

## Executive Summary

Tata Institute of Fundamental Research (TIFR) is an Autonomous Institution of the Department of Atomic Energy (DAE), Government of India, and has been declared a National Centre of the Government of India for Nuclear Science and Mathematics. The Main Campus of TIFR is in Colaba, Mumbai, where the TIFR administration is also housed. TIFR also has external campuses in Mumbai, Pune, Bengaluru and Hyderabad, where its Research Centres are located.

TIFR carries out fundamental research in the areas of physics, chemistry, mathematics, biology, computer science, and science education. The Main campus in Colaba comprises the Natural Sciences Faculty (Departments of *Astronomy and Astrophysics, Condensed Matter Physics and Materials Science, High Energy Physics, Nuclear and Atomic Physics, Theoretical Physics, Chemical Sciences and Biological Sciences*), the *School of Mathematics*, and the *School of Technology and Computer Science*.

The Research Centres of TIFR have been established to take its mandate of fundamental research forward. Each Research Centre is academically equivalent to a Department: it has about 10-20 faculty members, carrying out research activities in a focussed area. It however has a more autonomous governing structure and carries out its research activities independently. In this Self Study Report, for academic purposes the Centres are treated like other Departments of TIFR.

The Research Centres are located at the external campuses of TIFR. The Mumbai campus has *Homi Bhabha Centre for Science Education (HBCSE)*, in Chembur, Mumbai, while the Pune campus has *National Centre for Radio Astrophysics (NCRA)*. The Bengaluru campus has *National Centre for Biological Sciences (NCBS)*, *Centre for Applicable Mathematics (CAM)* and *International Centre for Theoretical Sciences (ICTS)* as its three Departments, and the Hyderabad campus has *TIFR Centre for Interdisciplinary Sciences (TCIS)* as its first Department.

TIFR is one of the premier research institutions in India. It has about 270 faculty members, most of whom are leaders in research in their own disciplines. The TIFR Deemed University, established in 2002, now has around 600 students pursuing their M.Sc. or Ph.D. degree. There is no undergraduate programme. The Graduate School of TIFR is one of the most coveted places for doing a Ph.D. in basic sciences in India.

**TIFR inception and management:**

TIFR was founded in 1945 through the initiative of the great scientist and visionary Homi J. Bhabha. The institute was established by the Trustees of Sir Dorabji Tata Trust and the then Government of Bombay, as an institution to promote excellence in scientific research. The Council for Scientific and Industrial Research (CSIR) had supported TIFR in the early stages. The current management structure of TIFR is derived from the 1954 Tripartite Agreement among the Government of India, the then Government of Bombay, and Sir Dorabji Tata Trust. The role of the Government of India was later taken over by the Department of Atomic Energy (DAE), while the role of the Government of Bombay was taken over by the State Government of Maharashtra.

The highest governing body of TIFR is the Council of Management, which consists of Mr. Ratan Tata as the Chair, the TIFR Director, the Chairman of the Atomic Energy Commission, eminent scientists including Bharat Ratna Prof. C.N.R. Rao and Dr. K. Kasturirangan, ex-Chairman of ISRO, and other representatives of the Government of India, Government of Maharashtra and Sir Dorabji Tata Trust. The Centre Directors, the Deans of Faculties / Schools, the Dean of Graduate Studies, the Department Chairs, and the Conveners of various Committees, all of whom are researchers and faculty members of repute, oversee the academic and administrative matters, along with the Registrar, Deputy Registrar and Assistant Registrar (Academic).

**TIFR contribution to scientific knowledge :**

TIFR has been carrying out research at the forefront of knowledge for more than seven decades, and has international stature as a top quality research institution. Some of the results that have come out of TIFR have made major impact on their respective disciplines, leading to new areas of research. Many have even found themselves in advanced textbooks. Important original scientific results have emerged from TIFR in the areas ranging from algebra, algebraic geometry, differential geometry, number theory, group theory, combinatorics, partial differential equations, to cosmic rays, astrophysics, cosmology, plasma physics, particle physics, superconductivity, statistical physics, number theory, string theory, nanomaterials, nuclear magnetic resonance, and further to neurobiology and developmental biology. This contribution has been recognised in the form of 32 Padma awards over the years. The current Faculty has 3 Padma awards, 7 Infosys awards, more than 25 Shanti Swarup Bhatnagar awards and 15 Swarnajayanti

Fellowships, as well as international awards like the ICTP Prize, TWAS Prize and the New Horizons Physics (Milner) Prize. The rate of publications from TIFR has been consistently high over the years, with more than 1000 publications (including Conference Proceedings) during 2014-15.

