INTERNAL REVIEW REPORT

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Department of Biochemical Engineering & Biotechnology
IIT Delhi

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Submitted to the

Indian Institute of Technology Delhi
New Delhi

Contents

Vision of the Department

Department of Biochemical Engineering and Biotechnology

Vision of the Department

The past few decades have seen a major, rather revolutionary, change in our knowledge regarding life forms and our ability to manipulate biological systems. This has translated into major strides in *Biotechnology*, with far-reaching impact on diverse areas such as health-care, diagnostics, agriculture, food, environment and consumer products. These biotechnical innovations are meaningless until and unless their benefits percolate down to the common man. This can happen only if such technologies are taken up for industrial scale production.

The Department offers a unique blend of expertise in applied biological sciences, chemical engineering and biochemical engineering. It strives for application of this expertise to evolve various biotechnological products and processes.

It is envisaged that such a **vision** can be achieved through:

- Generation of highly trained human resource capable of quantitative analysis of biological systems to facilitate their role in manning modern bioprocess industries and provide an integrated approach to research and development in biotechnology.
- To continue to evolve research and development programmes for environmentally sustainable bio-industrial products and services e.g., bio-energy, biopolymer, clean environment and therapeutics.
- Leading global innovations in Bioprocess Technology and Applied Biological Sciences, and facilitate participation in industrial consulting and sponsored research.
- Dissemination of knowledge generated through short term courses, workshops and conferences.

Some of the **focal areas of research** of the department are:

- Bioprocess Engineering
- Cell and Molecular Biotechnology
- Downstream Processing
- Systems and Computational Biology

Stronger faculty interactions and collaborations within department are envisaged.

Teaching

- Increased student strength (especially in Ph.D. and M.S(R) programs) is targeted.
- Introduction of new courses bridging biological and engineering sciences is planned.
- Development of 8 semester B.Tech. program and 4 semesters M.Tech programs
- Proposed areas for M.Tech level programs:
    - Biochemical Engineering and Biotechnology
    - Environmental Biotechnology

International Presence

- Transfer of knowledge created in the department through short-term courses, workshops and conferences at national & international levels to society at large.
- Participation in competitions on international platform
- Collaborative research programmes with internationally acclaimed institutes and Universities
- Exchange programmes for students and faculty members with Universities and Institutes of international repute having common mandates

Faculty recruitment

Targeted recruitment (e.g. Bioprocess Engineering, Cell and Molecular Biotechnology, Downstream Processing, Systems and Computational Biology) corresponding to newer proposed programmes. Each area of teaching and research is planned to be strengthened by recruiting faculty in respective areas.

Industrial collaboration

- To carry out research & development for any national industry in the area of biotechnology or pharmaceutical technology.
- To design joint projects with the industry where our students are engaged.

About the Department

Historical leadership of the department

The *Biochemical Engineering Research Centre* (BERC) at IIT Delhi was founded in 1974 by the then unprecedented vision that marrying Biology with Chemical Engineering could dramatically accelerate progress in Biotechnology. The BERC became the *Department of Biochemical Engineering and Biotechnology* (DBEB) effective 1993.

Over the last 39 years, this vision has borne rich dividends:

- The department was the first to develop a technically viable process for bioethanol production, a feat that earned it international visibility. Even today, it harbors the leading Indian researchers in membrane separations (Prof. G. P. Agarwal), enzyme technology (Prof. Subhash Chand), bioprocess technology & plant cell biotechnology (Profs. V. S. Bisaria and A. K. Srivastava), recombinant DNA technology (Prof. Saroj Mishra), biomolecular machines and bionanotechnology (Profs. Sunil Nath and Prashant Mishra), applied biocatalysis (Prof. M.N. Gupta), animal cell technology (Prof. P.K. Roychoudhary) and waste-water treatment (Prof. T. R. Sreekrishnan).
- The department was among the first in the country to secure significant extramural research funding from international agencies.
- Biotechnology departments in virtually all the Indian engineering schools are populated, and in many instances, headed by alumni of our department.
- Numerous technical and business leaders of the global and domestic biotechnology industry received their undergraduate or graduate education in our department.

Today, the department consists of 15 permanent faculty members and 2 Emeritus Professors. The research publications of our Faculty are very significant both qualitatively and quantitatively.

Over the years, the department has pioneered the development of a 5-year dual-degree undergraduate program culminating in B.Tech + M.Tech. degrees and graduate programs leading to M.S. (Research) and PhD degrees. Our interdisciplinary approach, which combines the principles of molecular biology and chemical engineering, has yielded academic recognition and reward. Our students have been admitted to highly ranked academic institutions within the country and abroad, where they have made, and continue to make, significant contribution to biotechnology in academics and industry.

Recent evolution of a new direction in our department

The prescient vision of marrying Biology with Chemical Engineering is now being replicated across the world, but there is a new twist. Rapid advances in molecular biology have made it possible (and perhaps, even essential), to pose key questions of biotechnology at the molecular level, thus making them amenable to the quantitatively rigorous theories of Physics, Chemistry, and Systems Engineering. The recognition of this fact has led to dramatic changes in the organizational structure and curriculum development of leading educational institutions across the world. Major schools of biology have spun off “Departments of *Systems* Biology” to emphasize their focus on attempts to explain cellular and tissue-level phenomena in terms of molecular biology. On the other hand, chemical engineering departments, which focused traditionally on cellular and tissue-level phenomena, have renamed themselves “Department of Chemical and *Biomolecular* Engineering” to highlight the new focus on the molecular level.

In the last 5 years, our department has undergone a similar transformation. We have hired seven new faculty members specializing in the new and emergent areas of Bioinformatics & Genomics (Dr. D. Sundar), Metagenomics (Dr. Shilpi Sharma), Systems Biology (Dr. Atul Narang), RNAi technology & microRNA therapeutics (Dr. Ritu Kulshreshtha), Single-Molecule Dynamics (Dr. Ravikrishnan Elangovan), chromosome maintenance (Dr. Preeti Srivastava) and Waste treatment & bioremediation (Dr. Ziauddin Ahammad). The research programs of all these new faculty members have a common underlying theme, namely, to attack higher-level problems of biotechnology from the molecular standpoint. These faculty members have also infused a fresh perspective to the teaching of biotechnology in our department. We are already offering new courses, such as Bioinformatics and Genomics. Traditional courses, such as Biochemical Reaction Engineering and Bioseparations have been transformed by the inclusion of mathematical theories, such as Nonlinear Dynamics, Bifurcation Theory, and Stochastic Processes. The description of new methodologies such as Metabolic Control Theory, RNAi Technology, Genome Engineering, Metagenomics, Bioprospecting and Synthetic Biology, has been incorporated into Current Topics in Biotechnology. Finally, in order to expose our students to the emerging technologies and issues of the twenty first century, we have embarked on new pedagogical initiatives, such as participation in the international Genetically Engineered Machines competition (iGEM) and the bioethics progam at IIT-D.

The department has actively pursued the recruitment of faculty to ensure cutting-edge research and teaching. We believe that we are ideally positioned to achieve the new synthesis of Biology with the quantitative areas of Physics, Chemistry, and Systems Engineering. First, our department has a long history of interdisciplinary work. Biologists and Chemical Engineers have fruitfully coexisted and collaborated in our department since the 1970's. Second, we are housed in IIT-D, a pre-eminent center of science & engineering in India, thus making it easy to establish cross-departmental and inter-institutional collaborations with other researchers in Physics, Chemistry, Engineering, and Computer Science. Finally, unlike many Biotechnology departments in the country, we have always maintained a strong quantitative slant. In the early years, this slant was toward the field of Process Engineering, but it is now firmly in the direction of Systems Biology.

Faculty members of the Department

Sl.	Name	Research Interests
Professor and Head		
1	Sreekrishnan, T.R.	Waste engineering, Environmental Biotechnology
Professors		
2	Agarwal, G.P.	Bioprocess Engineering, Membrane Based Protein Separation, Bioinformatics, Membranes for Heavy Metal Ions Removal and Waste Treatment
3	Bisaria, V.S.	Enzyme and Metabolic Regulation, Bioconversion, Plant Cell Biotechnology, Microbial Technology
4	Prashant Mishra	Enzyme Science and Engineering, Pharmaceutical Proteins, Bionanotechnology, Drug delivery
5	Roychoudhury, P.K.	Bioprocess Engineering, Cell Culture Engineering
6	Saroj Mishra	Molecular Enzymology and Applications of Hydrolytic Enzymes, Yeast Expression Systems, Enzyme Mediated Bioremediation
7	Srivastava, A.K.	Biochemical Engineering, Modelling, Optimisation and Control of Bioprocesses, Plant Cell Biotechnology
8	Sunil Nath	Bioseparation, Mechanism and Thermodynamics of ATP-based Molecular Machines, Molecular Systems Biology/Engineering
Emeritus Professors		
9	Subhash Chand	Bioprocess Engineering, Enzyme Engineering, Biosensors, Environmental Biotechnology
10	Gupta, M.N.	Applied Biocatalysis
Associate Professor		
11	Atul Narang	Systems Biology of Microbial Gene Regulation
Assistant Professors		
12	Preeti Srivastava	Microbial Genetics
13	Ravikrishnan Elangovan	Single Molecule Biophysics, Fluorescence Spectroscopy, Molecular Motors, Skeletal Muscle Mechanics.
14	Ritu Kulshreshtha	RNAi Technology, MicroRNAs in Cancer Biology, Cancer/Disease Biomarkers, Hypoxia Research
15	Shilpi Sharma	Functional microbial ecology in terrestrial and waste water treatment systems
16	Sundar, D.	Bioinformatics and Genomics
17	Ziauddin Ahammad	Biological waste treatment, Bioremediation of emerging pollutants

Curriculum

Section 1

Executive Summary: Curriculum

The approved **enrollment** in programs has been **48 UG** students, **15 Master's** students, and **90 research scholars**. Of the total credit requirements, **41**% at the UG level and **33**% at the PG level are elective. The Ph.D. program has **20**-credit requirement for students with B.Tech/M.Sc. degree and **6**-credit requirement for students with M. Tech. degree. Of the **24** courses at the UG level, **23**% have been introduced in the last decade. Of the **17** courses at the PG level, **35**% have been introduced in the last decade. The UG class has grown substantially over the past 5 years, and is at the upper limit of what can be sustained by current infrastructure. We recognize that there is a need to increase the number of research scholars. Several new courses were introduced during the curriculum review, which took place in 2003. Some courses have been added during the current curriculum review. We expect to offer more elective courses in the emerging areas with the hiring of new faculty.

1. Curriculum

1.1 List of degree programmes offered - UG + PG - and enrollment.

Level	***Program***	***Current sanctioned strength***
UG	B.Tech in Biochemical Engineering and Biotechnology and M.Tech in Biochemical Engineering and Biotechnology **(Dual Degree)**	48
PG	M.S (Research) in Biochemical Engineering and Biotechnology	15
	PhD in Biochemical Engineering and Biotechnology	90

*(a). Current enrollment for **B.Tech + M.Tech dual degree program***

2007 entry	**2008 entry**	**2009 entry**	**2010 entry**	**2011 entry**	**2012 entry**	**2013 entry**	**Students currently in position**
1	8	32	41	47	42	50	**221**

*(b). Current enrollment for **MS (Research)***

Institute Assistantships				**Total sanctioned Institute Assistantship**	**Students allowed in Other categories** [#]	**Total student sanctioned in all categories**	**Students currently in position**
General	**SC**	**ST**	**OBC**				
8	2	1	4	15	49	64	**12**

[#] Students under Part Time, project & sponsored categories

*(c) Current enrollment for **PhD***

Institute Assistantships												**Total Institute Assistantship (# 54)**			**Students allowed in other categories**	**Total in all categories**			**Students currently in position**
General			**SC**			**ST**			**OBC**										
S	**P**	**V**	**S**	**P**	**V**	**S**	**P**	**V**	**S**	**P**	**V**	**S**	**P**	**V**	[#]	**S**	**P**	**V**	**46**
14	11	3	4	2	2	2	0	2	7	3	4	27	16	11	63	90	**46**	43	

Note:

S = sanctioned P = in position V = vacant
[#] Students with fellowships awarded by CSIR, DBT, DST, ICMR, etc and students under Part Time and sponsored categories

1.2 Consistency of curricula with academic vision of the department.

The department had put together its vision statement in July 2013 and is given in Page 4 of this report.

The following programs that are being offered by the department are commensurate with the vision of the department:

1. *Dual Degree (Bachelor of Technology in Biochemical Engineering and Biotechnology, and Master of Technology in Biochemical Engineering and Biotechnology)*

The Department offers a 5-year integrated dual-degree program for students who have passed class XII and qualified JEE. At the end of 5 years the students receive both B. Tech. and M. Tech. degrees in Biochemical Engineering and Biotechnology. The course curriculum is carefully designed to impart training in Biology courses such as Microbiology, Biochemistry, Bioinformatics, Molecular Biology; Chemical Engineering courses such as Mass and Energy Balance, Fluid Mechanics, Heat and Mass Transfer, Chemical Reaction Engineering and Process Control; and Biochemical Engineering courses such as Bioprocess Engineering, Bioseparation, Downstream Processing, Enzyme Science and Engineering, and Plant Design. Advanced courses in more specific areas such as Animal Cell Culture, Plant Cell Culture, rDNA Technology and Immunology are also available to the students. In addition to courses in these areas the students supplement their departmental studies with courses in other areas such as Computer Science, Management and Humanities. A great emphasis is laid on laboratory courses, which are offered both at UG and PG levels. The students also have an opportunity to gain experience in research through summer and winter projects. This program is partially supported by the Department of Biotechnology (DBT), Government of India and a sum of Rs. 8000/- per month is offered as a stipend to the 5^{th} year students of this program.

