule 20	89,261,897.10	82,499,837.00
Other Administrative Expenses	Schedule 21	105,944,889.25	94,718,890.78
Expenditure on Grant, Subsidies etc	Schedule 22	9,768,461,481.57	7,985,840,954.46
Interest	Schedule 23	-	-
Depreciation (Net Total at the Year end)	Schedule 8	14,545,362.00	12,852,170.00
<b>Total (B)</b>		<b>9,978,213,629.92</b>	<b>8,175,911,852.24</b>
Excess of Income over Expenditure (A-B) (Before PPI & PPE)		<b>90,097,301.07</b>	-
Excess of Expenditure over Income (A-B) (Before PPI & PPE)		-	<b>(127,033,184.34)</b>
<b>Prior Period Income</b>	Schedule 24	188,423,801.02	185,100,328.97
<b>Prior period Expenditure</b>	Schedule 25	702,177.90	1,004,346.00
Excess of Income over Expenditure (A-B) (After PPI & PPE)		<b>277,818,924.19</b>	57,062,798.63
Excess of Expenditure over Income (A-B) (After PPI & PPE)		-	-
Transfer to Special Reserve (Specity each)		-	-
Transfer to / from General Reserve		-	-
Balance Being Surplus (Deficit) carried to Corpus/Capital Fund		<b>277,818,924.19</b>	<b>57,062,798.63</b>
Significant Accounting Policies	Schedule 26		
Contingent Liabilities and Notes to Accounts	Schedule 27		

\* CY- This amount reflect total grant received by SERB of Rs. 10,00,00,00,000/- less Fixed Assets purchased of Rs. 3,53,72,805/- (transferred to Corpus Fixed Assets Sch. 1)

\* PY- This amount reflect total grant received by SERB of Rs. 8,00,00,00,000/- less Fixed Assets purchased of Rs. 2,41,05,350/- (transferred to Corpus Fixed Assets Sch. 1)

For Science and Engineering Research Board

  
**Secretary**  
**SERB**

  
**Director-Finance**  
**SERB**

Date: 27<sup>th</sup> June 2019.

Place : New Delhi

Amount in Rs.

## Schedules Forming Part of Balance Sheet as at 31.03.2019

**Schedule 1 - Corpus / Capital Fund**

Particulars	Current Year	Previous Year
<b>Corpus Balance at the beginning of the year</b>	547,947,449.46	490,884,650.83
Add: Sale/Exchange of Fixed Assets (Laptop & Printer)	5,123.00	-
Add/(Deduct) : Balance of net income/(Expenditure) transferred from the Income & Expenditure Account	277,818,924.19	57,062,798.63
<b>Corpus Balance at the end of the year (A)</b>	<b>825,771,496.65</b>	<b>547,947,449.46</b>
<b>Corpus (Fixed Assets) Balance at the beginning of the year</b>	38,948,994.00	27,695,814.00
Add: Contributions towards Corpus/Capital Fund (Fixed Assets)		
FY 2017-18	-	24,105,350.00
FY 2018-19	35,372,805.00	-
Sale/Exchange of Fixed Assets (Laptop & Printer)	(5,123.00)	
Deferred Revenue Grant for FY 2017-18	-	(12,852,170.00)
Deferred Revenue Grant for FY 2018-19*	(14,545,362.00)	
<b>Corpus (Fixed Assets) Balance at the end of the year (B)</b>	<b>59,771,314.00</b>	<b>38,948,994.00</b>
<b>Total of Corpus &amp; Corpus (Fixed Assets) (A) + (B)</b>	<b>885,542,810.65</b>	<b>586,896,443.46</b>

Refer Point No. 12 In Schedule 26 Significant Accounting Policies

**Schedule 2 - Reserve and Surplus**

Particulars	Current Year		Previous Year	
<b>1. Capital Reserves :</b>				
As Per Last Account	-		-	
Addition during the year	-		-	
Less : Deductions during the year	-	-	-	-
<b>2. Revaluation Reserves :</b>				
As Per Last Account	-		-	
Addition during the year	-		-	
Less : Deductions during the year	-	-	-	-
<b>3. Special Reserve :</b>				
As Per Last Account	-		-	
Addition during the year	-		-	
Less : Deductions during the year	-	-	-	-
<b>4. General Reserve :</b>				
As Per Last Account	-		-	
Addition during the year	-		-	
Less : Deductions during the year	-	-	-	-
<b>Total</b>		-		-

## Schedules Forming Part of Balance Sheet as at 31.03.2019

Schedule 3A - Earmarked/Endowment Funds MFPI

Particulars	Current Year	Previous Year
<b>a) Opening Balance of the Funds</b>	<b>36,902,017.00</b>	<b>18,637,884.00</b>
<b>b) Additions to the funds</b>		
i) Donations / Grants	-	-
Grant in Aid (MFPI- General)	-	31,295,098.00
ii) Income from Investments made on account of Funds	-	-
iii) Other Additions	-	-
Interest from SERB on Saving Balance	76,605.00	398,123.00
Interest on MFPI Refund	7,267.00	-
Refund from previous year Grant FY 2012-13	934,442.00	-
Refund from previous year Grant FY 2013-14	-	550,005.00
Refund from previous year Grant FY 2014-15	956,553.00	418,116.00
Refund from previous year Grant FY 2015-16	-	39,471.00
Refund from previous year Grant FY 2016-17	76,204.00	313,927.00
Refund from previous year Grant FY 2017-18	84,864.00	-
<b>Total (a+b)</b>	<b>39,037,952.00</b>	<b>51,652,624.00</b>
<b>c) Utilization / Expenditure towards objectives of funds</b>		
<b>i) Capital Expenditure</b>	-	-
Fixed Assets	-	-
Other Additions	-	-
Grant-in-aid (MFPI- Capital)	113,356.00	799,832.00
<b>ii) Revenue Expenditure</b>		
Salary, Wages and allowance etc	-	-
Rent	-	-
Other Administrative Expenditure		
Grant-in-aid (MFPI- General)	6,347,246.00	13,950,775.00
<b>Total c)</b>	<b>6,460,602.00</b>	<b>14,750,607.00</b>
<b>Net Balance as at the year end (a+b-c)</b>	<b>32,577,350.00</b>	<b>36,902,017.00</b>

Amount in Rs.

## Schedules Forming Part of Balance Sheet as at 31.03.2019

Schedule 3B - Earmarked/Endowment Funds S & T Programme

Particulars	Current Year	Previous Year
<b>a) Opening Balance of the Funds</b>	<b>118,434,940.00</b>	<b>6,878,792.00</b>
<b>b) Additions to the funds</b>		
i) Donations / Grants	-	-
Grant in Aid (S & T Programme - Schedule Castes)	-	103,777,689.00
Grant in Aid (S & T Programme - Schedule Tribe)	-	6,900,000.00
ii) Income from Investments made on account of Funds	-	-
iii) Other Additions	-	-
S & T SC-Interest from SERB on Saving Balance	1,268,257.00	137,201.00
S & T ST-Interest from SERB on Saving Balance	-	41,536.00
S & T SC- Refund from previous year Grant FY 2013-14	1,195,360.00	689,212.00
S & T SC- Refund from previous year Grant FY 2014-15	6,872.00	-
S & T SC- Refund from previous year Grant FY 2016-17	102,679.00	1,162.00
S & T - Interest on Refund -SC	144.00	-
S & T - Interest on Refund -ST	-	9,348.00
<b>Total (a+b)</b>	<b>121,008,252.00</b>	<b>118,434,940.00</b>
<b>c) Utilization / Expenditure towards objectives of funds</b>		
i) Capital Expenditure	-	-
Fixed Assets	-	-
Other Additions	-	-
Grant-in-aid (S & T- Schedule Castes - Capital)	22,333,945.00	-
Grant-in-aid (S & T- Schedule Tribe - Capital)	-	-
ii) Revenue Expenditure		
Salary, Wages and allowance etc	-	-
Rent	-	-
Other Administrative Expenditure		
Grant-in-aid (S & T- Schedule Castes - General)	74,385,631.00	-
Grant-in-aid (S & T- Schedule Tribe - General)	8,242,000.00	-
<b>Total c)</b>	<b>104,961,576.00</b>	<b>-</b>
<b>Net Balance as at the year end (a+b-c)</b>	<b>16,046,676.00</b>	<b>118,434,940.00</b>

## Schedules Forming Part of Balance Sheet as at 31.03.2019

Schedule 3C - Earmarked/Endowment Funds AISTDF

Particulars	Current Year	Previous Year
<b>a) Opening Balance of the Funds</b>	-	215,276,691.00
<b>b) Additions to the funds</b>		
i) Donations / Grants	-	-
Grant in Aid- General (AISTDF)	-	-
ii) Income from Investments made on account of Funds	-	-
iii) Other Additions	-	-
Interest earned on Saving Account	-	613,295.00
<b>Total (a+b)</b>	-	215,889,986.00
<b>c) Utilization / Expenditure towards objectives of funds</b>		
i) Capital Expenditure	-	-
Fixed Assets	-	-
Other Additions	-	-
ii) Revenue Expenditure		
Salary, Wages and allowance etc	-	-
Rent	-	-
Other Administrative Expenditure- Bank Charges	-	15.00
<b>Total c)</b>	-	15.00
<b>Total (d) = (a+b-c)</b>	-	215,889,971.00
<b>e) LESS : Balance transferred to new Bank A/c opened no. 349902010047466 in the name of Asean India Science and Technology Development Fund on 27.04.2017</b>	-	215,889,971.00
<b>Net Balance as at the year end (d) - (e)</b>	-	-

Note: The balance of the new Bank A/c will be used for AISTDF activities and not for the SERB.