In the Indian context, TIFR has been one of the few institutions with the capability of taking up mega projects in fundamental science. The Kolar Gold Field experiment carried out by TIFR scientists was the first in the world to detect neutrinos from the atmosphere of the Earth. The Giant Metrewave Radio Telescope is one of the largest and most sensitive radio telescopes in the world, where international astronomers compete for observation time. Three of the five main detectors on Astrosat, the first Indian satellite for fundamental science and launched by ISRO, have been designed by TIFR astrophysicists. TIFR faculty members have also been a part of the high energy particle collider experiments that detected the top quark and the Higgs boson, and the LIGO experiment that detected the gravitational waves. An experimental science mega project in the country, the India-based Neutrino Observatory (INO), is spearheaded by TIFR scientists.

**TIFR Contribution to Nation building:**

From its inception, TIFR has been committed to training excellent scientific manpower and many of its alumni have played important roles both at the national and international levels. Several important Indian institutions have had their beginnings in TIFR, from BARC to ISRO to the ECIL, CDAC, and SAMEER. In nearly all Indian institutions of excellence TIFR alumni have played or are playing an important role in teaching, research and administration. In fact, TIFR has been the role model for the setting up of many institutions in India and some abroad. TIFR members have also been on the Scientific Advisory Committee to the Cabinet (SAC-C) and the Scientific Advisory Committee to the Prime Minister (SC-PM)

TIFR has also served as a knowledge resource centre. The visitors' programmes have allowed many researchers in the country to visit TIFR and collaborate with its faculty members. Many TIFR faculty members have served on national and international committees dealing with curriculum development, faculty selection, research advice, project selections for funding, etc. More than 35 faculty members of TIFR are Fellows of the National Academies, and contribute to their activities. There are also Fellows of The

World Academy of Sciences, and Fellows of the Royal Society among TIFR faculty members.

**TIFR Deemed University:**

The first Ph.D. was granted to a TIFR student in 1950 by the then University of Bombay. Until 2002, TIFR admitted students only for the Ph.D. program (except in Biology), and all the degrees were awarded by the University of Mumbai (formerly Bombay).

TIFR became a Deemed University in 2002, and started awarding its own degrees in the six disciplines of Physics, Chemistry, Biology, Mathematics, Computer Science, and Science Education. Each of the disciplines is taken care of the corresponding Subject Board. The overall academic program is governed by the Academic Council, which contains external members for advice and oversight. It is administered by the Dean of Graduate Studies, through the University Cell. TIFR acts as a research institution, with the Deemed University embedded in it.

The major advantage of a Deemed University in a Research Institute setting is that the students are exposed to research right from the first day. The flexibility offered by the structure also allows the instructors to introduce discussions of emerging areas and the topics of their own expertise in the coursework, which keeps the courses relevant and interesting. The admission in the TIFR Graduate School is very competitive, the coursework is very challenging, and the Ph.D. research is at the cutting edge. The students coming out with this training are expected to be “jack of all trades, master of at least one”.

Since the inception of the TIFR Deemed University, thirteen batches of students have been admitted and most of those who have graduated already established themselves in the scientific community, some already holding prestigious faculty positions in India and abroad. The UGC review committee, which visited TIFR and its Research Centres in 2010, has commented very positively on the multidisciplinary environment that TIFR offers its researchers and students, and uniqueness of its campuses / Research Centres.

Over the last decade, TIFR Deemed University also started admitting more students directly after their bachelor’s degrees, to enable some of the brightest Indian students to get an early start in high quality research, for which they would earlier have to go out of the country. This has now developed into formal integrated MSc-PhD programmes.