2. M.S. (Research)

A four-semester M.S. (Research) program is offered by the department. To enroll in the programme, the students need to qualify the Graduate Apptitude Test in Engineering (GATE) and have an outstanding academic record in their B. Tech. program in Chemical Engineering/ Biochemical Engineering/ Food Technology/ Industrial Biotechnology. This programme has been designed to act as an interface between the Bachelor's program and Ph.D. Under this programme, a project of 2-3 semesters duration is given to the students. There is more emphasis on the research component, which accordingly constitutes a major component of the whole programme. Various fellowships are available for collaborative research with German and Swiss Universities.

3. Ph.D.

The department also offers a Ph.D. in various areas of research being pursued by the faculty. A minimum number of courses are offered to students to prepare them to undertake advanced research in various frontier areas in Biochemical Engineering and Biotechnology. The normal duration of the Ph.D. program is about 4 years. Students with exceptional academic records can apply to the Ph.D. program at any time of the year.

1.3 Quality of programmes:

(a) Periodicity of curriculum review UG and PG.

The Department systematically and periodically reviews the UG and PG curriculum on a regular cycle of approximately 10 years to enhance the effectiveness of the program. Further, our dual degree program is partially supported by the Department of Biotechnology (DBT), Govt of India for 23 years now and there is a regular meeting of DBT Advisory Committee every alternate year to evaluate the teaching program of the department. This Committee consists of faculty members from other teaching institutions, research scientists and industry experts. The documents related to the curriculum review are available in the Departmental Curriculum Committee webpage that is accessible at http://privateweb.iitd.ac.in/~sundar/curriculum/

The Director had recently constituted a *Curriculum Advisory Committee* for the department, consisting of an expert from a sister Academic Institution, an expert from the Industry, an expert from a Research Institution/Laboratory, an alumnus of the department, a Professor from the department and a Professor from related area in another academic unit of the Institute. This Committee met on January 31, 2014 to discuss the revised Course/Credit structure for the dual degree program being offered by the department. This Committee also recommended the change in part of the dual degree seats currently being offered, to a 8-semester B.Tech program proposed by the Department for implementation starting the academic year 2014-2015.

(b) Mechanism for review at UG and PG level.

The Department has a *Curriculum Committee* that meets periodically all through the year to formulate guidelines to enhance the effectiveness of the teaching programs at the UG and PG level. The Committee consists of some departmental faculty members, some of whom are also part of the *Institute Curriculum Review Committee* or the *Institute Curriculum Implementation Committee*.

(c) Coursework for each UG, PG and PhD programme - Core / Elective.

(i). Course work for Dual Degree Program

Programme Code: BB5 / (BB)

***Bachelor of Technology** in **Biochemical Engineering and Biotechnology,** and*
Master of Technology** in **Biochemical Engineering and Biotechnology

Department of Biochemical Engineering and Biotechnology

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	60	DE	20
BS	20	HM	14
EAS	20	OC	35
HU	1		
TOTAL	*101*	*TOTAL*	*69*

Program Core (PC)		Program Elective (PE)	
Category	**Credits**	**Category**	**Credits**
PC	32	PE	16

Total credits = 218

Basic Sciences (BS) Core

CYL120	Inorganic and Organic Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL110	Mathematics - I	3-1-0	**4**
MAL120	Mathematics - II	3-1-0	**4**
PHL110	Fields and Waves	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
CHL110	Transport Phenomena	3-1-0	**4**
CSL101	Introduction to Computers and Programming OR	3-0-2	**4**
CSL102	Introduction to Computer Science	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**13-1-12**	**20**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

BEC450	Colloquium (BB)	0-3-0	**3**
BEL101	Biochemistry	3-1-3	**5.5**
BEL102	Bioprocess Calculations	3-1-0	**4**
BEL103	General Microbiology	3-0-3	**4.5**
BEL204	Molecular Biology and Genetics	3-0-3	**4.5**
BEL301	Bioprocess Engineering	3-0-0	**3**
BEL302	Fluid Solid Systems	3-0-0	**3**
BEL401	Bioprocess Technology	2-0-0	**2**
BEL403	Enzyme Engineering and Technology	3-0-2	**4**
BEN150	Introduction to Biochemical Engineering and Biotechnology	0-0-4	**2**
BEP303	Design of Bioprocesses	0-1-3	**2.5**
BET450	Practical Training (BB)	—	**NC**
CHL101	Introduction to Chemical Engineering Thermodynamics	2-1-0	**3**
CHL103	Chemical Reactor Analysis and Design	3-1-0	**4**
CHL202	Process Systems Analysis and Control	3-1-0	**4**
CHL203	Transport Processes - I	3-1-0	**4**
CHL204	Transport Processes - II	3-1-0	**4**
CHP304	Chemical Engineering Laboratory - I	0-0-3	**1.5**
CHP305	Chemical Engineering Laboratory - II	0-0-3	**1.5**
	TOTAL DC	**37-11-24**	**60**

Departmental Electives (DE)

BED350	Mini Project (BB)	0-0-6	**3**
BEL311	Physical and Chemical Properties of Biomolecules	2-1-0	**3**
BEL312	Carbohydrates and Lipids in Biotechnology	2-1-0	**3**
BEL411	Food Science and Engineering	3-0-0	**3**
BEL412	Immunology	3-0-2	**4**
BEL413	Modelling and Simulation of Bioprocesses	3-0-2	**4**
BEL414	Thermodynamics of Biological Systems	3-0-0	**3**
BEL415	Advanced Bioprocess Control	3-0-0	**3**
BEL416	Membrane Applications in Bioprocessing	3-0-0	**3**
BEL417	Biophysics	3-0-0	**3**
BEL418	Bioinformatics	2-0-2	**3**
BEL419	Enzyme Catalyzed Organic Synthesis	2-0-2	**3**
BEL420	Analytical Methods in Biotechnology	2-0-2	**3**
BEL421	Metabolic Regulation and Engineering	3-0-0	**3**
BEL422	Solid State Cultivation	3-0-0	**3**
BER350	Professional Practices (BB)	0-1-2	**2**
BES350	Independent Study (BB)	0-3-0	**3**
BEV330	Special Module in Biochemical Engineering and Biotechnology	1-0-0	**1**
CHL277	Materials of Construction	3-0-0	**3**
CHL332	Fluidization Engineering	3-1-0	**4**
CHL392	Polymer Science and Engineering	3-1-0	**4**

Program Core (PC)

BEC750	Seminar (BB)	1-0-0	**NC**
BED851	Major Project Part 1 (BB)	0-0-12	**6**
BED852	Major Project Part 2 (BB)	0-0-28	**14**
BED853	Major Project Part 1 (BB)	0-0-8	**4**
BED854	Major Project Part 2 (BB)	0-0-32	**16***
BEL701	Biotechnology Resource Planning and IPR Issues	2-0-0	**2** *
BEL702	Bioprocess Plant Design	3-0-4	**5**
BEL703	Downstream Processing in Biotechnology	3-0-4	**5**
	TOTAL PC	**9-0-48**	**32**

* BED853 and BED854 together are alternatives to BED851 and BED852.

Program Electives (PE)

BEL711	Recombinant DNA Technology	2-0-4	**4**
BEL712	Plant Cell Technology	2-0-2	**3**
BEL713	Microbial Engineering	3-0-0	**3**
BEL714	Protein Science and Engineering	3-0-0	**3**
BEL715	Biological Waste Treatment	3-0-2	**4**
BEL716	High Resolution Methods in Biotechnology	2-0-2	**3**
BEL717	Animal Cell Technology	3-0-2	**4**
BEL718	Combinatorial Biotechnology	3-0-0	**3**
BEL719	Current Topics in Biochemical Engineering and Biotechnology	3-0-0	**3**
BEL720	Biotechnology in Food Processing	3-0-0	**3**
BEL721	Bionanotechnology	3-0-0	**3**
BEL722	Genomics and Proteomics	3-0-0	**3**
BEL723	Data Analysis for DNA Microarrays	3-0-2	**4**
BEL724	Advanced Biochemistry	3-0-0	**3**

Note:

a) The above Course/Credit structure is applicable for students who have joined in the dual degree program until the year 2012.

b) The curriculum has been revised for the students joining from the year 2013 onwards and the credit structure along with the courses are given in the next section.

(ii). Course structure for the proposed B.Tech Program and the revised curriculum for the dual degree program for implementation under the new curriculum 2013-2014

B.Tech in Biochemical Engineering and Biotechnology

Course Category	Credits
Basic Sciences (BS)	22
Engineering Arts and Science (EAS)	18
Humanities and Social Sciences (HuSS)	15
Department linked EAS	11
Departmental Core	69
Departmental Electives	10
Open Category	10
Total Graded Credit requirement	**155**
+ Non Graded Credits	15

Dual Degree (B.Tech + M.Tech) in Biochemical Engineering and Biotechnology

Component	Course Category	Credits
B.Tech	Basic Sciences (BS)	22
	Engineering Arts and Science (EAS)	18
	Humanities and Social Sciences (HuSS)	15
	Department linked EAS	11
	Departmental Core	66 *
	Departmental Electives	10
	Open Category	10
	Total Graded Credit requirement (B.Tech part)	**152 ***
	+ Non Graded Credits	15
M.Tech	Program Core	32
	Program Electives	16
	Total Graded Credit requirement (M.Tech part)	**48**
Total Graded Credit requirement (for the dual degree - B.Tech + M.Tech)		**200**

* Those students who join the dual degree program from JEE or those who choose to pursue a M.Tech degree along with their B.Tech program, will not be required to do the BTP Project of 3 credits as part of the Departmental core requirement.

Courses for the proposed B.Tech and dual degree programs for implementation under the new curriculum 2013-2014

Courses under department linked EAS

Sl.	Category	Course Number	Course Title	L-T- P Structure			Credits
				L	T	P	
1	EAS	AML120	Introduction to Material Science and Engineering	3	0	2	4
2	EAS	CHL110	Transport Phenomena	3	1	0	4
3	BS	MAL235	Differential Equations	3	0	0	3
Sub Total							**11**

Departmental Core Courses

	Old Course Number	New Course Number	Course Title / Revised Course Title	L - T - P Structure			Credits
				L	T	P	
1		BED411	Major Project Part 1 (BB1)	0	0	6	3
2	BEL101	BEL131	Principles of Biochemistry	3	0	3	4.5
3	BEL102	BEL132	Mass and Energy Balances in Biochemical Engineering	3	0	0	3
4	BEL103	BEL133	General Microbiology	3	0	3	4.5
5	BEL401	BEL135	Bioprocess Technology	2	0	0	2
6	BEL301	BEL331	Bioprocess Engineering	3	0	0	3
7	BEL302	BEL332	Fluid Solid Systems	2	0	0	2
8	BEL403	BEL334	Enzyme Science & Engineering	3	0	2	4
9	BEL204	BEL336	Molecular Biology and Genetics	3	0	3	4.5
10	BEL418	BEL431	Bioinformatics	2	0	2	3
11	BEL702	BEL731	Bioprocess Plant Design	3	0	2	4
12	BEL703	BEL733	Bioseparation Engineering	3	0	3	4.5
13	BEL711	BEL735	Recombinant DNA Technology	2	0	3	3.5
14	BEP303	BEP333	Bioprocess Engineering Laboratory	0	0	3	1.5
15	New Course	CHL	Heat Transfer for Chemical Engineers	3	1	0	4
16	New Course	CHL	Mass Transfer	3	0	0	3
17	New Course	CHL	Chemical Engineering Laboratory - I	0	0	3	1.5
18	New Course	CHL	Chemical Engineering Laboratory - II	0	0	3	1.5
19	CHL122	CHL	Chemical Reaction Engineering (CRE) - I	3	1	0	4
20	CHL231	CHL	Fluid Mechanics for Chemical Engineers	3	1	0	4
21	CHL261	CHL	Process Dynamics and Control	3	1	0	4
GRAND TOTAL of Departmental Core							**69**

Departmental Elective Courses

	Old Course Number	New Course Number	Course Title / Revised Course Title	L - T - P Structure			Credits
				L	T	P	
1	BED350	BED350	Mini Project (BB)	0	0	6	3
2		BED412	Major Project Part 2 (BB1)	0	0	16	8
3	BEL311	BEL340	Physical and Chemical Properties of Biomolecules	2	1	0	3
4	BEL312	BEL341	Carbohydrates and Lipids in Biotechnology	2	1	0	3
5	BEL411	BEL440	Food Science and Engineering	3	0	0	3
6	BEL412	BEL441	Immunology	3	0	2	4
7	BEL413	BEL442	Modeling and Simulation of Bioprocesses	3	0	2	4
8	BEL415	BEL443	Advanced Bioprocess Control	3	0	0	3
9	BEL416	BEL444	Membrane Applications in Bioprocessing	3	0	0	3
10	BEL417	BEL445	Biophysics	3	0	0	3
11	BEL419	BEL446	Enzyme Catalyzed Organic Synthesis	2	0	2	3
12	New Course	BEL447	Environmental Biotechnology	3	0	0	3
13	BER350	BER350	Professional Practices (BB)	0	1	2	2
14	BES350	BES350	Independent Study (BB)	0	3	0	3
15	BEV330	BEV330	Special Module in Biochemical Engineering and Biotechnology	1	0	0	1
16	CHL277	CHL	Materials of Construction	3	0	0	3
17	CHL332	CHL	Fluidization Engineering	3	1	0	4
18	CHL392	CHL	Polymer Science and Engineering	3	1	0	4