SERB facilitates management of AISTDF A/c as per the provisions of the MOU between DST & SERB. Accordingly separate financial accounts of AISTDF shall be prepared and submitted to DST.

Amount in Rs.

## Schedules Forming Part of Balance Sheet as at 31.03.2019

**Schedule 3D - Earmarked/Endowment Funds DOT**

Particulars	Current Year	Previous Year
<b>a) Opening Balance of the Funds</b>	14,912,289.00	-
<b>b) Additions to the funds</b>		
i) Donations / Grants	-	-
Grant in Aid (DOT- General)	-	19,100,000.00
ii) Income from Investments made on account of Funds	-	-
iii) Other Additions	-	-
<b>Total (a+b)</b>	<b>14,912,289.00</b>	<b>19,100,000.00</b>
<b>c) Utilization / Expenditure towards objectives of funds</b>		
<b>i) Capital Expenditure</b>	-	-
Fixed Assets	-	-
Other Additions	-	-
Grant-in-aid (DOT- Capital)	-	87,711.00
<b>ii) Revenue Expenditure</b>		
Salary, Wages and allowance etc	-	-
Rent	-	-
Other Administrative Expenditure		
Grant-in-aid (DOT- General)	4,884,411.00	4,100,000.00
DOT- Meeting Expenses - FY 2018-19	198,304.00	-
DOT- Meeting Expenses Reimbursement_FY 2014-15 to FY 2017-18*	2,388,580.50	-
<b>Total c)</b>	<b>7,471,295.50</b>	<b>4,187,711.00</b>
<b>Net Balance as at the year end (a+b-c)</b>	<b>7,440,993.50</b>	<b>14,912,289.00</b>

\* Note: Refer Schedule 24 Prior Period Income

## Schedules Forming Part of Balance Sheet as at 31.03.2019

Schedule 3E - Earmarked/Endowment Funds IMPRINT-II

Particulars	Current Year	Previous Year
<b>a) Opening Balance of the Funds</b>	-	-
<b>b) Additions to the funds</b>		
i) Donations / Grants	-	-
Grant in Aid (IMPRINT-II)	310,000,000.00	-
ii) Income from Investments made on account of Funds	-	-
iii) Other Additions	-	-
<b>Total (a+b)</b>	<b>310,000,000.00</b>	<b>-</b>
<b>c) Utilization / Expenditure towards objectives of funds</b>		
<b>i) Capital Expenditure</b>	-	-
Fixed Assets	-	-
Other Additions	-	-
Grant-in-aid (IMPRINT-II- Capital)	172,651,054.00	-
<b>ii) Revenue Expenditure</b>		
Salary, Wages and allowance etc	32,916.00	-
Rent	-	-
Other Administrative Expenditure		
Grant-in-aid (IMPRINT-II- General)	137,316,030.00	-
<b>Total c)</b>	<b>310,000,000.00</b>	<b>-</b>
<b>Net Balance as at the year end (a+b-c)</b>	<b>-</b>	<b>-</b>

Amount in Rs.

## Schedules Forming Part of Balance Sheet as at 31.03.2019

Schedule 4 - Secured Loans and Borrowings

Particulars	Current Year		Previous Year	
1. Central Government		-		-
2. State Government		-		-
3. Financial Institutions				
a) Term Loans	-		-	
b) Interest accrued and dues	-	-	-	-
4. Banks :				
a) Term Loans	-		-	
Interest accrued and due	-		-	
b) Other Loans	-		-	
Interest accrued and due	-	-	-	-
5. Other Institutions and Agencies		-		-
6. Debentures and Bonds		-		-
7. Others		-		-
<b>Total</b>		-		-

Schedule 5 - Unsecured Loans and Borrowings

Particulars	Current Year		Previous Year	
1. Central Government		-		-
2. State Government		-		-
3. Financial Institutions				
4. Banks :				
a) Term Loans	-		-	
b) Other Loans	-	-	-	-
5. Other Institutions and Agencies		-		-
6. Debentures and Bonds		-		-
7. Fixed Deposites		-		-
8. Others		-		-
<b>Total</b>		-		-

Schedule 6 - Deferred Credit Liabilities

Particulars	Current Year		Previous Year	
a) Acceptances secured by Hypothecation of Capital Equipment & other assets		-		-
b) Others		-		-
<b>Total</b>		-		-

## Schedules Forming Part of Balance Sheet as at 31.03.2019

Schedule 7 - Current Liabilities And Provisions

Particulars	Current Year		Previous Year	
<b>A) Current Liabilities</b>				
<b>1. Acceptances</b>		-		
<b>2. Sundry Creditors</b>				
a) For Goods		-		
b) Others:				
Moets Catering Service, Delhi	11,275.00		-	
Shree Bhagatrams, New Delhi	-		12,150.00	
Uneecode Inc., Delhi (RSM Enterprises, New Delhi)	35,394.00		15,627.00	
Suresh Malik & Co. (VPCA and Associates)	791,760.00		637,200.00	
National Mission on Bamboo Application	1,080,145.00		1,080,145.00	
FDS Management Services Private Limited	306,774.00		313,080.00	
Mansarover Industrial Corporation, New Delhi	2,350.00		2,350.00	
Sonu Printing Press Pvt. Ltd.	27,052.00		6,264.00	
Suncity Projects Private Limited, New Delhi	126,394.00		115,064.00	
Balmer Lawrie & Co. Ltd., New Delhi	199,833.00		113,429.00	
Dinesh Singh Tomer, New Delhi	-		2,679.00	
Carrider, Delhi	-		33,454.00	
Shalu Tour And Travels, New Delhi	117,431.00		211,700.00	
R S Travels Solution Private Limited	105,279.00		242,205.00	
Sonpal	16,815.00		15,770.00	
Sr. Post Master Sarojini Nagar, H.P.O.	4,826.00		-	
Deldsl-Digital NTC	74,100.00		75,400.00	
Digital NTC-New Delhi	29,640.00		23,200.00	
Airtel	33,941.00		36,108.00	
National Informatics Centre Service INC., New Delhi	-		24,241.00	
NSDL E Governanace Infrastructure Limited	830.00		826.00	
Net Creative Mind Solutions Private Limited	49,622.00	3,013,461.00	-	2,960,892.00
<b>3. Advances Received</b>		-		-
<b>4. Interest accrued but not due on :</b>				
a) Secured Loans / Borrowings		-		-
b) UnSecured Loans / Borrowings		-		-
<b>5. Statutory Liabilities</b>				
a) Over Due		-		-
b) Others : TDS - Section 194C	13,453.00		17,113.00	
TDS - Section 194J	1,200.00		4,118.00	
TDS - Section 192	676,119.00		668,902.00	
GST -TDS	143,363.00	834,135.00	-	690,133.00
<b>Total (1)</b>		<b>3,847,596.00</b>		<b>3,651,025.00</b>

Amount in Rs.

## Schedules Forming Part of Balance Sheet as at 31.03.2019

Schedule 7 - Current Liabilities And Provisions

Particulars	Current Year		Previous Year	
<b>6. Other Current Liabilities</b>				
<b>Expenses Payable</b>				
Salary Payable	5,886,354.00		5,731,865.00	
Wages Payable	7,500.00		-	
EPF Payable Employee Contribution	158,400.00		142,200.00	
EPF Payable Employer Contribution	176,420.00		158,398.00	
NPS Contribution Payable	485,304.00		480,066.00	
Audit Fee Payable	529,500.00		540,500.00	
Telephone Expenses Payable (Reimbursement)	7,074.00		12,677.00	
Children Education Allowance Payable (Reimbursement)	297,000.00		-	
Medical Expenses Payable (Reimbursement)	72,850.00		85,044.00	
Travelling Expenses Payable (Domestic)	47,241.00		-	
Accommodation Expenses Payable	5,807.00		-	
Honorarium Expenses Payable (Non-Official)	36,000.00	7,709,450.00	-	7,150,750.00
<b>Expenses (Current Liabilities Staff)</b>				
Satish Marar	6,835.00		2,065.00	
Prahlad Ram	-		-	
Dr. G. Harish Kumar	751.00		751.00	
Praveen Kumar S	418.00	8,004.00	418.00	3,234.00
<b>Time barred cheques taken back (FY 2011-12)</b>		344,235.00		344,235.00
<b>Time barred cheques taken back (FY 2012-13)</b>		11,933,916.00		11,933,916.00
<b>Time barred cheques taken back (FY 2013-14)</b>		16,251,065.00		16,251,065.00
<b>Time barred cheques taken back (FY 2014-15)</b>		222,593.00		222,593.00
<b>Total (2)</b>		<b>36,469,263.00</b>		<b>35,905,793.00</b>
<b>Total (A) =(1) + (2)</b>		<b>40,316,859.00</b>		<b>39,556,818.00</b>
<b>B. Provision</b>				
1. For Taxation		-		-
2. Gratuity		-		-
3. Superannuation / Pension		-		-
4. Accumulated Leave Encashment		6,459,218.00		5,868,955.00
5. Trade Warranties / Claims		-		-
6. Others		-		-
<b>Total (B)</b>		<b>6,459,218.00</b>		<b>5,868,955.00</b>
<b>Total (A+B)</b>		<b>46,776,077.00</b>		<b>45,425,773.00</b>

Amount in Rs.