**TIFR educational activities:**

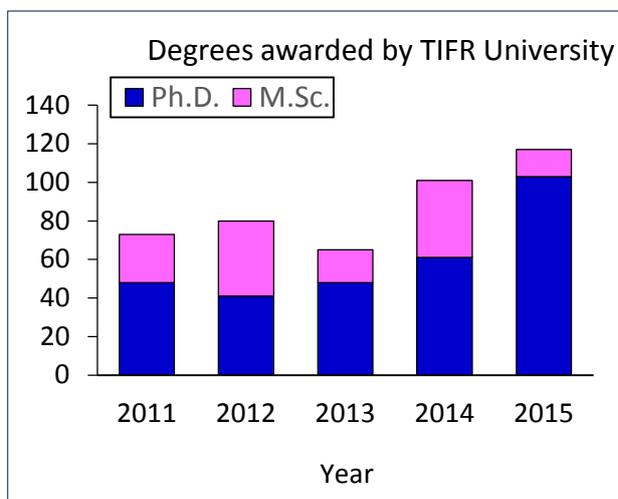
In addition to the activities of its Deemed University, TIFR faculty members continue to participate in educational activities for students and teachers in the country who are not directly connected with TIFR. The Visiting Students' Research Programme was started by TIFR more than 30 years ago. TIFR faculty members have also been involved in teaching in advanced summer schools, and in conducting Teachers' Training programmes. They play a major role in the National Centre for Mathematics (a joint Centre with IIT Bombay), and in the Centre for Excellence in Basic Sciences in the Mumbai University. The Homi Bhabha Centre for Science Education is the Indian nodal agency for all the International Science Olympiads and conducts training camps. It also holds the National Initiative on Undergraduate Science (NIUS), which exposes undergraduate science students from across the country to research at the forefront. It also works on improving science education in schools, by creating teaching materials and textbooks.

The Outreach programme of TIFR attracts school children as well as the public at to science, through interesting activities. These involve Science Café lectures like Chai and Why, Sawaal–Jawaab, etc., night sky observations, Public Lectures, Science Day celebrations and Open House days for school children. Groups of TIFR scientists and students also visit rural areas in Maharashtra with science experiments that have to do with daily life.

**TIFR vision:**

TIFR plans to maintain its focus on fundamental research, and aims to be one of the top institutions in the world for research as well as education. Our major strength in achieving this is our world-class faculty. The high quality of scientific research and scholarship which characterises TIFR is well-known and attracts some of the best young minds in the country. To all its members, TIFR provides a vibrant intellectual atmosphere and encouragement to grow and flourish. Nevertheless, TIFR faces the twin challenges of limited space and resources, as well as the ever-present competition from top-rate foreign institutions. The new campus in Hyderabad, may be expected to ease some of the former and offer opportunities for expansion in newer and more challenging areas. However, TIFR will continue to seek improvement in all aspects to retain its place as one of the leading scientific institutions in India and the world.

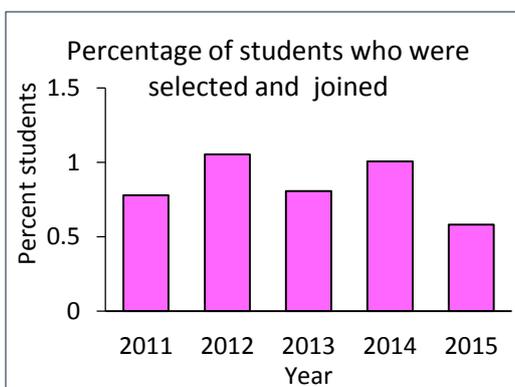
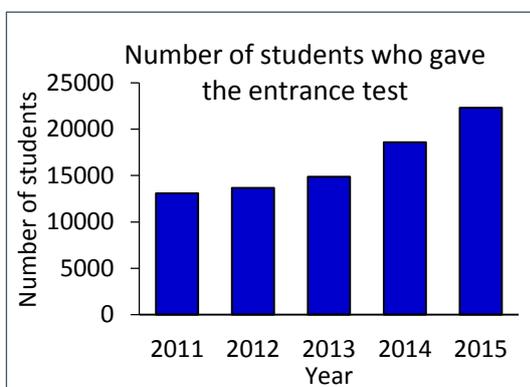
## TIFR: Deemed University and Graduate School



- Deemed University since 2002
- Ph.D., Integrated M.Sc.-Ph.D. and M.Sc. programmes in:
  - Physics
  - Chemistry
  - Biology
  - Wildlife biology
  - Mathematics
  - Computers and Systems Science
  - Science Education