Program Core Courses

	Old Course Number	New Course Number	Course Title / Revised Course Title	L - T - P Structure			Credits
				L	T	P	
1	BEL421	BEL732	Metabolic Regulation and Engineering	3	0	0	3
2	BEL722	BEL734	Genomics and Proteomics	2	0	2	3
3	BEL713	BEL737	Dynamics of microbial systems	3	0	0	3
4	BEL420	BEL739	Instrumentation and Analytical Methods in Bioengineering	2	0	2	3
5	BED851	BED851	Major Project Part 1 (BB5)	0	0	12	6
6	BED852	BED852	Major Project Part 2 (BB5)	0	0	28	14
7	BED853	BED853	Major Project Part 1 (BB5)	0	0	8	4
8	BED854	BED854	Major Project Part 2 (BB5)	0	0	32	16
9			Seminar	1	0	0	NC
GRAND TOTAL of Program Core							**32**

* BED853 and BED854 together are alternatives to BED851 and BED852

Program Elective Courses

	Old Course Number	New Course Number	Course Title / Revised Course Title	L - T - P Structure			Credits
				L	T	P	
1	BEL712	BEL740	Plant Cell Technology	2	0	2	3
2	BEL714	BEL741	Protein Science and Engineering	3	0	0	3
3	BEL715	BEL742	Biological Waste Treatment	3	0	2	4
4	BEL716	BEL743	High Resolution Methods in Biotechnology	2	0	2	3
5	BEL717	BEL744	Animal Cell Technology	3	0	2	4
6	BEL718	BEL745	Combinatorial Biotechnology	3	0	0	3
7	BEL719	BEL746	Current Topics in Biochemical Engineering and Biotechnology	3	0	0	3
8	BEL721	BEL747	Bionanotechnology	3	0	0	3
9	BEL723	BEL748	Data Analysis for DNA Microarrays	3	0	2	4
10	New Course	BEL749	Cancer Cell Biology	3	0	3	4.5
11	New Course	BEL750	Genome Engineering	2	0	2	3

*(iii). Course structure for the **MS (Research) program***

The M.S. (Research) program comprises of 20 credits of course work and 40 credits of research work. The larger project component gives the student an opportunity to conduct in-depth investigation on a topic of his/her interest. The project is monitored by the Student Research Committee (SRC) and the student will have to register for thesis (Project course no. BED800) for 40 credits. An "X" grade is awarded at the end of each semester until the project work gets completed and the thesis is written. Normally, the M.S.(Research) programme is expected to take 4 semesters (excluding summer). Upon completion of project work, a thesis is written that is evaluated by one internal and one external examiner. Upon satisfactory recommendations from the examiners, the thesis defence can be conducted before a committee. Conversion to Ph.D. program is also possible.

Core Courses

All the MS (Research) students are required to take the Core courses listed below:

BEL810 - Enzyme and Microbial Technology
BEL820 - Downstream Processing
BEL830 - Microbial Biochemistry
BEP840 - Laboratory Techniques in Microbial Biochemistry
BEL850 - Advanced Biochemical Engineering
BEL800 - Major Project

Registration Limit: In the first semester, the student has to register for a minimum of 15 and a maximum of 20 credits of course work only. In the subsequent 3-semesters, the student shall complete the research work and the course work remaining, if any.

*(iv). Course structure for the **PhD program***

Course requirements

The candidates who are admitted to the PhD program in the department and having a B.Tech/M.Sc degree, are required to complete a minimum of 20 credits. The M.Tech or equivalent degree holders are required to complete a minimum of 6 credits.

Courses for the PG students

The course requirement will be determined by the DRC on the recommendations of the supervisor after due consideration of the background of the student in relation to the proposed topic of research. These courses are prescribed from the existing advanced PG courses including a laboratory course given below:

BEL810 - Enzyme and Microbial Technology
BEL820 - Downstream Processing
BEL830 - Microbial Biochemistry
BEP840 - Laboratory Techniques in Microbial Biochemistry
BEL850 - Advanced Biochemical Engineering
HUL810 - Communication Skills (Audit)

In general, students with biology/biotechnology (M.Sc) background are advised to take BEL810, BEL820 and BEL850 courses, and students with engineering background (B.Tech/M.Tech) are advised to take BEL830 and BEP840.

Course No. DTD899 (Doctoral Thesis)

All PhD students have to compulsorily register for this course DTD899 (Doctoral Thesis) at the time of registration/renewal of registration for the PhD research work until they submit the thesis. At the end of each semester, the PhD students are required to submit their Progress Report. An 'X' grade will be awarded if the progress is satisfactory and 'U' grade will be awarded for unsatisfactory progress.

Oral and Written Comprehensive Exam

The full-time/part-time PhD student will be required to complete the comprehensive examination and approval of research plan within 18 and 24 months from the date of their joining respectively.

Written Comprehensive Exam Format

The written examination will consists of two papers - Paper 1 and Paper 2.

Paper 1 will consist of two sub-sections, namely, *Fundamentals of Biochemical Engineering (Part A)* and *Principles of Microbiology and Biochemistry (Part B)*. All the students will be required to attempt questions in both these sub-sections.

Paper 2 will consist of two sub-sections, namely, *Biochemical Engineering* and *Advanced Biochemistry & Molecular Biology*. Students are required to attempt only ONE of these sub-sections. Students wih background in Biology may wish to choose *Advanced Biochemistry & Molecular Biology*, while those with a background in Biochemical Engineering/Chemical Engineering/Biotechnology may wish to choose *Biochemical Engineering*. The choice is left entirely to the student, the only restriction being that one must choose one and only one sub section.

Question Paper Pattern -

- Paper - 1 (50 marks from each sub-section = total 100 marks) - Six questions from each section (worth 60 marks) is given; so students have one choice in each sub-section
- Paper - 2 (100 marks) - Questions worth 120 marks (12 questions of 10 marks each) is given; so students have two choices
- Both Paper 1 and Paper 2 are of three hours duration.

To pass in the written comprehensive exam, a student must secure -

- an overall minimum of 50% out of 200 total marks in both the Papers &
- a minimum of 40% in each Paper &
- a minimum of 30% in each sub-section of Paper 1.

(d) Pre PhD courses offered (*in last 5 yrs*).

There are no separate pre-PhD courses offered by the Department. However, as described on page 20, a set of 800-level courses are offered by the department that are designated as advanced PG courses and the MSR/PhD students are advised to take the courses for completion of their required course work.

(e) New advanced Masters / Pre-PhD courses introduced in last 5 yrs.

The department has not introduced any specific pre-PhD course in the last five years. However, several new program electives have been introduced in the past and some new electives are also proposed in the new curriculum revision.

(f) Overlap between courses (c) and (d) & (e), including opening latter to UG.

The department offers 700-800 level courses that are core and elective courses for the PG programs. Usually, 800 level courses are advanced courses for MSR and PhD students, while the 700 level courses are also open to the dual degree students and this is enforced through a requirement of minimum number of earned credits.

(g) Seminar series (weekly/regular) held each semester (*provide list*).

List of Seminar Speakers who visited the department during 2009-2013 are provided in the table below:

	Visitor	Date	Lecture/Seminar Topic
1	Dr. Hameed Khan, National Institutes of Health (NIH), USA	06 October 2009	The impact of genetic revolution on our lives during 21st century and beyond
2	Prof. Ariel Ruiz i Altaba, Department of Genetic Medicine and Development, University of Geneva Medical School, Geneva, Switzerland.	11 January 2010	Role of Hedgehog-GLI signaling in stem cells, cancer and cancer stem cells
3	Prof. Saurabh Raghuvanshi, Department of Plant Molecular Biology, University of Delhi South Campus, New Delhi.	20 January 2010	Whole genome annotation strategies: Recent trends
4	Dr. Stefan Klumpp, Max Planck Institute of Colloids and Interfaces, Potsdam-Golm, Germany.	28 January 2010	Growth rate-dependent global effects on gene expression in bacteria
5	Dr. Alok Krishna Sinha, National Institute of Plant Genome Research (NIPGR), New Delhi.	23 February 2010	Mitogen-activated protein kinase cascade in rice: a point of signal integration and distribution
6	Dr. R. Uma Shaanker, University of Agricultural Sciences, GKVK, Bangalore.	18 March 2010	Bioprospecting in the Western Ghats: flavour, promises and challenges
7	Prof. Ron APPEL, Executive Director, Swiss Institute of Bioinformatics (SIB), Basel	26 October 2010	Swiss Institute of Bioinformatics (SIB)
8	Prof. Thomas KAPPLER, Swiss-Prot Group, Institute of Bioinformatics (SIB), Basel	26 October 2010	A glimpse of Swiss-Prot
9	Prof. Torsten SCHWEDE, SIB Group Leader, Protein Structure Bioinformatics - University of Basel - Biozentrum	26 October 2010	Protein modeling/Swiss Model
10	Prof. Andreas Wagner, Evolutionary Systems Biology, University of Zurich	26 October 2010	The origin of evolutionary innovations
11	Prof. Alok Bhattacharya, School of Life Sciences, Jawaharlal Nehru University (JNU), New Delhi	26 October 2010	Comparative genomics and patterns in genome evolution
12	Prof. S. Ramakumar, Indian Institute of Science (IISc), Bangalore	26 October 2010	Design of molecules that inhibit amyloid formation. Insights from computational analysis of beta-sheets in proteins.
13	Dr. Dinesh Gupta, International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi	26 October 2010	Machine learning in bioinformatics
14	Prof. Pinak Chakrabarti, Bose Institute, Kolkata	26 October 2010	Protein-protein interactions – structural features, residue conservation and energy contribution, and location of the

			binding site
15	Prof. Rajiv Bhat, School of Biotechnology, Jawaharlal Nehru University (JNU), New Delhi	26 October 2010	Understanding solvent effects on the stability, folding and aggregation of proteins
16	Prof. Sven BERGMANN, SIB Group Leader, Computational Biology - University of Lausanne	27 October 2010	A modular approach for integrative analysis of large-scale gene expression and drug-response data
17	Prof. Philipp BUCHER, SIB Group Leader, Computational Cancer Genomics, Institute of Bioinformatics (SIB), Basel	27 October 2010	What ChIP-Seq data tell us about gene regulation?
18	Prof. Conradin KRAEMER, Department of Biosystems Science and Engineering - Federal Institute of Technology Zurich (ETHZ)	27 October 2010	Vertebrate limb bud development - Towards a comprehensive, spatio-temporal mathematical model of organogenesis
19	Prof. P. Balaji, School of Biosciences and Bioengineering, IIT Bombay	27 October 2010	Identification of the glycosylation loci in prokaryotic genomes by comparative genomics approach
20	Dr. G. Narahari Sastry, Indian Institute of Chemical Technology (IICT), Hyderabad	27 October 2010	On the issue of subtype selectivity in drug design
21	Dr. Vinod Scaria, Institute of Genomics & Integrative Biology (IGIB), New Delhi, India	27 October 2010	Non-coding RNAs in host-pathogen interactions
22	Prof. Patrick Ruch, HEG – Haute Ecole de Gestion de Genève/University of Applied Sciences – Information Science Department	27 October 2010	Towards automatic text-driven biocuration for functional genomics
23	Prof. R. Sankararamakrishnan, Department of Biosciences and Bioengineering, IIT Kanpur, India	27 October 2010	From microbial to mammalian aquaporins: sequence analysis to simulations
24	Dr. Debasisa Mohany, National Institute of Immunology (NII), New Delhi	27 October 2010	In silico approaches for discovery of novel secondary metabolites by genome mining
25	Dr. Alok Krishna Sinha, National Institute of Plant Genome Research (NIPGR), New Delhi.	12 November 2010	Metabolic engineering towards better understanding of monoterpenoid indole alkaloid (MIA) pathway in Catharanthus roseus
26	Dr. Saurabh Chattopadhyay, Lerner Research Institute, Cleveland Clinic, Cleveland, Ohio, USA	24 November 2010	A New Pathway for Cellular Antiviral Response
27	Dr. Mahak Sharma, Harvard Medical School / Brigham and Womens Hospital, Boston, USA	03 December 2010	Multiple roles of an Arf-like Small G Protein, Arl8b, at the lysosomes
28	Dr. Zakir Thomas, Project Director - Open Source Drug Discovery (OSDD), CSIR, New Delhi.	07 January 2011	Open Source Drug Discovery - OSDD
29	Dr. Anshu Bhardwaj, Institute of Genomics & Integrative Biology (IGIB), New Delhi.	07 January 2011	Open Source Drug Discovery - OSDD