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2019

SCHEDULE 8-FIXED ASSETS (PURCHASED OUT OF GRANT-IN-AID RECEIVED FROM DST) DESCRIPTION	Rate of Depreciation	GROSS BLOCK				DEPRECIATION				NET BLOCK		
		Cost / valuation at beginning of the year	Additions during the year	Deductions during the year	Cost / valuation at the year end	As at the beginning of the year	On Opening balance	On Additions during the year	On Deductions during the year	Total up to the year end	As at the current year end	As at the previous year end
<b>A. FIXED ASSETS</b>												
<b>I. LAND</b>												
a) Freehold												
b) Leasehold												
<b>2. BUILDING</b>												
a) On Freehold Land												
b) On Leasehold Land												
c) Ownership Flats/Premises												
d) Interior work	10%	21,247,421.00	2,049,904.00		23,297,325.00		1,200,342.00	202,721.00		10,647,062.00	12,650,263.00	12,003,422.00
<b>3. PLANT &amp; MACHINERY</b>	15%	1,127,268.00	445,640.00		1,572,908.00		119,012.00	66,846.00		519,715.00	1,053,193.00	793,411.00
<b>4. VEHICLES</b>												
<b>5. FURNITURE &amp; FIXTURES</b>	10%	11,667,550.00	2,379,009.00		14,046,559.00		764,960.00	243,269.00		5,026,175.00	9,020,384.00	7,649,604.00
<b>6. OFFICE EQUIPMENT</b>	15%	3,929,004.00	120,006.00		4,049,010.00		325,489.00	19,968.00		2,104,544.00	1,944,466.00	2,169,917.00
<b>7. COMPUTER/PERIPHERALS</b>												
A) COMPUTER SOFTWARES	40%	48,015,142.00	10,840,660.00		58,855,802.00		4,685,515.00	4,335,084.00		45,321,956.00	13,533,846.00	11,713,785.00
B) PERIPHERALS	40%	994,278.00	110,948.00		1,105,226.00		150,228.00	25,022.00		793,959.00	311,267.00	375,569.00
C) PRINTERS/SCANNERS	40%	3,149,437.00	907,422.00		3,980,959.00		404,574.00	322,777.00		2,789,881.00	1,191,078.00	1,011,888.00
D) COMPUTERS	40%	9,140,132.00	1,325,388.00		10,400,220.00		776,928.00	422,041.00		8,331,703.00	2,068,517.00	1,946,340.00
<b>8. ELECTRIC INSTALLATIONS</b>	10%	1,302,138.00	1,053,447.00		2,355,585.00		51,386.00	228,938.00		1,068,599.00	1,286,986.00	513,863.00
<b>9. LIBRARY BOOKS</b>	40%	67,844.00	11,167.00		79,011.00		12,006.00	2,960.00		52,796.00	26,215.00	30,014.00
<b>10. TUBEWELL &amp; W. SUPPLY</b>												
<b>II. INTANGIBLE ASSETS</b>												
a) SERB Website	25%	449,440.00			449,440.00		23,331.00			379,449.00	69,991.00	93,322.00
b) Logo	25%	412,000.00			412,000.00		32,590.00			314,231.00	97,769.00	1,30,359.00
c) Vajra Website	25%	690,000.00			690,000.00		129,375.00			301,875.00	388,125.00	517,500.00
<b>TOTAL OF CURRENT YEAR (A)</b>		102,191,654.00	19,243,591.00	141,200.00	121,294,045.00	63,242,660.00	8,675,736.00	5,869,626.00	136,077.00	77,651,945.00	43,642,100.00	38,948,994.00
<b>PREVIOUS YEAR</b>		77,736,304.00	24,455,550.00		102,191,654.00	50,390,490.00	5,098,759.00	7,753,411.00		63,242,660.00	38,948,994.00	27,345,814.00
<b>B. CAPITAL WORK IN PROGRESS</b>			16,129,214.00		16,129,214.00						16,129,214.00	
<b>TOTAL (A+B)</b>		102,191,654.00	35,372,805.00	141,200.00	137,423,259.00	63,242,660.00	8,675,736.00	5,869,626.00	136,077.00	77,651,945.00	59,771,314.00	38,948,994.00

Amount in Rs.

## Schedules Forming Part of Balance Sheet as at 31.03.2019

**Schedule 9 - Investments from Earmarked/Endowment Funds**

Particulars	Current Year	Previous Year
1. In Government Securities	-	-
2. Other approved Securities	-	-
3. Shares	-	-
4. Debentures and Bonds	-	-
5. Subsidiaries and Joint Ventures	-	-
6. Others (to be Specified)	-	-
<b>Total</b>	-	-

**Schedule 10 - Investments - Others**

Particulars	Current Year	Previous Year
1. In Government Securities	-	-
2. Other approved Securities	-	-
3. Shares	-	-
4. Debentures and Bonds	-	-
5. Subsidiaries and Joint Ventures	-	-
6. Others	-	-
<b>Total</b>	-	-

## Schedules Forming Part of Balance Sheet as at 31.03.2019

## Schedule 11 - Current Assets, Loans, Advances Etc

Particulars	Current Year		Previous Year	
<b>A) Current Assets</b>				
<b>1. Inventories :</b>				
a) Stores and Spares (Stationery Stock)		641,261.00		66,883.00
b) Loose Tools		-		-
c) Stock-in-Trade				
Finished Goods		-		-
Work-in-Progress		-		-
Raw Material		-		-
<b>2. Sundry Debtors :</b>				
a) Debts outstanding for a period exceeding six months		-		-
b) others:		-		-
<b>3. Cash Balances in Hand (including Cheques / Drafts and Imprest)</b>				
<b>Petty Cash Account</b>		20,000.00		20,000.00
<b>4. Bank Balances :</b>				
a) With Scheduled Banks :				
On Current Accounts		-		-
On Deposit Accounts		-		-
<b>On Savings Accounts - SERB (Union Bank of India)</b>		626,742,669.47		738,773,151.78
SERB EPFO Account (UBI)		112.00		9.00
SERB RTI Account (UBI)		294.68		176.68
AISTDF Account (UBI)		-		-
		626,743,076.15		738,773,337.46
b) With non-Scheduled Banks :				
On Current Accounts		-		-
On Deposite Accounts		-		-
On Savings Accounts		-		-
<b>5. Post Office - Savings Accounts</b>		-		-
<b>Total (A)</b>		<b>627,404,337.15</b>		<b>738,860,220.46</b>

Amount in Rs.

## Schedules Forming Part of Balance Sheet as at 31.03.2019

**Schedule 11 - Current Assets, Loans, Advances Etc**

Particulars	Current Year		Previous Year	
<b>B) Loans, Advances and Other Assets :-</b>				
<b>1. Loans:</b>				
a) Staff Loan		-		-
b) Other entities engaged in activities/objectives similar to that		-		-
c) Others		-		-
<b>2. Advances and other amounts recoverable in cash or in kind or for value to be received:</b>				
a) On Capital Account	-		-	
b) Prepayments				
Computer software expenses	234,121.00		190,860.00	
Video Conferencing License	827,567.00		689,020.00	
Vajra Website-Update Expenses	120,263.00		120,263.00	
Membership Fee - India International Centre, New Delhi	61,360.00		61,360.00	
AMC Biometric Attendance System	5,708.00		-	
Cyberoam Firewall - Licence Fee	15,296.00	1,264,315.00	72,852.00	1,134,355.00
c) Security Deposit				
BNPL Sarojini Nagar PO Security Deposit	-		446.00	
Deldsl-Digital NTC (Security Deposit)	20,000.00		20,000.00	
Digital NTC (Security Deposit)	10,000.00	30,000.00	10,000.00	30,446.00
d) Others-				
Gung HO Marketing Services Pvt. Ltd., New Delhi	-		1,063,475.00	
Centre for Development of Advanced Computing, Noida	7,485,920.00		6,898,280.00	
Lemon Tree Premier, Delhi Airport, New Delhi	200,000.00		-	
Red fox Hotel Aerocity, New Delhi	17,500.00		-	
Dr. Praveen Kumar S	118,376.00		-	
Sujit Mohanta	-		10,000.00	
Dr. Pramod Kumar Prasad	-		10,000.00	
Mrs. Madhu Wadhawan Sinha	34,500.00		-	
AISTDF Expenditure by SERB	11,999.00		-	
Department of Science & Technology (IMPRINT-II Expenditure by SERB)	275,723,693.00		-	
MFPI Expenditure by SERB	205,244.00	283,797,232.00	2,590,604.00	10,572,359.00
<b>3. Income Accrued:</b>				
a) On Investments from Earmarked/ Endowment Funds	-		-	
b) On Investment - Others	-		-	
c) On Loans and Advances	-		-	
d) Others (includes income due unrealized )	-		-	
Interest accrued on Saving A/c Balance - SERB UBI	16,116,706.00		13,025,086.00	
SERB RTI Account (UBI)	2.00		2.00	
SERB EPFO Account (UBI)	1.00		-	
AISTD Account (UBI)	-	16,116,709.00	-	13,025,088.00
<b>4. Claim Receivable</b>				
		-		-
<b>Total = (B)</b>		<b>301,208,256.00</b>		<b>24,762,248.00</b>
<b>Total (A) + (B)</b>		<b>928,612,593.15</b>		<b>763,622,468.46</b>