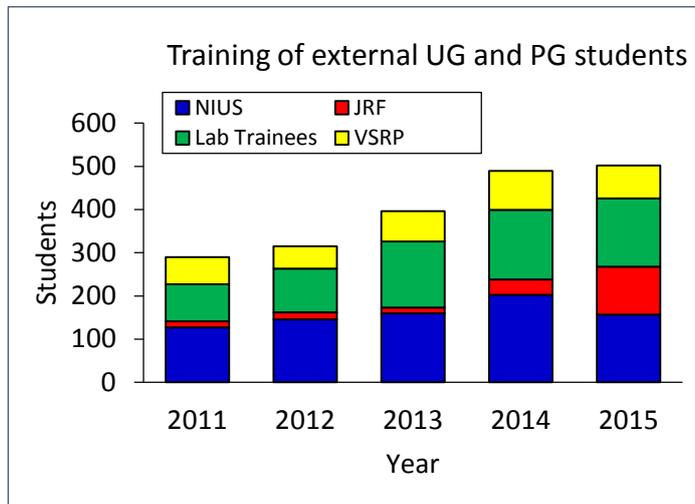
- Courses held in the Main campus in Colaba as well as in Centres in Mumbai, Pune, Bangalore, Hyderabad
- Graduates of TIFR Graduate School in faculty positions at many universities and institutes, in India and abroad

## Nationwide testing at postgraduate level



- One of the most recognized Graduate School Entrance tests in Physics, Chemistry, Biology, Mathematics, Computer Science, and Science Education
- Held simultaneously in more than 25 centres all over India
- Extremely competitive, only about the top 1% get into TIFR
- Joint Entrance Screening Test (JEST) in Physics, started by NCRA-TIFR, now accepted by more than 30 institutions in India for admission to Ph.D. programmes
- Joint Graduate Entrance Examination for Biology and Interdisciplinary Life Sciences (JGEEBILS), organised by TIFR, now used by 12 more institutes in India

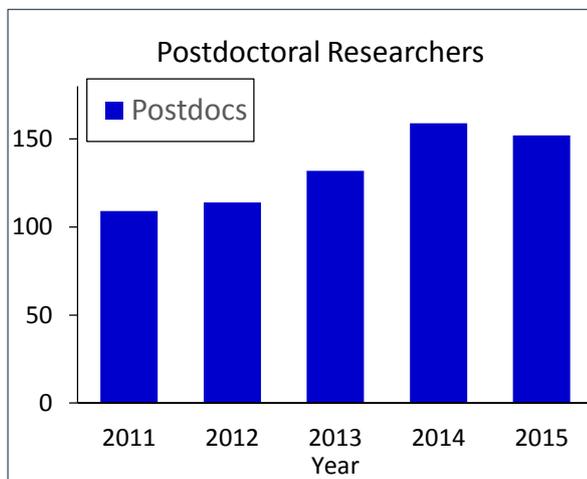
## Training of UG and PG students from other universities and institutes



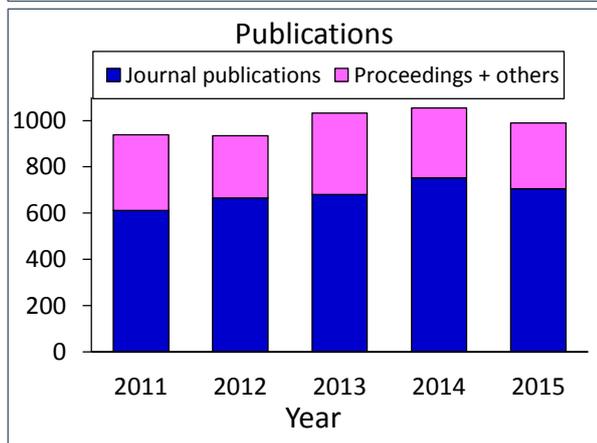
- NIUS: National Initiative on Undergraduate Science
- VSRP: Visiting Students Research Programme (started first in India)
- JRF: Junior Research Fellows registered for Ph.D. elsewhere
- TIFR Faculty members teach regularly at: Centre for Excellence in Basic Sciences (CBS), University of Mumbai SERC Schools (for more than 25 years)

- Running the Graduate Training Program of India-based Neutrino Observatory (INO) for the last 6 years
- Web-based courses (NPTEL) and online video lecture courses

## Preparing future teachers and researchers



- Vibrant postdoctoral programme, duration of 1 to 3 years
- Postdocs from all over the country as well as abroad, some on Prize fellowships
- Many have freedom to work on their own research projects



- Students and postdocs are exposed to cutting-edge research, and are involved in most of the impressive number of publications from TIFR every year