30	Dr. Deva Priyakumar, Centre for Computational Natural Sciences and Bioinformatics, International Institute of Information Technology (IIIT), Hyderabad.	28 January 2011	On the Stability of Proteins and DNA in Hyperthermophiles
31	Dr. Gaurav Pandey, Process Development, Malaria Vaccine Development Program, New Delhi.	21 February 2011	Overview of Vaccine Development Path
32	Dr. Sudip Mondal, National Centre for Biological Sciences (NCBS), Tata Institute of Fundamental Research (TIFR), Bangalore.	09 March 2011	Lab-on-chip technology for biological applications: genetic material to whole organism
33	Prof. Anton Hartmann, Head, Department of Microbe-Plant Interactions, German Research Center for Environmental Health, Neuherberg, Germany.	25 March 2011	Interkingdom signaling of bacterial quorum sensing compounds
34	Dr. Dhiraj Kumar, International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi.	04 April 2011	Biological systems as complex systems: realization and implications
35	Dr. Ipsita Roy, School of Life Sciences, University of Westminster, London, UK.	24 August 2011	Natural polymers of bacterial origin and their medical applications
36	Mr. Deepesh Agarwal, Computational Structural Biology Group, National Institute for Research in Computer Science and Control (INRIA), Sophia Antipolis, France.	22 September 2011	Spatio-temporal modeling of Bacterial Chemotaxis pathway
37	Prof. John Villadsen, Department of Chemical and Biochemical Engineering, Technical University of Denmark.	08 November 2011	Industrial Bioreactors: New ideas to improve mass transfer and mixing
38	Dr. Rikke Festersen, Head of R&D, Novozymes, Bangalore.	16 December 2011	Introduction to Global Novozymes and Novozymes India
39	Dr. Torben Vedel Borchert, Senior Director, Novozymes, Copenhagen.	16 December 2011	Protein Optimization
40	Prof. Andreas Stolz, Institute of Microbiology, University of Stuttgart, Germany	09 January 2012	Construction of recombinant whole cell catalysts expressing a bacterial nitrilase for the enantioselective synthesis of carboxylic acids and carboxamides
41	Prof. Naresh Magan, Senior Research Director and Head - Applied Mycology Group, Cranfield University, Bedford, UK	19 January 2012	Secondary metabolites and volatiles from fungi: ecophysiology of production, quantification, detection and discrimination using sensor arrays
42	Prof. David W. Graham, School of Civil Engineering and Geosciences, Newcastle University, Newcastle upon Tyne, UK	01 February 2012	Environmental pollution, antibiotics and antibiotic resistance
43	Consultants from Wikimedia Foundation, India	09 February 2012	Wikimedia workshop

44	Prof. Wei-Shou Hu, Department of Chemical Engineering and Materials Science, University of Minnesota, USA	22 February 2012	Reaction Engineering Classics in Systems Biotechnology
45	Dr. Russell Davenport, Newcastle University, UK	29 March 2012	Next Generation Sequencing and Data Analysis for Microbial Applications
46	Dr. Matthew Wade, Newcastle University, UK	30 March 2012	Next Generation Sequencing and Data Analysis for Microbial Applications
47	Dr. Shivaji Ganesan Ramalingam, Ecole des Mines de Nantes, France	27 July 2012	Industrial Research for the commercialization of biogas production and upgrading
48	Dr. A. Krishnamachari, Centre for Computational Biology and Bioinformatics, Jawaharlal Nehru University, New Delhi	22 October 2012	Biological Sequence Analysis
49	Dr. Dinesh Gupta, International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi	22 October 2012	European Molecular Biology Open Software Suite
50	Dr. Gitanjali Yadav, National Institute of Plant Genome and Research (NIPGR), New Delhi	22 October 2012	Network Theory and its Application to Biology
51	Prof. Saurabh Raghuvanshi, Department of Plant Molecular Biology, University of Delhi South Campus, New Delhi.	22 October 2012	Computational aspects of whole genome sequencing & annotation
52	Dr. Andrew Lynn, Centre for Computational Biology and Bioinformatics, Jawaharlal Nehru University, New Delhi	23 October 2012	Open Source Drug Discovery - OSDD
53	Dr. Abhinav Grover, School of Biotechnology, Jawaharlal Nehru University, New Delhi	23 October 2012	Molecular modeling and simulation in drug discovery
54	Dr. Kanika Bajaj, Department of Molecular and Cell Biology, University of California at Berkeley, USA	04 December 2012	Understanding determinants of protein trafficking: A new perspective on COPII vesicular transport
55	Dr. Deepak Dugar, MIT, USA	07 January 2013	Fuels and Chemicals: Past, Present and “Future?”
56	Dr. Karin Pritsch, German Research Center for Environmental Health, Neuherberg, Germany	08 January 2013	Functional plasticity in ectomycorrhizal systems
57	Mrs. Sonia Vergis Khatri and Dr. Garima Chawla, Life sciences Business Analytics	09 April 2013	Competitive Intelligence: Need for Biopharmaceutical Industry
58	Dr. Jean-Numa Gillet, Visiting Professor, Centre for Computational Biology and Bioinformatics, Jawaharlal Nehru University, New Delhi	29 July 2013	Ab Initio Models for Lipid Mixtures and Misfolded Proteins
59	Dr. Arun Shukla, Division of Cardiology at the Department of Medicine, Duke University Medical Center, North Carolina, USA.	05 August 2013	Structural basis of β-arrestin dependent regulation and signaling of G Protein-Coupled Receptors

60	Gautam V. Soni, Kavli Institute of NanoScience, Dept. of Bionanoscience, TU Delft, The Netherlands	12 August 2013	Nanopore Biophysics: From Gene Sequencing to Gene Silencing

(h) Placement details.

Placement details : On Campus (Years 2010 – 2013) #, $

Program Type	Program Name	No. of graduating students	No. of core companies that asked for program by name	Number of students selected in core companies	Number of non-core companies that recruited students	Number of students placed in non-core companies	Number of students not placed at graduation time
Dual Degree	B.Tech/M.Tech in Biochemical Engineering and Biotechnology	103	2	4	4	65	34
MSR	Master of Science (Research) in Biochemical Engineering and Biotechnology	10	2	3	3	3	4

Data obtained from the Institute's *Training and Placement Cell*

$ The above data does not include the students who opted for higher studies or sought a job on their own. A partial list of graduated dual degree students who joined in the PhD program is given under Section 5.13 on page 91.

List of Core companies for Dual Degree Program

Sl.	Company Name	No. of students recruited
1	Novartis Vaccines & Diagnostics Limited	3
2	Wockhardt Biotech Park	1
Total		**4**

List of Non-Core companies for Dual Degree Program

Sl.	Company Name	No. of students recruited
1	American Express India Pvt. Limited	1
2	Bain and Company	2
3	Bank of India	1
4	Barclays shared Services Pvt. Ltd (BSS)	1
5	Booz & Company	1
6	Citibank	1
7	Citicorp Services India Ltd	1
8	Deloitte Consulting	4
9	DeNA Co. Ltd.	1

10	Deutsche Bank	1
11	Deutsche Bank Global Markets Centre, Mumbai	1
12	Diamond Management and Technology Consultants	2
13	ESSEX Lake Group LLC	2
14	Estee Advisors Private Limited	1
15	Evalueserve	3
16	EXL Service	1
17	Flipkart Online Services (P) Ltd.,	3
18	Fractal Analytics Ltd	1
19	Futures First Info Services Pvt. Ltd.	3
20	Grail Research India Pvt. Ltd.	1
21	IBM India Pvt. Ltd.	1
22	K L University (Koneru Lakshmaiah Education Foundation)	1
23	Kinapse India Scientific Services Pvt.	8
24	KPMG IT Advisory Services	2
25	M H Alshaya Co. W.L.L.	1
26	MarketRx, a Cognizant Company	4
27	McKinsey & Company, Inc.	2
28	MGH World	1
29	Nagarro Software Pvt Ltd	1
30	Opera Solutions	2
31	Polaris Software Lab Limited	1
32	RBS Business Services	2
33	Schlumberger Asia Services Limited	1
34	The Boston Consulting Group(India) Private Limited (B.C.G.)	1
35	Trident Group- Abhishek Industries Limited	1
36	Verity Knowledge Solutions Pvt Ltd	1
37	Zinnov	1
38	ZS Associates India Private Limited	2
Total		**65**

List of Core companies for MSR Program

Sl.	**Company Name**	**No. of students recruited**
1	Biocon	2
2	Tata Consultancy Services (Bioinformatics Division)	1
Total		**3**

List of Non-Core companies for MSR Program

Sl.	**Company Name**	**No. of students recruited**
1	K L University	1
2	Polaris Software Lab Limited	1
3	Educational Initiatives Pvt Ltd.	1
Total		**3**

(i) Relevance of UG and programmes to recruiters, potential and on-campus recruiters.

The very few Biotech companies that have recruited our students consider CGPA for the initial short-listing of candidates and have their own mechanism for the final selection. Our interdisciplinary training and curriculum appears to be of direct relevance to these Biotech companies that have come for campus recruitment.

A large number of our students choose to join in non-core companies. The reason for this could be that the starting salary in non-core companies is much higher when compared to the meager compensation that a biotech company may offer. The other reason could the availability of jobs in the core Biotech sector in the country.

No formal survey data on testing the relevance of our curriculum to the potential recruiter is available.

(j) Benchmarking of curriculum.

The benchmarking of curriculum, research and teaching were carried out based on the following parameters are given under Section 8 on page 147:

for curriculum	for Research	For Teaching
(a). Total Credit Requirement (a). Core Credits (b). Elective credits (c). Core credit as % of total credits (d). Number of theory courses in core curriculum (e). Comparison of core courses across the institution (f). Number and nature of laboratories (g). Thesis requirement (h). Important differences with the peers	(a). No of Masters and PhD students supported (b). No of PhD (per faculty) (c). Research Area (d). Avg Publication per faculty (last 5 yrs) (e). Publications (Journal) (f). Avg. citation of the dept (total citation since 2009)/total faculty (g). Number of sponsored projects (h). Number of consultancies (i). Number of large interdisciplinary projects	(a). Student- Teacher ratio (b). Student – TA Ratio (c). No of Lab Technicians (d). Gross Lab Space for UG/PG teaching

Teaching Environment

Executive Summary: Teaching Environment

The average **class size** is **48** for UG courses and is **40** for PG courses. The average **contact hour** of the faculty is **5** hrs per week of UG teaching, and **2** hrs per week of PG teaching. The **laboratories** have been modernised with **~20**% of experiments in UG and **~30**% of experiments in PG being revamped in the last decade. The teaching load has increased over the past five years. We are developing a viable TA support system to conduct laboratory classes. We expect the teaching labs to be modernised substantially in the next few years with the progressive hiring of new faculty and the increased availability of new elective courses.

2. Teaching environment

2.1 Student-Teacher ratio separately and total for UG, PG, PhD (based *on gross numbers and on class size basis*)

Student-Teacher ratio in *Lecture* courses *

Programs	2008	2009	2010	2011	2012
UG & PG	27	29	33	37	34

Average number of student per faculty in a *Project* course *

Program	2008	2009	2010	2011	2012
B.Tech/M.Tech Dual Degree	1.53	1.64	1.29	1.35	1.76

* Data from ERP Academic System for the years 2008 - 2013 (https://campus1.iitd.ac.in/hcmprod1/signon.html)

2.2 No. of students graduated in each programme, incl. PhD, (*data for 5 yrs*)

Program	2008	2009	2010	2011	2012	2013	Total
B.Tech/M.Tech Dual Degree	26	28	22	23	30	28	**157**
MS (Research)	3	-	-	-	6	4	**13**
PhD	4	10	3	5	2	3	**27**

2.3 Student-T.A. (or student-hours/T.A.) ratio

The student-TA ratio varies across the departmental courses. Typically, it is 30 students/TA in a lecture course and 15 students/TA in a laboratory course.

2.4 No. of skilled technical staff

Sl.	Employee Code	Name of the Employee	Designation
1	26150	Mr. Bhagwan Singh	Technical Superintendent
2	26155	Ms. Renu Sethi	Technical Superintendent
3	26156	Mr. Mukesh Anand	Technical Superintendent
4	25713	Mr. Sant Ram	Junior Technical Superintendent
5	26207	Mr. Shanti Prakash Rana	Junior Technical Superintendent
6	26646	Mr. Rajeev Kumar Dahiya	Junior Technical Superintendent
7	26813	Mr. Sumeet Kapoor	Junior Technical Superintendent
8	26214	Mr. Kishan Chand	Senior Laboratory Assistant
9	26927	Mr. Anish Raju	Junior Laboratory Assistant

2.5 Gross laboratory space; break-up of lab space for core UG / PG teaching

Total space occupied by the department:

	In square feet
Faculty Space	3,571
Research Labs	16,263
Teaching Labs	3,347
Utility Space	3,450
Pilot Plant	4,800
Total Space	**31,431**

Teaching Labs

S.No.	Name of the laboratory	Room No.	Total area	In square feet
1	M.Tech Laboratory	Block I (Rooms 321-324)	32 × 29	928
2	Biochemical Laboratory	Block I (Rooms 33)	25 × 25	625
3	Bioscience Laboratory II	Block I (Rooms 130-A)	32 × 24	768
4	BTIS - Bioinformatics	I-233 A-B	38 × 27	1,026
			Total	**3,347**