## Schedules Forming Part of Income &amp; Expenditure for the year ended 31.03.2019

**Schedule 12 - Income From Sales / Services**

Particulars	Current Year	Previous Year
<b>1. Income from Sales</b>		
a) Sale of finished Goods	-	-
b) Sale of Raw Material	-	-
c) Sale of Scraps	-	-
<b>2. Income from Services</b>		
a) Labour and Processing Charges	-	-
b) Professional / Consultancy Services	-	-
c) Agency Commissions and Brokerages	-	-
d) Maintenance Services (Equipment/Property)	-	-
e) Others	-	-
<b>Total</b>	-	-

**Schedule 13 - Grants / Subsidies**

Particulars	Current Year		Previous Year	
<b>1. From Central Government</b>				
a) Grant in Aid (General)	7,471,500,000.00		5,800,000,000.00	
Transferred to Corpus/Fixed Assets (Schedule 1)	(35,372,805.00)	7,436,127,195.00	(24,105,350.00)	5,775,894,650.00
b) Grant in Aid (Capital)		1,860,000,000.00		1,675,000,000.00
c) Grant in Aid (Scheduled Castes - General)		308,500,000.00		290,000,000.00
d) Grant in Aid (Scheduled Castes - Capital)		220,000,000.00		210,000,000.00
e) Grant in Aid (Scheduled Tribe - General)		65,000,000.00		-
f) Grant in Aid (Scheduled Tribe - Capital)		35,000,000.00		-
g) Grant in Aid (Salaries)		40,000,000.00		25,000,000.00
<b>2. State Government(s)</b>		-		-
<b>3. Government Agencies</b>		-		-
<b>4. Institutions Organisations</b>		-		-
<b>5. International Organisations</b>		-		-
<b>6. Other</b>		-		-
<b>Total</b>		<b>9,964,627,195.00</b>		<b>7,975,894,650.00</b>

Amount in Rs.

## Schedules Forming Part of Income &amp; Expenditure for the year ended 31.03.2019

Schedule 14 - Fees / Subscriptions

Particulars	Current Year	Previous Year
1. Entrance Fees	-	-
2. Annual Fees / Subscriptions	-	-
3. Seminar / Program Fees	-	-
4. Consultancy Fee	-	-
5. Others	-	-
<b>Total</b>	-	-

Schedule 15 - Income From Investments (Income on Invest. From Earmarked/Endowment Funds transferred to Funds)

Particulars	Investment from Earmarked Funds		Investment -Others	
	Current Year	Previous Year	Current Year	Previous Year
<b>1. Interest</b>				
a) On Govt. Securities	-	-	-	-
b) Other Bonds/Debentures	-	-	-	-
<b>2. Dividends</b>				
a) On shares	-	-	-	-
b) On Mutual Fund Securities	-	-	-	-
<b>3. Rents</b>	-	-	-	-
<b>4. Others : Interest on MFPI Balance in Saving Account</b>	76,605.00	398,123.00	-	-
Interest on S & T SC Balance in Saving Account	1,268,257.00	137,201.00	-	-
Interest on S & T ST Balance in Saving Account	-	41,536.00	-	-
Interest on AISTDF Balance in Saving Account	-	613,295.00	-	-
<b>Total</b>	<b>1,344,862.00</b>	<b>1,190,155.00</b>	-	-
<b>Transferred to Earmarked/Endowment Funds</b>	<b>1,344,862.00</b>	<b>1,190,155.00</b>		

Schedule 16 - Income from Royalty, Publication Etc.

Particulars	Current Year	Previous Year
1) Income from Royalty	-	-
2) Income from Publications	-	-
3) Other	-	-
<b>Total</b>	-	-

## Schedules Forming Part of Income &amp; Expenditure for the year ended 31.03.2019

## Schedule 17 - Interest Earned

Particulars	Current Year	Previous Year
<b>1. On Term Deposits</b>		
a) With Scheduled Banks	22,391,982.00	8,003,425.00
b) With Non-Scheduled Banks	-	-
c) With Institutions	-	-
d) Others	-	-
<b>2. On Savings Accounts</b>		
a) With Scheduled Banks	63,673,845.00	50,153,121.00
b) With Non-Scheduled Banks	-	-
c) Post Office Savings Accounts	-	-
d) Others	-	-
<b>3. On Loans :</b>		
a) Employees / Staff	-	-
b) Others	-	-
<b>4. Interest on Debtors and Other Receivables</b>	-	-
<b>5. Interest on Refund</b>	3,044,679.99	1,974,881.90
<b>Total</b>	<b>89,110,506.99</b>	<b>60,131,427.90</b>

## Schedule 18 - Other Income

Particulars	Current Year	Previous Year
<b>1. Profit on sale/disposal/exchange of Assets</b>		
a) Owned assets	-	-
b) Assets acquired out of grants, or received free of cost	27,501.00	-
2. Export Incentives realized	-	-
3. Fees for Miscellaneous Services	-	-
4. Deferred Revenue Grant (AS-12)	14,545,362.00	12,852,170.00
5. Miscellaneous Income- Other Income RTI Receipts	366.00	420.00
<b>Total</b>	<b>14,573,229.00</b>	<b>12,852,590.00</b>

Amount in Rs.

## Schedules Forming Part of Income &amp; Expenditure for the year ended 31.03.2019

Schedule 19 - Increase / (Decrease) in stock of Finished Goods & Work in Progress

Particulars	Current Year	Previous Year
<b>a) Closing Stock</b>		
Finished Goods	-	-
Work-in-Progress	-	-
<b>b) Less : Opening Stock</b>		
Finished Goods	-	-
Work-in-Progress	-	-
<b>Total</b>	-	-

Schedule 20 - Establishment Expenses

Particulars	Current Year	Previous Year
a) Salaries and Wages	81,544,222.00	73,293,485.00
b) Allowances and Bonus	-	-
c) Contribution to Provident Fund- Employer	2,046,953.00	1,724,554.00
d) Contribution to Other Fund (NPS Employer Contribution)	2,849,312.00	2,697,004.00
e) Staff Welfare Expenses	-	-
f) Expenses on Employee's Retirement & Terminal Benefits		
Leave Encashment Provision	590,263.00	2,722,572.00
g) Others		
Telephone Expenses Reimbursement	201,808.00	227,455.00
School Fee Reimbursement	297,000.00	6,150.00
Newspaper Reimbursement	61,833.00	18,062.00
Medical Reimbursement	656,042.10	744,060.00
Leave Encashment	108,086.00	247,344.00
Leave Travel Concession	906,378.00	819,151.00
<b>Total</b>	<b>89,261,897.10</b>	<b>82,499,837.00</b>

## Schedules Forming Part of Income &amp; Expenditure for the year ended 31.03.2019

Schedule 21 - Other Administrative Expenses

Particulars	Current Year	Previous Year
a) Bank Charges	112,628.75	71,515.78
b) Car Hire Charges	4,281,267.00	5,353,622.00
c) Professional Fees	2,004,993.00	3,521,468.00
d) Electricity Charges	1,932,916.00	1,529,656.00
e) Membership fee : India International Centre, New Delhi	61,360.00	51,750.00
f) Meeting Expenses	5,139,575.00	36,664.00
g) Honorarium Expenses (Non- Official)	2,413,000.00	746,000.00
h) Hospitality Expenses	1,813,293.00	1,918,788.00
i) Printing & Stationery	6,701,805.00	6,922,371.00
j) Rent- Building	52,864,738.00	47,964,925.00
k) Advertisement/Publication	2,227,793.00	5,332,115.00
l) Water Charges	5,992.00	-
m) Conveyance Expenses	3,484.00	2,950.00
n) Housekeeping/Security Expenses	3,408,393.00	3,014,266.00
o) International Conference	764,387.00	877,539.00
p) Repair & Maintenance	1,330,349.00	775,599.00
q) Travelling Expenses (Domestic)	9,326,681.00	8,794,675.00
r) Travelling Expenses (International)	2,130,781.00	1,549,000.00
s) Audit Fee	449,500.00	305,500.00
t) Accommodation Expenses (Domestic)	128,307.50	173,847.00
u) Accommodation Expenses (International)	439,713.00	-
v) Computer Hardware & Software	1,355,831.00	618,134.00
w) Internet Charges	1,330,838.00	1,356,832.00
x) Newspaper & Periodicals	15,813.00	16,775.00
y) Postage Expenses	113,405.00	99,106.00
z) Telephone Expenses	297,360.00	281,400.00
aa) Festival Expenses	206,500.00	121,820.00
ab) NSDL E Governance Charges	3,490.00	3,450.00
ac) Training Expenses	30,680.00	95,000.00
ad) AMC	2,006,209.00	2,043,539.00
ae) Digitisation Cost	2,262,434.00	-
af) Miscellaneous Expenses	781,373.00	1,140,584.00
<b>Total</b>	<b>105,944,889.25</b>	<b>94,718,890.78</b>

Amount in Rs.