Faculty Offices

S.No.	Name	Rooms No.	Total area	In square feet
1	Prof. Sunil Nath	Block I, Room 124	17 × 12	204
2	Prof. G.P. Agarwal	Block I, Room 126	17 × 12	204
3-6	Dr. Ritu Kulshreshtha Dr. Ziauddin Ahammad Prof. T.R. Sreekrishnan Prof. P.K. Roychoudhary	Block I, Rooms 134-138	55 × 12	660
7-10	Dr. Preeti Srivastava Dr. Shilpi Sharma Prof. Saroj Mishra Prof. V. S. Bisaria	Block I, Rooms 139-145	66 × 12	792
11	Dr. D. Sundar	Block I, Room 228	12 × 10	120
12	Prof. A.K. Srivastava	Block I, Room 229	16 × 22	352
13	Dr. E. Ravikrishnan	Block I, Rooms 327-328	21 × 12	252
14	Prof. Prashant Mishra	Block I, Rooms 331-332	21 × 18	378
15	Dr. Atul Narang	Block I, Room 333	15 × 15	225
16	Faculty Office - 1	Block I, Room 133	12 × 8	96
17	Faculty Office - 2	Block I, Room 137	12 × 8	96
18	Visiting Faculty Office	Block I, Room 325	12 × 8	96
19	Faculty Office – 3	Block I, Room 326	12 × 8	96
			Total	**3,571**

Research Labs

S.No.	Laboratory Name	Room No.	Total area	In square feet
1.	Plant Cell Culture - II	I-24	25 × 17	425
2.	Pharmaceutical Biotech	I-25	25 × 16	400
3.	RNA I	I-26	25 × 16	400
4.	Plant Cell Culture I	I-27	26 × 25	650
5.	Bioseparation	I-31	25 × 20	500
6.	Animal Cell Culture	I-32	25 × 20	500
7.	Bioprocess	I-103	94 × 32	3,008
8.	Waste Treatment	I-121-22	32 × 32	1,024
9.	Downstream Processing	I-127	32 × 16	512
10.	Metagenomics	I-128	20 × 16	320
11.	RNA II	I-130	24 × 11	264
12.	Computation	I-132	21 × 16	336
13.	Biochemical Research (BRL)	I-205	80 × 32	2560
14.	Structural Biology (SBL)	I-206 A	32 × 20	640
15.	Protein Engineering (PEL)	I-206 B	32 × 15	480
16.	Radioactivity	I-207	32 × 19	608
17.	Instrumentation Lab II	I-231	40 × 16	640
18.	Molecular Modeling	I-232	32 × 13	416
19.	Instrumentation Lab I	I-233 C	37 × 32	1,184
20.	Enzyme Engineering	I-329	49 × 20	980
21.	Enzyme Engineering Extn	I-337	32 × 13	416
			Total	**16,263**

Utility Space

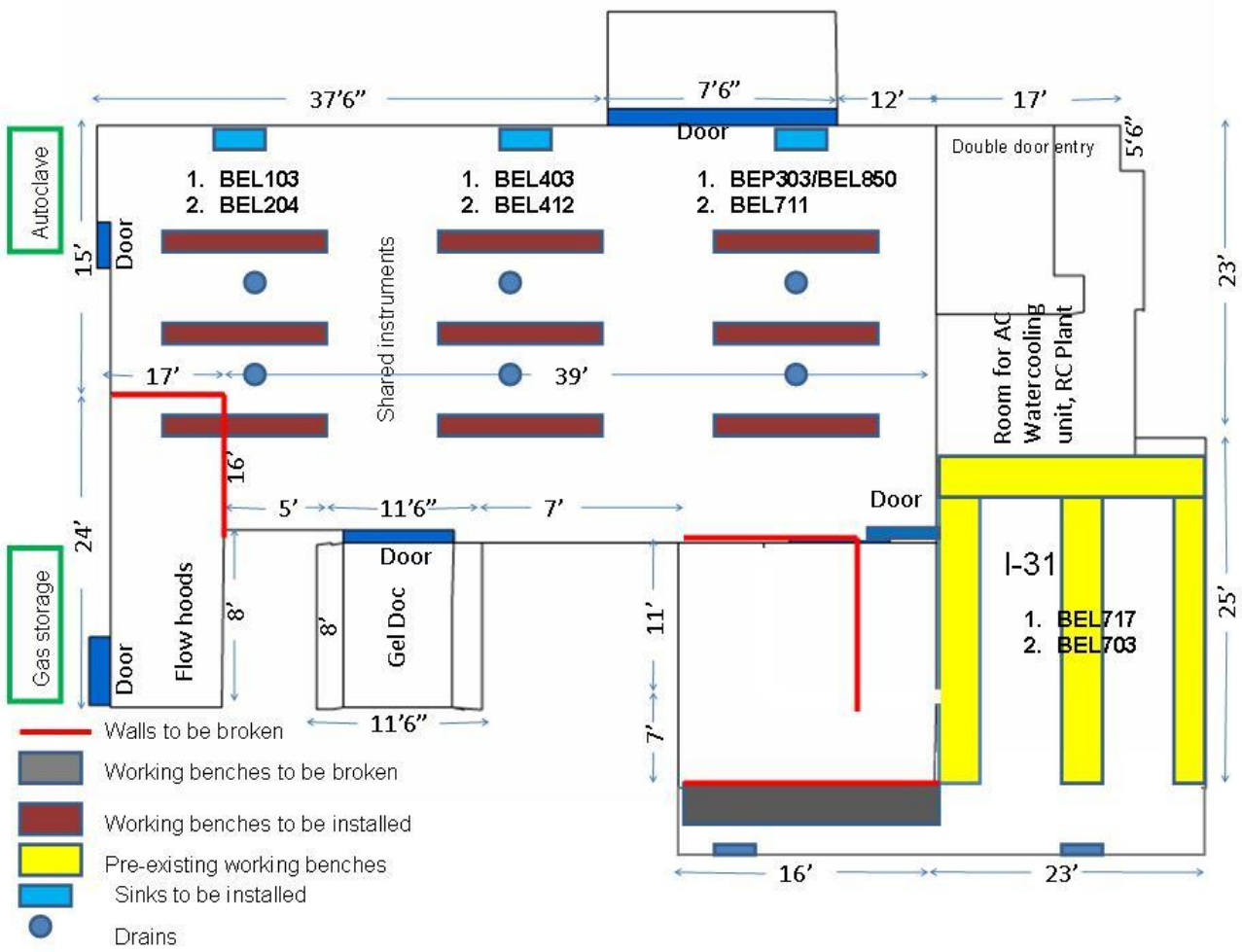
S.No.	Name	Room No.	Total area	In square feet
1.	Office	I-224 I-226	32 × 16 20 × 16	512 320
2.	Committee Room	I-236	32 × 16	512
3.	Seminar Room	I-222-23	32 × 31	992
4.	Documentation Unit	I-221	32 × 13	416
5.	Cold Room	I-125	16 × 20	320
6.	Stores	LT-II	27 × 14	378
			Total	**3,450**

Pilot Plant

S.No.	Name	Room No.	Total area	In square feet
1.	Pilot Plant	I-131 Ground Floor	32 × 75	2,400
2.	Pilot Plant	I-131 Basemen t	32 × 75	2,400
			Total	**4,800**

2.6 Laboratory modernization performed in last 5 years for (i) UG core, (ii) PG core, (iii) elective courses

The ground floor of the Pilot Plant is being developed as labs for UG/PG teaching as per the plan given below:



Lab courses to be conducted in Block I, Room No. 31:

1. Semester 1: BEL 717 (Animal Cell Technology)
2. Semester 2: BEL 703 (Downstream Processing)

Lab courses to be conducted in new lab to be developed at the ground floor level below

Pilot Plant **:**

- *Semester 1:* BEL 103 (Microbiology), BEL 303 (Bioprocess Design), BEL 403 (Enzyme Engineering) / BEL850 (Advanced Biochemical Engineering)
- *Semester 2:* BEL 204 (Mol Bio & Genetics), BEL 412 (Immunology), BEL 711 (Recombinant DNA Technology)

Civil maintenance planned in the new lab **:**

- Removal of walls labeled with red line in figure shown above.
- Removal of working bench shown in dark grey.
- Installation of **vitrified Kajaria tiles** on floors for bearing the heavy modular lab benches that will be subsequently installed.
- Installation of **Neoprene gasket lined aluminum windows** to create dust-free environment.
- Installalation of **Laminated board false ceiling** without dust collecting pockets.
- Installalation of **Hindware ceramic sinks** in areas marked with blue rectangles.
- Construction of autoclave room outside the lab (room labeled **Autoclave** in map)
- Construction of fenced storage area for gas cylinders (shown as **Gas storage** in map).
- Installation of gas connections to room labeled **Flow hoods**, and on all working benches.
- Provision of drains at the locations shown in the map as blue circles.

Electrical work being planned in the new lab **:**

- Provision of air conditioning (essential for biological labs BEL103, BEL204, BEL412, BEL711).
- Dedicated 20 kVA UPS for this facility.
- **Legrand** electrical connections to supply power on panels along the walls of the lab.
- **Legrand** electrical supply to the three modular working benches which will be purchased by the department and installed at the locations shown on map in dark brown.

The following equipments are being procured for installation in the new laboratory:

(a). Equipment common to all courses:

- 4 UV/visible spectrophotometers (Rs 4 lakhs)
- 4 large bench-top centrifuges (Rs 20 lakhs)
- 4 weighing balances (Rs 6 lakhs)
- 2 water baths (Rs 4 lakhs)
- RO water dispenser.
- 1 ice-maker (4') (Rs 5 lakhs)
- 4 refrigerators (12') (Rs 2 lakhs)
- 4 lab shakers (16') (Rs 8 lakhs)
- 3 laminar flow hoods (Rs 3 lakhs)
- 1 large fume hood. (Rs 2 lakhs)
- 3 autoclaves of different capacities. (Rs 4.5 lakhs)

(b). Course-specific equipment:

Microbiology and Molecular Biology:

- 1 -20C freezer (Rs 50,000)
- 1 gel documentation system. (Rs 6 lakhs)
- 3 PCR's (6 lakhs)
- Several micro centrifuges (3 lakhs)

Bioprocess and Advanced Biochemical Engineering:

- 2 fully equipped bioreactors (with chillers, gas analyzers, etc).

2.7 Course files for each course for last 5 years

The course files are maintained by the Course Coordinators and are available with them.

2.8 Study materials (monographs, notes, books, videos, web-based materials, etc.) prepared, course-wise,

The study materials used by the Course Coordinators are available with them as part of the Course File maintained by each of them.

2.9 Research and Innovations in teaching-learning processes

***iGEM*:** *iGEM* is the international Genetically Engineered Machines competition, held at MIT, USA. This annual worldwide competition involves undergraduate and graduate students. It differs radically from most high-level educational experiences in that participants often begin with limited science backgrounds. iGEM addresses the question: "Can simple biological systems be built from standard, interchangeable parts and operated in living cells? Or is biology just too complicated to be engineered in this way?"

An excellent way to answer this is to actually try to engineer biological devices. The iGEM competition facilitates this by providing a library of standardized parts (called BioBrick standard biological parts) to students, and asking them to design and build genetic devices ("machines") with them. Students make their own new BioBrick standard biological parts as well. Successful projects produce cells that exhibit new and unusual properties by engineering sets of multiple genes together with mechanisms to regulate their expression. Information about BioBrick standard biological parts, and a toolkit to make and manipulate them, are provided by the Registry of Standard Biological Parts, a resource for iGEM that has evolved rapidly to meet iGEM's needs.

In the year 2010, our departmental students participated for the first time in the iGEM competition. The IIT-D team worked on developing and optimizing a device to secrete a peptide inhibitor of rennin, a key enzyme of the RAAS (Renin Angiotensin Aldosterone System) that controls the blood pressure and other essential features. The system was optimized to control the expression of this inhibitor according to an elicitor injection into a nutrient stream mimicking the human blood stream. Two of the student team members went to MIT in Nov 2010 to participate in the Annual Jamboree and presented their work.

The current 2013 IIT-D iGEM team plans to combine the studies exploring pH inducible promoters in molecular biology with logical systems present in the iGEM parts registry to create a Global Bacterial pH sensor akin to the Universal pH Indicator. They have made a mathematical model of the circuit and simulated it on MATLAB to observe the response characteristics and have also indicated through a simple wet lab experiment that RFP degradation is independent of pH.

Our departmental students have voted with their feet – they love iGEM. This will further enhance IIT's and India's prestige in the international Synthetic Biology arena. More details are available at URL - http://privateweb.iitd.ac.in/~sundar/review.

2.10 No. of students (UG and PG separately) who have spent at least a semester at another university/institute (overseas or Indian).

Sl.	Year	Student	Entry Number
1	2008 - 2009	Suneer Verma	2006BB50026
2	2008 - 2009	Vibhuti Agrawal	2006BB50029
3	2009 - 2010	Sumedha Roy	2007BB50028
4	2011 - 2012	Vaibhav Yadav	2009BB50035
5	2011 - 2012	Mayank Goyal	2009BB50039
6	2012 - 2013	Sofia	2010BB50038
7	2013 - 2014	Devesh Mohnot	2011BB50016

The following dual degree students of our department have obtained the prestigious fellowship of ***Khorana Program*** to pursue summer research in University of Wisconsin-Madison and other partner institutions in USA:

Year	Students
2011	Vivek Dwivedi, Bhuvan Molparia
2012	Sukriti, Gupta, Kriti Gupta
2013	Kanika Khanna, Shachi Mittal, Abhishek Persad, Charu Mehta

The following dual degree student of our department obtained the prestigious ***Summer Undergraduate Fellowship Program*** (SURF) to pursue summer research at CALTECH, USA:

Year	Student
2013	Rohit Sharma

2.11 No. of students from overseas universities who have taken classes, done project work or internship, UG & PG separately, in the department.