## Schedules Forming Part of Income &amp; Expenditure for the year ended 31.03.2019

Schedule 22 - Expenditure on Grants, Subsidies Etc

Particulars	Current Year	Previous Year
<b>Grants given to Institutions/Organisations</b>		
a) Grants in Aid (Capital Assets) (Ann. 24 & 24A)	2,124,898,354.00	1,505,083,752.00
b) Grant in Aid (General) (Ann. 25 & 25A)	6,957,763,305.57	5,804,208,358.06
c) Grant in Aid (Scheduled Castes - Capital)	227,935,104.00	275,143,100.00
d) Grant in Aid (Scheduled Castes - General)	360,300,422.00	345,933,316.40
e) Grant in Aid (Scheduled Tribe - Capital)	34,435,000.00	18,445,000.00
f) Grant in Aid (Scheduled Tribe - General)	63,129,296.00	37,027,428.00
<b>Total</b>	<b>9,768,461,481.57</b>	<b>7,985,840,954.46</b>

Schedule 23 - Interest

Particulars	Current Year	Previous Year
a) On Fixed Loans (Including Bank Charges)	-	-
b) On Other Loans (Including Bank Charges)	-	-
c) Others	-	-
<b>Total</b>	<b>-</b>	<b>-</b>

## Schedules Forming Part of Income &amp; Expenditure for the year ended 31.03.2019

**Schedule 24 - Prior Period Income**

Particulars	Current Year	Previous Year
<b>A) Refund received against previous year grants</b>		
a) Refund from Projects (Capital) FY 2011-12	8,275.00	1,786,873.00
b) Refund from Projects (General) FY 2011-12	240,146.00	126,548.00
c) Refund from Projects (Capital) FY 2012-13	2,709,784.63	1,217,645.00
d) Refund from Projects (General) FY 2012-13	2,053,795.00	3,472,349.00
e) Refund from Projects (Capital) FY 2013-14	4,151,966.00	11,797,447.06
f) Refund from Projects (General) FY 2013-14	2,485,572.66	6,463,020.00
g) Refund from Projects (SC-Capital) FY 2013-14	939,309.00	670.00
h) Refund from Projects (SC-General) FY 2013-14	226,601.00	26,235.00
i) Refund from Projects (ST-Capital) FY 2013-14	343,873.00	-
j) Refund from Projects (Capital) FY 2014-15	9,382,534.71	7,124,707.59
k) Refund from Projects (General) FY 2014-15	6,700,754.90	6,434,513.54
l) Refund from Projects (SC-Capital) FY 2014-15	8,453.24	-
m) Refund from Projects (ST-Capital) FY 2014-15	603,713.00	-
n) Refund from Projects (ST-General) FY 2014-15	5,175.00	44.00
o) Refund from Projects (Capital) FY 2015-16	8,734,377.66	6,664,882.00
p) Refund from Projects (General) FY 2015-16	8,043,296.64	23,876,868.47
q) Refund from Projects (SC-Capital) FY 2015-16	693,218.00	900,000.00
r) Refund from Projects (SC-General) FY 2015-16	2,024,960.30	1,411,811.00
s) Refund from Projects (ST-General) FY 2015-16	500,406.00	94,348.00
t) Refund from Projects (Capital) FY 2016-17	17,186,753.44	20,424,494.00
u) Refund from Projects (General) FY 2016-17	34,696,267.10	57,307,594.31
v) Refund from Projects (SC-Capital) FY 2016-17	175,596.00	3,750,000.00
w) Refund from Projects (SC-General) FY 2016-17	441,606.00	1,433,106.00
x) Refund from Projects (ST-Capital) FY 2016-17	160,000.00	-
y) Refund from Projects (ST-General) FY 2016-17	277,817.00	233,694.00
z) Refund from Projects (Capital) FY 2017-18	9,826,318.60	-
aa) Refund from Projects (General) FY 2017-18	68,713,812.22	-
ab) Refund from Projects (SC-Capital) FY 2017-18	211,786.00	-
ac) Refund from Projects (SC-General) FY 2017-18	3,676,326.42	-
ad) Refund from Projects (ST-General) FY 2017-18	275,377.00	-
ae) Refund from Projects SERC	20,468.00	153,479.00
af) Refund from Projects PY	516,881.00	-
<b>B) Refund from DOT against previous year grants</b>		
a) Grant-in-Aid (General) FY 2014-15	2,103,154.50	4,939,798.00
b) Grant-in-Aid (Capital) FY 2014-15	-	5,310,202.00
c) Grant-in-Aid (General) FY 2015-16	103,413.50	5,280,650.00
d) Grant-in-Aid (Capital) FY 2015-16	-	10,169,350.00
e) Grant-in-Aid (General) FY 2016-17	31,936.00	4,700,000.00
f) Grant-in-Aid (General) FY 2017-18	150,076.50	-
<b>Total A) + B)</b>	<b>188,423,801.02</b>	<b>185,100,328.97</b>

Amount in Rs.

## Schedules Forming Part of Income &amp; Expenditure for the year ended 31.03.2019

Schedule 25 - Prior Period Expenditure

Particulars	Current Year	Previous Year
a) Professional Fees	3,323.00	14,000.00
b) Audit Fee (CAG Auditors)	231,025.00	-
c) International Conference	-	18,075.00
d) Travelling Expenses (Domestic)	22,741.00	20,445.00
e) Conference Expenses	22,713.00	-
f) Grant-in-Aid (Capital)	90.00	-
g) Newspaper Reimbursement	15,598.00	2,817.00
h) Medical Expenses Reimbursement	58,399.90	31,352.00
i) Telephone Expenses Reimbursement	16,830.00	34,552.00
j) School Fee Reimbursement	290,850.00	18,000.00
k) Salary Arrear (Regular Employees)	(45,440.00)	718,905.00
l) NPS Employer Contribution (Arrear)	-	72,015.00
m) AMC Computers & Printers	29,972.00	-
n) AMC Photocopier	4,033.00	-
o) AMC SERB Website	50,478.00	-
p) AMC Video Conferencing System	1,565.00	1,570.00
q) Housekeeping Expenses	-	58,122.00
r) Video Conferencing System Licence	-	14,493.00
<b>Total</b>	<b>702,177.90</b>	<b>1,004,346.00</b>

## Receipts &amp; Payments for the Year Ended 31.03.2019

Receipts		Current Year	Previous Year	Payments		Current Year	Previous Year
1	<b>Opening Balances</b>			1	<b>Expenses</b>		
a)	Cash in hand	20,000.00	20,000.00	a)	Establishment Expenses (corresponding to Schedule 20)	89,266,991.00	79,552,811.00
b)	Bank balances			b)	Administrative Expenses (corresponding to Schedule 21)	107,147,263.25	95,135,195.78
i)	In Current Accounts	-	-	2	<b>Payments made against funds for various projects</b>		
ii)	In Deposit Accounts	-	-	<b>Grants given to Institutions/Organisations</b>			
iii)	Savings Accounts : SERB UBI	738,773,151.78	530,512,306.83	a)	Grants in Aid (Capital Assets)	2,124,898,444.00	1,505,083,752.00
	: AISTDF UBI	-	214,396,671.00	b)	Grant in Aid (General)	6,957,763,305.57	5,804,208,358.06
	: SERB RTI	176.68	10.00	c)	Grant in Aid (Scheduled Castes - Capital)	227,935,104.00	275,143,100.00
	: SERB EPFO	9.00	-	d)	Grant in Aid (Scheduled Castes - General)	360,300,422.00	345,933,316.40
2	<b>Grants Received</b>			e)	Grant in Aid (Scheduled Tribe - Capital)	34,435,000.00	18,445,000.00
a)	From Government of India	10,000,000,000.00	8,000,000,000.00	f)	Grant in Aid (Scheduled Tribe - General)	63,129,296.00	37,027,428.00
b)	From State Government	-	-	3	<b>Investments &amp; Deposits made</b>		
c)	From Other Sources (details)	-	-	a)	Out of Earmarked/Endowment Funds	-	-
3	<b>Income on Investments from</b>			b)	Out of Own Funds (Investments-Others)	-	-
a)	Earmarked/Endowment Funds	-	-	4	<b>Expenditure on Fixed Assets &amp; Capital Work-in</b>		
b)	Own Funds	-	-	a)	Purchase of Fixed Assets	27,387,950.00	24,105,350.00
4	<b>Interest Received</b>			b)	Expenditure on Capital Work-in Progress	-	-
a)	On Bank Deposits	84,319,068.00	67,172,854.00	5	<b>Refund of surplus money/loans</b>		
b)	Loans Advances	-	-	a)	To the Government of India	-	-
c)	Interest on Refund	3,044,679.99	1,974,881.90	b)	To the State Government	-	-
5	<b>Other Income</b>	366.00	420.00	c)	To other providers of Funds	-	-
6	<b>Amount Borrowed</b>	-	-	6	<b>Finance Charges (Interest)</b>	-	-
7	<b>Any Other Receipts</b>			7	<b>Other Payments (Specify)</b>		
a)	Refunds Received Against Previous Year Grant	186,035,220.52	185,100,328.97	a)	MFPI Earmarked Payment	6,460,602.00	14,750,607.00
b)	MFPI Earmarked Receipt	2,059,330.00	32,616,617.00	b)	S & T Earmarked Payment	105,231,534.00	-
c)	S & T Earmarked Receipt	1,575,013.00	111,377,411.00	c)	AISTDF Earmarked Transferred (new Bank A/c no. 349902010047466)*	-	215,889,986.00
d)	AISTDF Earmarked Receipt	-	1,493,315.00	d)	IMPRINT-2 Earmarked Payment	310,000,000.00	-
e)	DOT Earmarked Receipt	-	19,100,000.00	e)	MFPI Expenditure by SERB	450,000.00	950,000.00
f)	IMPRINT-2 Earmarked Receipt	310,000,000.00	-	f)	DOT Earmarked Payment	5,082,715.00	4,187,711.00
g)	Receipt against MFPI Expenditure by SERB	4,007,152.00	3,422,892.00	g)	IMPRINT-2 Expenditure by SERB	275,723,693.00	-
h)	Dr. P Sanjeeva Rao	9,524.00	-	h)	AISTDF Expenditure by SERB	11,999.00	-
				i)	Pramod Kumar Prasad	-	10,000.00
				j)	Mrs. Madhu Wadhawan Sinha	34,500.00	-
				k)	Praveen Kumar S	118,376.00	-
				l)	Centre for Development of Advanced Computing, Noida	7,485,920.00	6,898,280.00
				m)	Gung Ho Marketing Services Pvt Ltd, New Delhi	-	1,063,475.00
				n)	Lemon Tree Premier- Delhi Airport, New Delhi	200,000.00	-
				o)	Red Fox Hotel Aerocity, New Delhi	17,500.00	-
				p)	Sujit Mohanta	-	10,000.00
				8	<b>Closing Balances</b>		
				a)	Cash in hand	20,000.00	20,000.00
				b)	Bank balances		
				i)	In Current Accounts	-	-
				ii)	In Deposit Accounts	-	-
				iii)	Savings Accounts : SERB UBI	626,742,669.47	738,773,151.78
					: AISTDF UBI	-	-
					: SERB RTI	294.68	176.68
					: SERB EPFO	112.00	9.00
Total		11,329,843,690.97	9,167,187,707.70	Total		11,329,843,690.97	9,167,187,707.70

For Science and Engineering Research Board

Date: 27<sup>th</sup> June  
Place: New Delhi 2019.