Sl.	Year	Student	Entry Number
1	2009	Fonteneau Heloise	2006BB50026
2	2009	Astoul Juliette	2006BB50029
3	2010	Saanchi Pal	2007BB50028
4	2011	Goutte Flarian	2009BB50035
5	2011	Demarcy Thomas	2009BB50039
6	2013	Ambre Fau	2010BB50038

2.12 Course feedback.

The Office of Dean (Academics) administers and supports the Student Feedback on Courses at the Institute level. The students provide feedback on courses twice in a semester (mid-term and at the semester end). This helps the faculty to gather formative feedback from students that is used to improve the quality of teaching, the course and also the student learning experiences.

2.13 Industry experts who have delivered lecture(s), seminars, discussions as part of a core/elective course – UG and PG separately.

As part of the Professional Practice course, experts are invited to deliver lectures to the senior students and share their experiences. We also have regular speakers from industry and academia as part of the Seminar Series every semester. A partial list of speakers was listed under the earlier Section 1.3(g) on page 22.

2.14 Industry exposure to students – course-related visits to factories, sites, industry exhibitions, field trips, etc. – UG and PG separately.

As part of the dual degree curriculum, all the students are required to undergo an 8-week summer internship in an industry. Upon successful certification by the industry, the students are required to present their work as part of the non-graded colloquium course on return from the training program.

Research

Executive Summary: Research

Averaged over the last five years, **20**% of the dual-degree students, **0%** of the MS(R) students, and **66**% of the research scholars have been supported by **external funding**. The average number of **Ph.D.'s graduated** over the last 5 years per faculty has been **1.6** and the average SCOPUS cited **publication per faculty** is **11.2**. The amount of research projects per faculty is **4.1** and industrial consultancy is **0.6** per faculty. In **23**% of the projects, investigators from other units are collaborators. The project goal here is to increase the number of PhDs graduated per faculty and attract additional extramural funding required to sustain the larger number.

3. Research

3.1 No. of Masters and Ph.D. students supported - (i) by Institute Assistantship, (ii) on sponsored projects/consultancies, (iii) others sources and (iv) sponsored by external organizations.

Sl	Program	Current enrollment	Source of Assistantship for the students	
			from Institute	from Other sources *
1	PhD	**46**	16	30
2	MSR	**11**	11	-

* Other sources of funding for students include CSIR-NET (JRF), UGC-NET (JRF), DBT-BET (JRF)-Category-A, DBT-BET (JRF)-Category-B, DBT-BINC (JRF), ICMR-JRF, DST-INSPIRE Fellowship, Sponsored projects of Faculty, etc.

3.2 No. of Ph.D.s enrolled, graduated per faculty for last 5 years

Faculty	Students Graduated	Students Enrolled
T.R.Sreekrishnan	Vikrant Sarin * (2013) (Chemical Engg, IITD) Kankana Kundu * (2013) SurajbhanSevda * (2013) Motipalli Ramesh (2012) Shukla Pal * (2012) (Chemical Engg, IITD) Kapil Kumar * (2012) (Energy Studies, IITD) Asheesh K. Yadav (2011) (CRDT, IITD) Ashish Pathak * (2011) (Energy Studies, IITD) Sheikh Ziauddin Ahammad (2010) Meenu Chhabra * (2010) Mukesh Goel (2009)	Bhuvanesh, S. Satyendra Singh * Akanksha Mehrotra Pragya Dinesh K Upadhyay * (Civil, IITD) Isha * (Civil, IITD) Pushap Chawla * (CRDT, IITD) Arpita Ghosh * (Energy Studies, IITD) Akanksha Gupta *
A.K. Srivastava	Gunnet Kaur (2013) Ashish Baldi * (2010) Smita Srivastava (2010) P. K. Sofia (2009)	Anveshika Aditya Nivedita Patra * Swati Shalini Dhara Devang Thakore Geeta Gahlawat (thesis submitted)
V.S. Bisaria	M.V.R.K.Sarma * (2011) Abhinav Grover * (2011) Vinod Kumar * (2010) Ashish Baldi * (2009) Anjali Madhavan (2009)	Rashi Gupta * Anees Kaprakkaden * Richa Sharma * Gautam Anand *
P.K. Roychoudhary	Shweta Kamthan (2013) Sucharita Sen (2012)	Sucharita Sen Shweta Kamthan Neha Nagpal * Rahul Agrawal * Siddhi *
Prashant Mishra	Naresh Mohit VS * (2012) Saurabh Bansal * (2012) Raju Shankarayan (2011) Roohi Gupta * (2010) Bhawna Madan (2009)	Prabha Arya * Swati Jaiswal Surabhi Goel Neeti
Subhash Chand	Swati Ojha * (2014) Mohd. Younis Rather * (2012)	

Sunil Nath		Khusboo Rastogi * Vidhu S *
Saroj Mishra	Swati Ojha * (2014) Mohd. Younis Rather * (2012) Ashwani Kumar * (2011) Richa Baranwal (2011) Meenu Chhabra * (2010) Mohd. Asif Shah * (2010)	Sakshi Aggarwal Rishabh Gangwar * Mool Chand Ashwani Gautam Arpita Vats Tenzin Kenzom * Jyoti Batra (thesis submitted)
G.P. Agarwal	Mohd. Javed Eqbal (2014)	Md. Javed Eqbal Muthu mareeswaran M. R. Satyendra Singh * Premnath Sunil Kumar Himanshu Singh
Atul Narang		Shilpi Jain Shraddha Maitra Ritesh Aggarwal Anamika Singh
D. Sundar	Abhinav Grover * (2012)	Shayoni Dutta Shashank P. Katiyar Jaspreet Kaur Dhanjal
Shilpi Sharma	Kankana Kundu * (2013)	Nivedita Patra * Rashi Gupta * Richa Sharma * Gautam Anand *
Ritu Kulshrestha		Neha Nagpal * Rahul Agrawal * Aji Alex * Sonam Takkar
Ravikrishnan Elangovan		Khusboo Rastogi * Vidhu S * Saurabh Singh * Vikas Pandey * Megha Singh *
Preeti Srivastava		Tenzin Kenzom * Pooja Singh Anees Kaprakkaden *
Ziauddin Ahammad	Kasim Mohammed * (2013) (CEGS, Newcastle University, UK)	Siddhi S * Deepak Gola* (CRDT, IITD) <u>Students at Newcastle Univ (UK)</u> Olorunwa Khaerullah Tijani * Catherine Hands * Edmond Ndam *

* indicates that the student is working under the mentorship of more than one Supervisor. The co-supervisor could be from within the department or other academic units within the Institute or in another Institution (additional details are provided under Section 3.13 on page 58).

3.3 Areas of research (e.g. areas listed in Prospectus, and others) by (i) Volume (quantifiable parameters), (ii) Breadth, and (iii) Years these have been research areas

Faculty	Name of Research	PhD's (enrolled)	Journal papers	Conference Papers	Sponsored projects
M N Gupta	Protein expression aggregation and refolding	0	16	2	2
	Nanotechnology	0	9	0	1
	Bioseparation	0	8	0	0
	Biofuels	0	2	1	2
	Biocatalysis in low water media	2	26	3	3
T.R. Sreekrishnan	Environmental Engineering / Environmental Biotechnology	10	37		12
A.K.Srivastava	Plant Cell Cultivation	4	4	11	6
	Bioprocess Engg.	3	10	10	
V.S. Bisaria	Biotechnology of lignocellulose conversion, microbial upgradation of agro-residues to animal feed, production of secondary metabolites by plant cell fermentation				
P.K. Roychoudhary	Hybridoma Technology	2	3	2	DBT
	Micro RNA in Cancer Biology	2	1		
	Ethanol Production	1			
Prashant Mishra	Microbial lipids, pentose utilization, molecular imprinting and protein stability, Nano-biotechnology				
Saroj Mishra	Molecular enzymology and application of hydrolytic enzymes	1	20	2	6
	Yeast expression system	3			
	Enzyme mediated bioremediation	2			
S. Nath	Thermodynamics and transport in chemical and biological systems				
Subhash Chand	Bioprocessing of industrial/ agricultural feedstock using immobilized cells/ enzyme systems, microbial production purification & characterization of industrial enzymes, application of enzymes in process industry.				
G.P. Agarwal	Molecular Biology	1	1	1	-
	Heavy Metal Ion Remediation	1	-	2	1
	Membrane Technology	4	3	2	3
Atul Narang	Systems biology	2	0	0	1
	Bioprocess Engineering	2	0	0	0
D Sundar	Bioinformatics and Genomics	4	30	29	As PI (6) and As Co-PI (6)
Shilpi Sharma	Efficacy of pro and prebiotics on human gut microflora	0	0	0	1 (DST-MOFPI)

	Rhizosphere biology	3	4	9	1 (DBT sponsored)
	Comparison of non-target effects of chemical and bio-pesticides	0 (1 MSR)	1	1	1 (DST sponsored)
	Hairy root culture for production of artemisinin	1	1	9	0
Ritu Kulshrestha	Cancer and micro RNA	3	9	4	4
	Gene Delivery in Cancer Cells	1	-	-	-
	Stem cells and MicroRNA	None	-	1	1
Ravikrishnan Elangovan	Biophysics of molecular machines	2	4	2	1 (DST) 1 (DBT)
	Low cost diagnostics/Biosensors	-			1 (DBT)
Preeti Srivastava	Biodesulfurization of petroleum fractions	1	1	2	1
	Biological upgrading of heavy crude oil				
	Chromosome maintenance in Rhodococcus				1
	Aleuritic acid biosynthesis	1			
	Engineering of laccases	1			
Ziauddin Ahammad	Environmental Engineering/ Environmental Biotechnology	5	10	6	0
	Bioprocess Engineering	1	0	0	0

3.4 Publications per faculty (average per year for last five years) in academic journals.

Faculty Name	Total publications in academic journals during the period 2008-13	Average publications per year for the period 2008-13
M.N.Gupta	48	9.6
T.R.Sreekrishnan	37	7.4
A.K. Srivastava	30	6
V.S. Bisaria	27	5.4
P.K. Roychoudhary	4	0.8
Prashant Mishra	11	2.2
Saroj Mishra	20	4
Subhash Chand	15	3
Sunil Nath	5	1
G.P. Agarwal	4	0.8
Atul Narang	7	1.4
D. Sundar	30	6
Shilpi Sharma	18	3.6
Ritu Kulshrestha	9	1.8
Ravikrishnan Elangovan	4	0.8
Preeti Srivastava	4	0.8
Ziauddin Ahammad	6	1.2

The complete list of publications of the departmental faculty for the period 2008- 2013 is provided in *Appendix 3a* on page 59 and the publication/citation metrics are given in the next page.

3.5 Publications (journal and conference) total and per (a) Ph.D. student, (b) Masters student, (c) UG student.

Faculty Name	Total number of publication in journals 2008-13	Other publications (conference, books) 2008-13	Average publications per PhD student (graduated)[b]	Publications per MSR/ MTech student	Total citations of 2008-2013	*h - index* (for articles of 2008-2013)
M.N.Gupta	48	6	13		203	8
T.R.Sreekrishnan	37		3.7		196	8
A.K. Srivastava	30		8.3		123	6
V.S. Bisaria	27	6	4		201	7
P.K. Roychoudhary	4		2		1	1
Prashant Mishra	11		2.2		52	4
Saroj Mishra	20	2	3	0	102	6
Subhash Chand	15				63	4
Sunil Nath	5				32	4
G.P. Agarwal	4		1		4	1
Atul Narang	7		NA		56	5
D. Sundar	30	4	10	1	119	7
Shilpi Sharma	18		5		15	2
Ritu Kulshrestha	9	4	NA	1	44	1
Ravikrishnan E	4	3	NA		14	1
Preeti Srivastava	4		NA		4	1
Ziauddin Ahammad	6	1	NA		3	1

Total number of papers published by the department during 2008 - 2013 : 191 *
Average number of publications per faculty during 2008 - 2013 : 11.2

Total number of citations for papers published during 2008 - 2013 : 1232
Average number of citations per publication of 2008 - 2013 : 5.65
Average number of citations per faculty member for 2008 - 2013 : 72.47

* Papers having joint authorship of departmental faculty members have been included only once when counting the total number of publications

Notes

1. Publications of the years 2008-2013 that listed the affiliation of IIT Delhi were included for counting the number of citations.
2. Citations of indexed-publications of the years 2008-2013 were obtained from *Thomson Reuters - Science Citation Index* through the *Web of Science* database on February 19, 2014.
3. *Hirsch index* - The Hirsch index (*h*-index) measures the research performance of an author. It measures the impact of a set of articles published by the faculty member and shows the number of citations per publication. The *h-index* of a faculty member with an index of **h**, has published **h** papers, each of which has been cited in other papers at least **h** times.