*Sandhya Kesava Wadhawan*  
Secretary  
SERB

*Wadhawan*  
Director-Finance  
SERB

Refer Schedule 3C- Earmarked/Endowment Fund AISTDF

## SCHEDULE FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31.03.2019

## SCHEDULE 26

## SIGNIFICANT ACCOUNTING POLICIES

**1. Basis of Preparation of Financial Statements**

These financial statements have been prepared on the accrual basis of accounting, under historical cost convention, in accordance with the accounting principles generally accepted in India.

**2. Fixed Assets**

Fixed assets are stated at cost of acquisition less accumulated depreciation and impairment losses, if any. Cost of fixed assets comprises purchase price, duties, levies and other directly attributable costs of bringing the assets to its working conditions for the intended use.

**3. Capital Work in Progress**

Expenditure incurred on construction of assets which are not ready for their intended use are carried at cost less impairment (if any), under Capital work-in-progress.

**4. Depreciation**

Depreciation on fixed assets is computed on the written down value (WDV) method at the rates and in the manner prescribed under the Provisions of Income Tax Act.

In respect of additions to/deductions from fixed assets during the year, depreciation is considered on pro-rata basis. Assets costing Rs.5,000/- each or less are fully provided.

**5. Grant/ Subsidies Received**

Grants, subsidies or similar assistance received for the general purposes and objectives of the Entity, on an irrevocable basis, be treated as income on receipt basis.

**6. Expenditure on Grants, Subsidies etc.**

Grants, subsidies or other similar assistance given to the Institutions/Organisations for general purposes and objectives of the Entity, on an irrevocable basis, be treated as expenditure when they are released.

**7. Interest Income of SERB**

Besides the grant-in-aid received from Central Government, SERB also generates income from: -

- a. Interest on Short term FD's of the Grant-in Aid
- b. Interest on the Saving A/c Balance
- c. and Interest on Refund

Further the above income generated is applied for meeting the expenses as indicated in para 10(2) of the SERB Act 2008.

**8. Prior period Income/Expenditure**

Income/expenditure relating to previous Financial Years has been booked as Prior Period Income/Expenditure in the Income and Expenditure Account.

**9. Refund from beneficiaries:**

- a) Refund/repayment of grant/assistance received by SERB from the beneficiaries as per the conditions stipulated in the sanction document is accounted for on receipt basis.
- b) Refund/repayment of grant/assistance given and received back in the same financial year has been netted off with Grant-in-Aid (expenditure) in the Income and Expenditure Account.
- c) Refund/repayment of grant/assistance given in previous years and received back in later years (i.e. not in same financial year) has been shown as "Refund received against Previous Year Grant" in the Income and Expenditure Account under "Prior Period Income".

**10. Unspent balances of Grants received from DST:**

The unspent balances of Grants received from DST are not to be refunded to DST as grants released by the Government are credited to Science and Engineering Research Board in terms of Section 10(1) of SERB Act, 2008.

**11. Time barred cheques**

All cheques issued by SERB during the FY 2018-19 have been encashed within its validity period of 3 months from the date of the issue of Cheque. So, no amount has been transferred to the head "Time Barred Cheques Taken Back" under Current Liabilities for cheques issued during the FY 2018-19.

**12. Government Grant for Fixed assets of SERB**

In order to comply with AS-12 Accounting for Government Grants under direction of C&AG, amount equivalent to cost of acquisition of fixed assets out of Grants in Aid (General) has been shown as Corpus Fixed Assets. Depreciation for the year amounting Rs. 1,45,45,362/- is being credited to Income & Expenditure A/c as Deferred Revenue Grant as per para 8 of AS 12.

**13. Retirement Benefits**

SERB makes provision for liability towards encashment of leave lying to the credit of employees as on the last day of current financial year subject to the maximum period of leave allowable as per extant rules and retirement benefits shall be governed by the National Pension System (NPS) as applicable to the officers of equivalent rank of the Central Government as amended from time to time

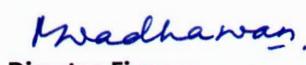
**14. Surplus/Deficit in Income & Expenditure A/c**

Surplus/Deficit in Income & Expenditure Account at the year-end has been transferred to Corpus/Capital Account.

**For Science and Engineering Research Board**



Secretary  
SERB



Director-Finance  
SERB

Date: 27<sup>th</sup> June 2019.

Place: New Delhi

## SCHEDULE FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31.03.2019

## SHCHEDULE- 27 CONTINGENT LIABILITIES AND NOTES TO ACCOUNTS

**1. CONTINGENT LIABILITIES**

1.1 Claims against the Entity not acknowledge as debts **Rs. NIL** (Previous year **Rs. NIL**)

1.2 In respect of

- Bank Guarantees given by/on behalf of the Entity **Rs. NIL** (Previous year **Rs. NIL**)
- Letters of Credit opened by Bank on behalf of the Entity **Rs. NIL** (Previous year **Rs. NIL**)
- Bills discounted with banks **Rs. NIL** (Previous year **Rs. NIL**)

1.3 Disputed demands in respect of:

- Income tax **Rs. NIL** (Previous year **Rs. NIL**)
- Sales Tax **Rs. NIL** (Previous year **Rs. NIL**)
- Municipal Taxes **Rs. NIL** (Previous year **Rs. NIL**)
- In respect of claims from parties for non-execution of orders but contested by the Entity **Rs. NIL** (Previous year **Rs. NIL**)

1.4 Income Tax (*Refer Para 6 below*)

- Current Year – Rs 12,12,88,862/-      Previous year – Rs 12,12,88,862/-

	Current Year	Previous Year
FY 2011-12	Rs. 9,43,38,079/-	Rs. 9,43,38,079/-
FY 2012-13	Rs. 2,69,50,783/-	Rs. 2,69,50,783/-
FY 2013-14	Nil	Nil
FY 2014-15	Nil	Nil
FY 2015-16	Nil	Nil
FY 2016-17	Nil	Nil
FY 2017-18	Nil	Nil
FY 2018-19	Nil	Nil
<b>Total</b>	<b>Rs. 12,12,88,862/-</b>	<b>Rs. 12,12,88,862/-</b>

**2. CAPITAL COMMITMENTS**

- Estimated value of contracts remaining to be executed on capital account and not provided for (net of advances) **Rs. NIL** (Previous year **Rs. NIL**)

**3. LEASE OBLIGATIONS**

- Future obligations for rentals under finance lease arrangements for plant and machinery amount to **Rs. NIL** (Previous year **Rs. 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, at least equal to the amount at which they are stated in the Balance Sheet.

#### **5. Net Profit in Current FY 2018-19**

Total Income of Current FY 2018-19 is Rs. 1006,83,10,930.99 whereas Total Expenditure of Current FY is Rs. 997,82,13,629.92

In Income & Expenditure A/c excess of Income over Expenditure shows a difference of Rs. 9,00,97,301.07 as Gross Profit.

SERB is having Net Profit of Rs. 27,78,18,924.19 in FY 2018-19 after considering Prior Period Income of Rs. 18,84,23,801.02 and Prior Period Expenditure of Rs. 7,02,177.90

#### **6. TAXATION**

SERB has got exemption u/s 10(46) of the Income Tax Act, 1961 for 5 financial years from FY 2013-14 to FY 2017-18 vide gazette notification no. 24/2017/F.No.196/15/2013-ITA-I published on 31<sup>st</sup> March, 2017.

Since our original application for exemption u/s 10(46) was from inception of SERB, the matter has been taken up again with CBDT to grant us exemption for FY 2011-12 and FY 2012-13 also.

Further we have applied for exemption u/s 10(46) of the Income Tax Act, 1961 to CBDT and Income Tax Department for FY 2018-19 and onwards.

In such a situation we have shown Contingent Liability for Income Tax at point 1.4.

SERB is registered as charitable organization u/s 12A of the Income Tax Act, 1961 from AY 2017-18 and eligible for exemption from Income Tax u/s 11 of the Income Tax Act, 1961.

**7. FOREIGN CURRENCY TRANSACTIONS**

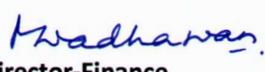
(Amount Rs.)

<b>7.1 Value of Imports Calculated on C.I.F. Basis:</b>	<b>Current Year</b>	<b>Previous Year</b>
Purchase of finished Goods	Nil	Nil
Raw Materials & Components (Including in transit)	Nil	Nil
Capital Goods	Nil	Nil
Stores, Spares & Consumables		
<b>7.2 Expenditure in foreign currency:</b>		
a) Travel	Rs. 7,64,387/-	Rs. 8,77,539/-
b) Remittances and Interest Payment to Financial Institutions/ Banks in Foreign Currency	Nil	Nil
c) Other expenditure:		
- Commission on Sale	Nil	Nil
- Legal and Professional Expenses	Nil	Nil
- Miscellaneous Expenses	Nil	Nil
- Grant-in-Aid (General)	RS. 9,80,67,135/-	RS. 5,14,00,759/-
<b>7.3 Earning:</b>		
Value of Exports on FOB basis	Nil	Nil
<b>7.4 Remuneration to Auditors:</b>		
- Auditors Fee (CAG)	Rs. 1,25,000/-	Rs. 40,000/-
- Auditors Fee (CA)	Rs. 3,24,500/-	Rs. 2,65,500/-
- Taxation matters	.....	.....
- For management services	.....	.....
- For certificate	.....	.....
- Others	.....	.....

8. Previous Year figures have been regrouped /recast wherever found necessary.  
9. Schedules 1 to 27 are annexed to and form an integral part of the Balance Sheet as at 31.03.2019 and the Income and Expenditure Account for the year ended on that date.

For Science and Engineering Research Board

  
Secretary  
SERB

  
Director-Finance  
SERB

Date: 27<sup>th</sup> June 2019.  
Place: New Delhi



कार्यालय महानिदेशक लेखापरीक्षा

वैज्ञानिक विभाग

नई दिल्ली-110 002

OFFICE OF THE DIRECTOR GENERAL OF AUDIT,  
SCIENTIFIC DEPARTMENTS,  
A.G.C.R. BUILDING, I.P. ESTATE  
NEW DELHI-110 002

सं.म.नि.वै.वि./नि.1(24)/SERB/Annual A/cs/2019-20/ 999-1000 दिनांक: 16/12/2019

सेवा में,

**प्रोफेसर संदीप वर्मा**

**सचिव**

विज्ञान और इंजीनियरी अनुसंधान बोर्ड

5 और 5ए, निचला भू-तल,

वसंत स्क्वायर माल,

सैक्टर - बी, पॉकेट-5, वसंत कुंज,

नई दिल्ली - 110 070

**विषय: विज्ञान और इंजीनियरी अनुसंधान बोर्ड के वर्ष 2018-19 के वार्षिक लेखों पर अंतिम पृथक ऑडिट रिपोर्ट।**

महोदय,

मुझे विज्ञान और इंजीनियरी अनुसंधान बोर्ड के वर्ष 2018-19 के लेखों पर पृथक ऑडिट रिपोर्ट अग्रेषित करने का निर्देश हुआ है।

संसद के दोनों सदनों में प्रस्तुत करने से पहले वर्ष 2018-19 के वार्षिक लेखों को विज्ञान और इंजीनियरी अनुसंधान बोर्ड द्वारा अपनाया जाए। प्रत्येक दस्तावेज जो संसद में प्रस्तुत किया जाए उसकी तीन प्रतियां इस कार्यालय तथा दो प्रतियां भारत के नियंत्रक एवं महालेखापरीक्षक को अग्रेषित की जाएं। संसद के दोनों सदनों में प्रस्तुत करने की तिथि(यां) भी इस कार्यालय को सूचित की जाएं।

यह महानिदेशक द्वारा अनुमोदित है।

भवदीया,

संलग्नक: यथोपरि।

  
उप निदेशक (निरीक्षण)

**Separate Audit Report of the Comptroller & Auditor General of India on the accounts of Science & Engineering Research Board, New Delhi for the year ended 31 March 2019**

We have audited the attached Balance Sheet of Science & Engineering Research Board (SERB), New Delhi as at 31st March 2019, the Income & Expenditure Account and Receipts & Payments Account for the year ended on that date under Section 19 (2) of the Comptroller & Auditor General's (Duties, Powers & Conditions of Service) Act, 1971 read with Section 13 (3) of the SERB Act, 2008. These financial statements are the responsibility of the SERB's management. Our responsibility is to express an opinion on these financial statements based on our audit.

2. This Separate Audit Report contains the comments of the Comptroller & Auditor General of India (CAG) on the accounting treatment only with regard to classification, conformity with the best accounting practices, accounting standards and disclosure norms, etc. Audit observations on financial transactions with regard to compliance with the Law, Rules & Regulations (Propriety and Regularity) and efficiency-cum-performance aspects, etc., if any, are reported through Inspection Reports/CAG's Audit Reports separately.

3. We have conducted our audit in accordance with auditing standards generally accepted in India. These standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatements. An audit includes examining, on a test basis, evidences supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of financial statements. We believe that our audit provides a reasonable basis for our opinion.

4. Based on our audit, we report that:

- (i) 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;
- (ii) The Balance Sheet, Income & Expenditure Account and Receipts & Payment Account dealt with by this report have been drawn up in the format prescribed by Ministry of Finance, Government of India.
- (iii) In our opinion, proper books of accounts and other relevant records have been maintained by the SERB in so far as it appears from our examination of such books.

iv) We further report that:

**A. Balance Sheet:**

**A.1 Corpus/ Capital Fund and Liabilities**

**A.1.1 Corpus/ Capital Fund (Schedule 1) Rs. 88.55 crore**

Above has been overstated by Rs. 82.57 crore -being the amount of savings from the grants received from Department of Science and Technology, refunds of grants received from various grantee institutions and interest on bank balances<sup>1</sup>. **Current liabilities** (on account of amount of government grants refundable) have been understated by the same amount.

**A.1.2 Current liabilities and provisions(Schedule 7) Rs. 4.68 crore**

Current liabilities included Rs. 10.43 lakh on account of provision for accumulated leave encashment for employees who had already availed leave encashment before re-employment/absorption in SERB<sup>2</sup>. This led to overstatement of the provision by Rs. 10.43 lakh and corresponding understatement of surplus for the year by the same amount.

**B. Comments on Significant Accounting Policy**

**B.1 Interest on unspent balances of grants**

SERB does not refund the unspent balances of grants received from DST as per clause 10 of their significant accounting policy, Whereas as per rule 230(7) and 230(8) of GFR 2017 and also as per terms and conditions of sanction order, the unspent grant alongwith interest and other earnings has to be remitted to Consolidated Fund of India immediately after finalisation of accounts. Thus the significant accounting policy on unspent balances is in violation of General Financial Rules as well as sanction order issued by DST.

**B.2 Policy of charging depreciation on fixed assets**

The uniform Format of Accounts prescribe for straight line method for charging of depreciation on fixed assets. SERB is charging depreciation on fixed assets at written down

<sup>1</sup>GFRs 230(7) and 230(8) as well as terms and conditions of the grants sanctioned by DST require the unspent grant along with interest and other earnings against grants-in-aid to be refunded to the Consolidated Fund of India.

<sup>2</sup> DOPT No. 14028/1/2017-Estt(L) dated 27.06.2017 prescribes leave encashment up to a maximum of 300 days including the period for which encashment was allowed at the time of retirement (before re-employment)

value, which is in contravention of the Uniform Format of Accounts prescribed for all autonomous bodies under Union Government.

### C Grants-in-aid

Out of Rs. 1054.32 crore (including opening balance of Rs. 54.32 crore and an amount of Rs. 1000.00 crore received as grants during the year), the Board could utilize a sum of Rs. 999.23 crore<sup>3</sup> leaving a balance of Rs. 55.09 crore as unutilized balance as on 31<sup>st</sup> March 2019.

**D. Management Letter-** Deficiencies which have not been included in the Audit Report have been brought to the notice of SERB through a management letter issued separately for remedial/corrective actions.

v) Subject to our observations in the preceding paragraphs, we report that the Balance Sheet, Income & Expenditure Account, and Receipts & Payments Account dealt with by this report are in agreement with the books of accounts.

vi) In our opinion and to the best of our information and according to the explanations given to us, the said financial statements read together with the Accounting Policies and Notes on Accounts and subject to the significant matters stated above and other matters mentioned in Annexure to the Audit Report give a true and fair view in conformity with accounting principles generally accepted in India

(a) in so far as it relates to the Balance Sheet of the State-of-affairs of the SERB as of 31st March, 2019 and

(b) in so far as it relates to the Income and Expenditure Account of the surplus for the year ended on that date.

Dated: .12.2019  
Place: New Delhi

For and on behalf of CAG of India

Director General of Audit  
(Scientific Departments)

<sup>3</sup> Receipt and Payments for the year ended 31.03.2019

*Annexure***1. Adequacy of Internal Audit System**

SERB does not have its own Internal Audit Wing. The Internal Audit of SERB is conducted by the Internal Audit Wing, Principal Pay & Accounts Office of Department of Science & Technology, New Delhi. Internal Audit of SERB upto March 2018 has been conducted by the Principal Pay & Accounts Office of Department of Science & Technology, New Delhi. Seven observations from previous inspection report (2014-16) and eight observations for the period 2016-18 were pending.

**2. Adequacy of Internal Control Systems –**

During the audit of SERB, the following deficiencies in relation to internal control system were observed:

**2.1 Conflict of interest due to handling of dual charges**

Audit observed that the Board has only one Under Secretary and two vacant posts of Section Officers. As such the Under Secretary is handling the charge of Administration as well as Drawing and Disbursing Officer. In effect, this is leading to the same person passing the payments who sanctioned them in the first place. Audit is of the view that this lacuna in internal control system of the Board needs to be viewed and separation of duties needs to be ensured on urgent basis.