3.6 Best papers in last 5 years: (i) Individual best 3, (ii) department best 10; and brief justifications.

The best papers of individual faculty in last 5 years are listed below -

M.N.Gupta	• Raghava, S., Singh, P.K., Ranga Rao, A., Dutta, V. and Gupta, M.N. (2009) Nanoparticles of unmodified titanium dioxide facilitate protein refolding. *Journal of Materials Chemistry* 19, 2830-2834 • Solanki, K., Halling P J., Gupta, M.N. (2012) Examining structure-activity correlations of some high activity enzyme preparations for low water media. *Bioresource Technology* 115, 147–151. • Rather, G. M., Mukherjee, J., Halling, P. J. and Gupta, M.N. (2012) Activation of Alpha Chymotrypsin by Three Phase Partitioning is Accompanied by Aggregation. *PLoS One* 7(12). • Majumder, A.B. and Gupta, M.N. (2013) Lipase catalyzed condensation reaction of 4-nitrobenzaldehyde with acetyl acetone in aqueous-organic co-solvent mixtures and in nearly anhydrous media. *Synth. Comm*. • Banerjee, A.; Singh, V., Solanki, K., Mukherjee, J. and Gupta, M.N. (2013) Combi-protein coated microcrystals of lipases for production of biodiesel from oil from spent coffee grounds. *Sustainable. Chem. Processes*, 1:14.
T.R.Sreekrishnan	• Sevda S, Dominguez-Benetton X, Vanbroekhoven K, De Wever H, Sreekrishnan TR, Pant D. (2013) High Strength Wastewater Treatment Accompanied by Power Generation using Air Cathode Microbial Fuel Cell. *Applied Energy* 105, 194-206 • Kundu K, Sharma S, Sreekrishnan TR. (2013) Changes in microbial communities in a hybrid anaerobic reactor with organic loading rate and temperature. *Bioresource Technology* 129: 538-47 • Ahammad SZ, Davenport RJ, Read LF, Gomes J, Sreekrishnan TR, Dolfing J. (2013) Rational immobilization of methanogens in high cell density bioreactors. *RSC Advances* 3(3): 774-81. • Chhabra M, Mishra S, Sreekrishnan TR. (2009) Laccase/mediator assisted degradation of triarylmethane dyes in a continuous membrane reactor. *Journal of Biotechnology* 143(1):69-78. [Impact Factor 3.045; Cited by 20] • Saravanan V, Sreekrishnan TR. (2008) A mathematical model for a hybrid anaerobic reactor. *Journal of Environment Management* 88(1):136-46.
A.K. Srivastava	• Smita Srivastava, A.K. Srivastava, (2012) Azadirachtin Production by hairy root cultivation of *Azadirachta indica* in modified stirred tank reactor". *Bioprocess and Bio-systems Engineering* 35(9) 1549-53 • Geeta Gahlawat and Ashok K. Srivastava (2013) Development of a mathematical model for the growth associated Polyhydroxy--butyrate fermentation by *Azohydromonas australica* and its use for the design of fed-batch cultivation strategies. *Bioresource Technology* 137:98-105. • Guneet Kaur, A.K. Srivastava & Subhash Chand (2013) Bioconversion of glycerol to 1,3 Propanediol : A mathematical model-based nutrient feeding approach for high production using *Clostridium diolis. Bioresource Technology* 142:82-87. • Guneet Kaur, A.K. Srivastava & Subhash Chand (2012) Advances in Biotechnological Production of 1,3-propanediol. *Biochemical Engineering Journal* 64: 106–118

V.S. Bisaria	• Kumar, V., Sahai, V. and Bisaria, V.S. (2011) High-density Spore Production of *Piriformosporaindica*, a Plant Growth-Promoting Endophyte, by Optimization of Nutritional and Cultural Parameters, *Bioresour. Technol*. 102, 3169-3175. • Madhavan, A., Srivastava, A., Kondo, A. and Bisaria, V.S. (2012) Bioconversion of lignocellulose-derived sugars to ethanol by engineered *Saccharomyces cerevisiae*, *Crit. Rev. Biotechnol*., 32(1), 22-48. • Kumar, V.,Sarma, M. V. R. K., Saharan, K., Srivastava, R., Kumar,L., Sahai, V. Bisaria, V.S. and Sharma, A.K. (2012) Effect of formulated root endophytic fungus Piriformosporaindica and plant growth promoting rhizobacteria fluorescent pseudomonads R62 and R81 on *Vignamungo*, *World J. Microbiol. Biotechnol*.,28(2), 595-603.
P.K. Roychoudhary	• Sen, S. and Roychoudhury, P. K. (2012) Development of optimal medium for production of commercially important monoclonal antibody 520C9 by hybridoma cell', *Cytotechnology* 65(2):233-52. • Sen, S. and Roychoudhury P. K (2012) Step-up/step-down perfusion approach for increased mAb 520C9 production by a hybridoma cell line. *Biotechnology Letters* 35(2):153-63. • Kamthan S, Singh J, Banerjee K, Roychoudhury PK, & Gomes J (2013) A Study of Donor Age and Proliferation of Discarded Corneal Rim in Cell Culture. *GSTF International Journal of Biosciences* 2(2).
Prashant Mishra	• Shankarayan, R., Kumar S and Mishra P (2013) Differential permeation of piroxicam-loaded PLGA micro/nanoparticles and their in vitro enhancement. *J Nanopart Res* 15: 1496-1502 • Bansal S, Srivastava A, Mukherjee G, Pandey R, Verma AK, Mishra P and Kundu B. (2012) Hyperthermophilicasparaginase mutants with enhanced substrate affinity and antineoplastic activity: structural insights on their mechanism of action. *FASEB J* 26: 1161-1171. • Naresh M, Das S, Mishra P and Mittal A. (2012) The chemical formula of magnetotactic bacteria. *Biotechnol. Boengg* 109: 1205-1216. • Madan B and Mishra P (2010) Co-expression of the lipase and foldase of *Pseudomonas aeruginosa* to a functional lipase in *Escherichia coli*. *Appl. Microbiol. Biotechnol*. 85: 597-604. • Sareen R and Mishra P (2008) Purification and characterization of organic solvent stable protease from *Bacillus licheniformis* RSP-09-37. *Appl. Microbiol. Biotechnol*. 79:399-405.
Saroj Mishra	• M. Chhabra, S. Mishra and T.R. Sreekrishnan. (2009) Degradation and detoxification of triarylmethane dyes by laccase/mediator-assisted laccase of *Cyathusbulleri*. *J. Biotechnol*. 143, 69-78. • M.Y.Rather, S. Mishra, S. Aravinda. (2013) Exploring the synthetic potential of cell bound β–glycosidase of *Pichia etchellsii*. *J. Biotechnol* 165, 63-68. • J. Batra and S. Mishra. (2013) Organic solvent tolerance and thermostability of a β-glucosidase co-engineered by random mutagenesis. *J. Mol. Catal B: Enzyme* 96: 61-66.
Subhash Chand	• Guneet Kaur, A.K. Srivastava & Subhash Chand (2013) Bioconversion of glycerol to 1,3 Propanediol : A mathematical model-based nutrient feeding approach for high production using *Clostridium diolis. Bioresource Technology* 142:82-87. • Guneet Kaur, A.K. Srivastava & Subhash Chand (2012) Advances in Biotechnological Production of 1,3-propanediol. *Biochemical Engineering Journal* 64: 106–118

Sunil Nath	• Nath, S. (2010). Beyond the Chemiosmotic Theory: Analysis of Key Fundamental Aspects of Energy Coupling in Oxidative Phosphorylation in the Light of a Torsional Mechanism of Energy Transduction and ATP Synthesis - Invited Review Part 1. *Journal of Bioenergetics and Biomembranes* 42(4):293-300. • Nath, S. (2010). Beyond the Chemiosmotic Theory: Analysis of Key Fundamental Aspects of Energy Coupling in Oxidative Phosphorylation in the Light of a Torsional Mechanism of Energy Transduction and ATP Synthesis - Invited Review Part 2. *Journal of Bioenergetics and Biomembranes* 42(4):301-309.
G.P. Agarwal	• H. R. Lohokare, M. R. Muthu, G. P. Agarwal, U. K. Kharul (2008) Effective Arsenic removal using Polyacrylonitrile based Ultrafiltration membrane. *Journal of Membrane Science* 320, 159-166. • Agarwal, G.P., Raj Karan, Sachin Bharti, Hemant Kumar, SumitJhunjhunwala, T.R. Sreekrishnan and Ulhas Kharul (2013) Effect of foulants on arsenic rejection via polyacrylonitrile ultrafiltration (UF) membrane', *Desalination* 309, 243-246.
Atul Narang	• Narang, A. (2009) Quantitative effect and regulatory function of cyclic adenosine-5′-phosphate in *Escherichia* coli. J*. Biosci.* 34(3), 445-463. • J. T. Noel and A. Narang (2009) Gene regulation in continuous cultures: A unified theory for bacteria and yeasts. *Bull. Math. Biol.,* 71, 453–514. • V. P. Sharma, C. Sumners, G. Shaw and A. Narang (2008) Immunostaining evidence for PtdIns4,5P_2, localization at the leading edge of fMLP-stimulated HL-60 cells. *J. Leukocyte Biol.*, 84, 440-447. • Narang, A. and S. S. Pilyugin (2008) Bistability of the *lac* operon during growth of *Escherichia coli* on lactose and lactose + glucose. *Bull. Math. Biol.*, 70, 1032-1064. • E. May, D. I. Kopelevich and A. Narang. Coarse-grained molecular dynamics simulations of phase transitions in mixed lipid systems containing LPA, DOPE, and DOPE lipids. *Biophys. J.*,
D. Sundar	• Jayakanthan, M., Muthukumaran, J., Chandrasekar, S., Chawla, K, Punetha, A. and Sundar, D.(2009). Zif-BASE: a database of zinc finger proteins and associated resources. *BMC Genomics* 10(1): 421. • Grover, A., Shandilya, A., Agrawal, V., Bisaria, V.S. and Sundar, D.(2012). Computational evidence to inhibition of human acetyl cholinesterase by withanolide A for Alzheimer treatment. *Journal of Biomolecular Structure and Dynamics* 29(4): 651-662. • Grover, A., Priyandoko, D., Gao, R., Shandilya, A., Widodo, N., Bisaria, V.S., Kaul, S.C., Wadhwa, R. and Sundar, D.(2012). Withanone binds to mortalin and abrogates mortalin-p53 complex: computational and experimental evidence. *International Journal of Biochemistry and Cell Biology* 44(3): 496-504. • Grover, A., Singh, R., Shandilya, A., Priyandoko, D., Agrawal, V., Bisaria, V.S., Wadhwa, R., Kaul, S.C., and Sundar, D.(2012). Ashwagandha-derived withanone targets TPX2-Aurora A complex: computational and experimental evidence to its anticancer activity. *PLoS One* 7(1): e30890. • Roy, S., Dutta, S., Khanna, K., Singla, S. and Sundar, D. (2012). Prediction of DNA-binding specificity in zinc finger proteins. *Journal of Biosciences* 37(3): 483-491.

Shilpi Sharma	• R. Gupta, D. Bru, V. S. Bisaria, L. Philippot, S. Sharma (2012) Responses of *Cajanuscajan* and rhizospheric N-cycling communities to bioinoculants. *Plant and Soil* 358, 143-154. • K. Kundu, S. Sharma, T. R. Sreekrishnan (2012) Effect of temperature on the microbial community structure and dynamics in a high cell density anaerobic bioreactor. *Bioresource Technology* 118, 502–511. • S. Gupta, R. Gupta, S. Sharma (2013) Impact of chemical- and bio-pesticides on bacterial diversity in rhizosphere of *Vigna radiata*. *Ecotoxicology* 22: 1479-1489. • K. Kundu, S. Sharma, T. R. Sreekrishnan (2013) Transition of microbial communities in a hybrid anaerobic reactor with changes in organic loading rate and temperature. *Bioresource Technology* 129, 538–547. • K. Kundu, I. Bergmann, S. Hahnke, M. Klocke, S. Sharma and T. R. Sreekrishnan (2013) Carbon source - A strong determinant of microbial community structure and performance of an anaerobic reactor. *Journal of Biotechnology* 168: 616–624.
Ritu Kulshrestha	• Saxena S, Tandon B, Sharma S, Chameettachal S, Ray P, Ray AR, Kulshreshtha, R. (2013) Combined miRNA and mRNA signature identifies key molecular players and pathways involved in Chikungunya virus infection in human cells. *PloS One* Impact factor: 4.09 • Sharma S, Verma S, Vasudevan M, Samanta S, Thakur JK, Kulshreshtha R. (2013) The interplay of HuR and miR-3134 in regulation of AU rich transcriptome. *RNA Biology* 10(8). Impact factor-4.93 • Nagpal N, Ahmad HM, Molparia B, and Kulshreshtha R (2013) MicroRNA-191, an estrogen responsive microRNA, functions as an oncogenic regulator in human breast cancer. *Carcinogenesis*. 34(8):1889-99. Impact Factor- 5.7 • Vaz C, Ahmad HM, Sharma P, Gupta R, Kumar L, Kulshreshtha R, Bhattacharya A. (2011) Analysis of microRNA transcriptome by deep sequencing of small RNA libraries of peripheral blood. *BMC Genomics 11:288*. Impact Factor- 4.03, Citations-43 • Crosby M, Kulshreshtha R, Ivan M, Glazer PM. (2009) MicroRNA Regulation of DNA Repair Gene Expression in Hypoxic Stress. *Cancer Research*, 69:1221-9. Impact Factor- 7.856, Citations- 160
Ravikrishnan Elangovan	• R. Elangovan, M. Capitanio, L. Melli, F. SaverioPavone, V. Lombardi, and G. Piazzesi (2012). An integrated in vitro and in situ study of kinetics of myosin II from frog skeletal muscle. *J Physiol*. 590(5):1227-42.
Preeti Srivastava	• Jain, A. and Srivastava, P. (2013) Broad Host Range Plasmids. *FEMS Microbiol Lett.* 348: 87-96. • Srivastava, P., and Chattoraj, D. (2007) Selective chromosome amplification in *Vibrio cholerae*. *Mol. Microbiol.* 66: 1016-1028. IF: 4.961, citation: 18 • Srivastava, P., Demarre, G., Karpova, T.S., McNally, J. and Chattoraj, D. (2007) Changes in Nucleoid morphology and origin localization upon inhibition or Alteration of the actin homolog, MreB, of *Vibrio choleraeJ. Bacteriol.* 189: 7450-7463. IF: 3.194, citation: 26 • Venkova-Canova, T., Srivastava, P., and Chattoraj, D. (2006) Transcriptional inactivation of a regulatory site for replication of *Vibrio cholerae*chromosome II. *Proc. Natl. Acad. Sci. USA* 103: 12051-56. IF: 9.737, citation: 18 • Srivastava, P., Fekete, R., and Chattoraj, D. (2006) Segregation of the replication terminus of the two *Vibrio cholerae*chromosomes *J. Bacteriol* 188: 1060-70. IF: 3.194, citation: 20