**2.2 Non maintenance of records of assets created out of Grants for Creation of Capital Assets**

As per Schedule 22 of the Annual Accounts for the financial year 2018-19, the Board released Rs. 238.73 crores to 627 institutes as Grants for Creation of Capital Assets, Grant in Aid (Scheduled Caste-Capital) and Grants in Aid (Scheduled Tribe- Capital). The Board however has not disclosed any of the assets procured by these 627 Institutes in the annual accounts.<sup>4</sup>

**2.3 Non-disclosure of information relating to grantee bodies on SERB website**

<sup>4</sup> Rule 233 of GFR 2017 states that the ownership of the physical and intellectual assets created or acquired out of grants to various grantee institutions shall vest in the sponsor (SERB in this case).

The details of projects/programme implemented by the institutions or organizations, getting Grants-in-aid from SERB were also neither uploaded on the website of the SERB as per the provisions GFR 209(1) nor the Grants-in-aid Register in Form 39 as per GFR 212(4) was being maintained by the Board.

#### **2.4 Non maintenance of Register of Grants released by the board**

Register of Grants in Form GFR-21 needs to be maintained by the Board as per Rule 234, GFRs 2017, the same was not being done.

#### **2.5 Investment Policy**

Audit observed that the board invested Rs. 405 crore in short term fixed deposits (with tenure ranging from 25 to 31 days) during the financial year 2018-19. It was noted that the board does not have any approved investment policy for investing the amounts remaining unutilized during various spells of the years. It is suggested that the investment policy should be framed by the SERB for better investment and utilisation of the resources which remain unutilised during the year.

#### **2.6 Monitoring of Utilisation Certificates (UCs)**

Rule 238 (1) of GFRs 2017 provides that a certificate of actual utilization of the grant received for the purpose for which it was sanctioned in the form GFR 12-A which should be submitted within twelve months of the closure of the financial year by the grantee institution/ organization. However, audit observed that 9149 number of UCs amounting to a total of Rs 754.78 crore for the years 2011-12 to 2017-18 were outstanding as on March 2019.

#### **2.7 Non-utilisation of Gem Portal for goods and services procurement**

Rule 149 of the General Financial Rules, 2017 requires that the Procurement of Goods and Services by Ministries or Departments will be mandatory for Goods or Services available on Government e-Marketplace (GeM). For this purpose, the GeM portal shall be utilized by the Government buyers for direct on-line purchases. It was however observed that the Board is yet to begin using the GeM portal.

### **2.8 Non-conduction of peer review**

No peer review of the Board has been conducted by the Ministry since its inception as required under Rule 229 (ix) of GFRs 2017 despite the Board releasing a sizeable amount of grants in aid to various institutions/ universities.

### **3. System of Physical Verification of Fixed Assets**

No discrepancy was reported in the physical verification of fixed assets carried out for the financial year 2018-19.

### **4. System of Physical Verification of Inventory**

No discrepancy was reported in the physical verification of fixed assets carried out for the financial year 2018-19.

### **5. Regularity in payment of statutory dues**

The board has no statutory dues outstanding for more than six months from date of becoming due during 2018-19. An amount of Rs. 12.13 crore has been shown as contingent liability for income tax for the period 2011-12 to 2012-13 as exemption of income tax for the same period is awaited from Central Board of Direct Taxes.

  
Dy. Director (Insp)



**Sanjay Kumar Jha**

महानिदेशक लेखापरीक्षा  
वैज्ञानिक विभाग  
ए.जी.सी.आर. भवन, इन्द्रप्रस्थ एस्टेट,  
नई दिल्ली-110002  
DIRECTOR GENERAL OF AUDIT  
SCIENTIFIC DEPARTMENTS  
A.G.C.R. BUILDING, I.P. ESTATE  
NEW DELHI-110 002

D. O. No. DGA(SD)/Inspection/SERB/Annual A/cs/2018-19/ 78  
Dated: 16.12.2019

Dear *Sir,*

I have audited the Annual Accounts of the Science and Engineering Research Board, New Delhi for the year 2018-19 and have issued the Audit Report thereon vide letter dated .....12.2019. During the course of audit, some deficiencies were noticed which were of a relatively minor nature and were, therefore, not included in the Audit Report and are now enclosed in the Annexure. These are being brought to your notice for remedial and corrective action.

*Warm regards,*

Yours sincerely,

Encl: Annexure

**Prof Sandeep Verma**  
Secretary  
Science and Engineering Research Board  
5&5A, Lower Ground Floor  
Vasant Squarte Mall  
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New Delhi – 110070

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Annexure to Management Letter**1. Fixed assets (Schedule 8) – Rs 5.97 crore****Computer / Peripherals Rs. 1.71 crore**

This does not include stock amounting to Rs. 2.64 lakh purchased during 2018-19 as detailed below:

Sl. No.	Particulars of asset	Cost of Asset (Rs.)	Page reference in Stock Register
1	HP PROBOOK	80,240	100
2	HP OFFSETPRINT PRO	92,040	133
3	HP OFFSETPRINT.PRO	92,040	133
	<b>TOTAL</b>	<b>2,64,320</b>	

This resulted in the understatement of Computer/Peripherals by Rs. 2.64 lakh; depreciation during the year by Rs. 0.38 lakh and therefore understatement of expenditure by the same amount.

**2. Statement of Receipts and Payments - Grants Received**

Uniform Format of Accounts requires separate depiction of the grants received for capital and revenue expenditure. As against this, SERB is showing consolidated figure under the Grants received from the Government of India.

**3.General**

(i) SERB has not made provisions towards post retirement benefits of gratuity and pension in pursuance with Accounting Standard 15 of ICAI. Further the accounting policy for the same has also not been disclosed in the Schedule of Significant Accounting Policies.

(ii) Moreover, the provision for leave encashment has not been made on actuarial valuation basis.

## ABBREVIATIONS

<b>AB</b>	Ayurvedic Biology
<b>ACC</b>	Appointment Committee of Cabinet
<b>AKTIN</b>	Abdul Kalam Technology Innovation National
<b>ASTM</b>	American Society for Testing and Materials
<b>C&amp;AG</b>	Comptroller and Auditor General
<b>CFD</b>	Computational Fluid Dynamics
<b>CRG</b>	Core Research Grant
<b>DIA</b>	Distinguished Investigator Award
<b>DST</b>	Department of Science and Technology
<b>ECRA</b>	Early Career Research Award
<b>EMR</b>	Extra Mural Research
<b>GRF</b>	Graduate Research Fellow
<b>GROW</b>	Graduate Research Opportunities Worldwide
<b>HRD</b>	Human Resource Development
<b>HRHR</b>	High Risk High Reward
<b>ICC</b>	Internal Compliance Committee
<b>IMPRINT</b>	IMPacting Research and Innovation Technology
<b>INSPIRE</b>	Innovation in Science Pursuit for Inspired Research
<b>IRHPA</b>	Intensification of Research in High Priority Area
<b>IRRD</b>	Industry Relevant Research and Development
<b>ISO</b>	International Organization for Standardization
<b>ITS</b>	International Travel Support
<b>JC Bose</b>	Jagadish Chandra Bose
<b>JRF</b>	Junior Research Fellow
<b>MATRICS</b>	Mathematical Research Impact-Centric Support
<b>MoU</b>	Memorandum of Understanding
<b>NPDF</b>	National Post-Doctoral Fellowship
<b>NSF</b>	National Science Foundation
<b>ODF</b>	Overseas Doctoral Fellowship
<b>OPDF</b>	Overseas Post-Doctoral Fellowship
<b>OVDF</b>	Overseas Visiting Doctoral Fellowship
<b>PAC</b>	Program Advisory Committee
<b>PC</b>	Program Coordinator
<b>PI</b>	Principal Investigator
<b>PO</b>	Programme Officer
<b>PIRE</b>	Partnerships for International Research and Education
<b>PMF</b>	Prime Minister's Fellowship Programme for Doctoral Research
<b>R&amp;D</b>	Research and Development
<b>S&amp;T</b>	Science and Technology
<b>SERB</b>	Science and Engineering Research Board
<b>SRF</b>	Senior Research Fellow
<b>SRS</b>	SERB Research Scientists
<b>SSR</b>	Social Scientific Responsibility
<b>SS</b>	Seminar Symposia
<b>STEM</b>	Science, Technology, Engineering and Mathematics
<b>TARE</b>	Teacher Associateship for Research Excellence
<b>UAY</b>	Uchcatar Avishkar Yojana
<b>VAJRA</b>	Visiting Advanced Joint Research
<b>YoSCP</b>	Year of Science Chair Professorship
<b>YSS</b>	Young Scientist Scheme







## About SERB

Set up through an Act of Parliament, viz. the Science and Engineering Research Board Act, 2008, SERB serves as the national premier funding agency for planning, promoting and steering internationally competitive research in science and engineering. The mandate is to promote basic research in frontier areas of Science and Engineering and provide financial assistance to persons engaged in such research, academic institutions, research and development laboratories, and other agencies. This is achieved through various schemes like extramural research funding fellowships, grants, awards, scholarships and joint industrial relevant collaborations.



## Science and Engineering Research Board

Submit R&D proposals online at: [www.serbonline.in](http://www.serbonline.in)

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