Ziauddin Ahammad	• Ahammad, S. Z.; Gomes, J.; Sreekrishnan, T. R. (2011), A mathematical model for the interactive behavior of sulfate reducing bacteria and methanogens during anaerobic digestion. *Water Environment Research* 83(9), 791-801. • Ahammad, S. Z.; Yakubu, A.; Dolfing, J.; Mota, C. and Graham, D. W. (2012), Feasibility tests for treating shampoo and hair colorant wastewaters using anaerobic processes. *Water Science and Technology* 65(2), 303-308. • Ahammad, S. Z.; Davenport, R. J.; Read, L. F.; Gomes, J.; Sreekrishnan, T. R. and Dolfing, J. (2013), Rational immobilization of methanogens in high cell density bioreactors. *RSC Advances* 3, 774–781. • Ahammad, S. Z.; Zealand, A.; Dolfing, J.; Mota, C.; Armstrong, D. V. and Graham, D. W. (2013), Low-energy Treatment of Colourant Wastes using Sponge Biofilters for the Personal Care Product Industry. *Bioresource Technology* 129, 634-638. • Ahammad, S. Z.; Bereslawski, J. L.; Dolfing, J.; Mota, C.; Graham, D. W. (2013), Anaerobic–aerobic sequencing bioreactors improve energy efficiency for treatment of personal care product industry wastes. *Bioresource Technology* 139, 73–79.

Best papers in last 5 years of the department –

The top 10 publications from the department in the last 5 years are listed below. These papers have been identified based on the impact factor of journals where the article was published and the citation each article has received:

1. Kundu K, Sharma S and Sreekrishnan TR. (2013) Changes in microbial communities in a hybrid anaerobic reactor with organic loading rate and temperature. *Bioresource Technology*. 129: 538-47
2. Guneet Kaur, A.K. Srivastava & Subhash Chand (2013) Bioconversion of glycerol to 1,3 Propanediol: A mathematical model-based nutrient feeding approach for high production using *Clostridium diolis* (2013) *Bioresource Technology* 142:82-87.
3. Madhavan, A., Srivastava, A., Kondo, A. and Bisaria, V.S. (2012) Bioconversion of lignocellulose-derived sugars to ethanol by engineered *Saccharomyces cerevisiae, Crit. Rev. Biotechnol*. 32(1), 22-48.
4. Sen, Sucharita and Roychoudhury P. K, (2013) Step-up/step-down perfusion approach for increased mAb 520C9 production by a hybridoma cell line', *Biotechnology Letters*, DOI. 10.1007/s10529-012-1058-5
5. Bansal S, Srivastava A, Mukherjee G, Pandey R, Verma AK, Mishra P and Kundu B. (2012) Hyperthermophilicasparaginase mutants with enhanced substrate affinity and antineoplastic activity: structural insights on their mechanism of action. *FASEB J* 26: 1161-1171.
6. M.Y.Rather, S. Mishra and S. Aravinda (2013) Exploring the synthetic potential of cell bound β–glycosidase of Pichiaetchellsii. *J. Biotechnol* 165, 63-68.
7. Agarwal, G.P., Raj Karan, Sachin Bharti, Hemant Kumar, SumitJhunjhunwala, T.R. Sreekrishnan and UlhasKharul (2013) Effect of foulants on arsenic rejection via polyacrylonitrile ultrafiltration (UF) membrane. *Desalination* 309, 243-246.
8. Grover, A., Priyandoko, D., Gao, R., Shandilya, A., Widodo, N., Bisaria, V.S., Kaul, S.C., Wadhwa, R. and Sundar, D. (2012). Withanone binds to mortalin and abrogates mortalin-p53 complex: computational and experimental evidence. *International Journal of Biochemistry and Cell Biology* 44(3): 496-504.

9. K. Kundu, S. Sharma, T. R. Sreekrishnan (2012) Effect of temperature on the microbial community structure and dynamics in a high cell density anaerobic bioreactor. *Bioresource Technology*, 118, 502–511
10. Nagpal N, Ahmad HM, Molparia B, and Kulshreshtha R (2013) MicroRNA-191, an estrogen responsive microRNA, functions as an oncogenic regulator in human breast cancer. *Carcinogenesis*. 34(8):1889-99.

3.7 Average citation per department (in the last 5 years).

Total number of papers published by the department during 2008 - 2013 : 191 *
Average number of publications per faculty during 2008 - 2013 : 11.2

Total number of citations for papers published during 2008 - 2013 : 1232
Average number of citations per publication of 2008 - 2013 : 5.65
Average number of citations per faculty member for 2008 - 2013 : 72.47

* Papers having joint authorship of departmental faculty members have been included only once when counting the total number of publications

3.8 Changes, modifications, etc. done to improve the quality of (i) M.Tech. and (ii) Ph.D. graduates.

The Department systematically and periodically reviews the PG curriculum on a regular cycle of approximately 10 years to enhance the effectiveness of the program. Further, our dual degree program is partially supported by the Department of Biotechnology (DBT), Govt of India for 23 years now and there is a regular meeting of DBT Advisory Committee every alternate year to evaluate the teaching program of the department. This Committee consists of faculty members from other teaching institutions, research scientists and industry experts.

3.9 Sponsored projects - (i) individually, (ii) with another faculty of the group/section of the department, (iii) with another faculty of the department but from another group/section of the department (iv) with another faculty of another dept/center.

Faculty Name	Role	Title of the project	Funding agency	Amount sanctioned (Rs. in lacs)	Duration
M.N. Gupta	PI	An intensification of research in high priority areas (IRHPA) unit/ core group on applied biocatalysis	DST	163.96	2006-11
	PI	Biotechnological approaches for utilization of Jatrophacurcas oil cake and glycerol (obtained as byproduct during production of biodiesel) for obtaining value added products	DBT	55.82	2007-11
	PI	Development of novel protein refolding strategies	DBT	40.67	2007-10
	PI	Understanding high activity enzyme preparations for organic media	UKIERI	23.15	2008-11
	Co-PI	Development of reactive extraction process for production	DBT	58.82	2009-12

		of biolubricant from wild castor seeds			
	PI	Application of magnetic nanoparticles in bioseparation and immobilization of proteins/ enzymes	DBT	70.65	2010- 14
	Co-PI	Utilization of de oiled soybean cake for production of enzymes, bioactive components and protein products	MOFPI	15.60	2010-12
	Co-PI	Design of synthetic polymers for applications in separation and Biocatalysis	AICTE	24.95	
	PI	Strategies for preventing protein aggregation	DBT	79.00	2012-15
	PI	Lipase catalysedaldol condensation reactions	DST-SERB	49.96	2012-15
	PI	Bioprospecting for Alcohol Dehydrogenases for Chiral Synthesis	DBT	38.19	2012-15
T.R.Sreekrishnan	Co-PI	Decolourization / detoxification of waste waters using physico-chemical / biological routes.	DBT	22.81	
	Co-PI	Environmental Engineers of Tomorrow: Developing a shared tool box through collaboration.	EPSRC (U.K.) and MOEF	41.10	
	Co-PI	Optimization and application of microbial formulation for removal of toxic metals from effluents of small-scale industries.	MOEF	17.39	
	Co-PI	Ultrfiltration membranes for arsenic, chromium and nitrate rejection	DDWS	77.19	
	Co-PI	Development of Indegenous membrane bioreactor (MBR) using submerged flyash membranes and its application for municipal wastewater treatment	DST	28.49	
	Co-PI	Integrated process development for biogas production from wastewater grown algal biomass (a second generation biofuel (feed-stock) and testing of algae mediated biogas conditioning	MNRE	62.42	
	Co-PI	Sustainable semi-decentralized sewage treatment, reuse, nutrient recovery and biogas production in the Delhi metropolitan area	MOEF	21.52	
	Co-PI	Mass production of designer biodegradable copolymers from renewable resources	DBT	57.92	
	Co-PI	Bioremediation of agrochemicals and heavy metals present in	ICAR	84.57	

		drainage water used for irrigation in urban and peri-urban agricultural areas			
A.K. Srivastava	PI	Program Support for Microbial Production of designer Bio-polymers from renewable resources	DBT	247.52	2012-17
	PI	Mass production of Designer Biodegradable Copolymers from Renewable Resources	DBT	57.29	2012-15
	Co-PI	Production of high value therapeutic proteins using *Pichia* system	IIT-D	100.00	2011–16
	PI	Bioreactor Modeling and Stimulation Lab	MHRD	39.5	2010-14
	PI	Hairy Root Cultivation for Mass Scale Production of Shikimic Acid (Raw material for the drug for avian Flu)	ICMR	17.87	2010-12
	PI	Isolation and screening of potential microbial inoculants from rhizosphere of a medicinally important weed, *Cassia occidentalis*	DBT	10.12	2009 –12
V.S. Bisaria	PI	Production of Terpenoids in Normal and Transformed Cell, Organ Cultures and Whole Plants in Tea	DBT	30.01	2007-10
	PI	Mass scale multiplication of plant growth promoting rhizobacteria and development of consortium formulations with suitable carriers.	SDC, Switzerland & DBT	Rs. 61.53 + SFr 47,600	2008-12
	PI	Yield Enhancement Strategies for Production of Therapeutic Compounds by Cell and Tissue Cultures of*Tinosporacordifolia*	DBT	21.51	2011-14
	Co-PI	Metabolic engineering for production of terpenoids in tobacco plants	DBT	24.83	2013-16
	Co-PI	Efficacy and Risk Assessment of Bioinoculantsin*Cajanuscajan*: Impact on plant growth, rhizospheric microbial diversity, and genes involved in N turnover	DBT	68.58	2013-16
P.K. Roychoudhary	PI	Designing of novel perfusion culture system for large scale cultivation of mammalian cells.	DBT	37.0	2007-11
	Co-PI	Cell sheet engineering for assembling human corneal construct	IIT-D	100.0 l	2011-16
Prashant Mishra	PI	Biodegradable and biocompatible polymer nanoparticles containing protein pharmaceutical for wound dressings	Lockheed Martin, USA	63.27	2008-11

	PI	Nanoparticle-Encapsulated Bioactive Formulations for Mass Health Care	ICMR	332.72	2012-14
	Co-PI	Enzymatic Polysialylation to Improve the Stability of Erythropoietin	DST	25.1	2013-16
	Co-PI	Non-Silicon Based Technologies for Nanofabrication and Nanoscale devices	MCIT	4963.00	2010-15
	Co-PI	Applications of Magnetic Nanoparticles in Bioseparation and Immobilization of Protein/Enzymes	DBT	70.65	2010-14
		Strategies for preventing protein aggregation	DBT	61.82	2012-15
	Co-PI	Lipase Catalyzed Aldot Condensation Reactions	DST	49.96	2012-15
	Co-PI	Bioprospecting for Alcohol Dehydrogenases for Chiral Synthesis	DBT	38.19	2012-15
Saroj Mishra	PI	Production of high value therapeutic proteins using *Pichia* system	IIT-D	100.0	2011-16
	PI	Bioprocess Development for Cost-effective and Environment Friendly Production of Cellobiose Dehydrogenase Enzyme and Lactobionic Acid	DBT	49.72	2009-13
	Co-PI	A novel strategy for the production of ethanol	DBT	35.51	2008-10
	PI	Engineering of β-glucosidases for Improved Yield of Glycoconjugates	DST	24.00	2007-11
	PI	Decolorisation/Detoxification of Waste Waters Using Physico chemical/ Biological Routes	DBT	22.81	2007-10
	PI	Enzyme Catalyzed synthsesis of Alkyl Glucosides and Polyglucosides Using B-Glucosidase in Microaqeous / Organic Medium	LSRB, DRDO	25.06	2007-10
Subhash Chand	PI	Synthesis of Prebiotic, Galactooligosaccharides By Microbial B Galactosidase and synergistic effect with Probiotics on human intestinal pathogens	DST	24.6	2012-15
	PI	Studies on microbial chitosanases for production of novel bioactive chitooligosaccharides	DST	18.49	2009-12
	PI	NAD(H) Linked enzymatic reactions in ATPS Using Immobilized Multi-enzyme Systems on Nano-particles	Lock Heed Martin, USA	28.54	2008-10

Sunil Nath	Co-PI	In Vitro Reconstruction of Muscle Contraction	DST	22.7	2012-15
G.P. Agarwal	PI	Ultrafiltration Membrane for Arsenic, Chromium and Nitrate Rejection	DDWS	78.0	2009-13
	PI	Removal of Arsenic from Drinking Water using Polymeric Membrane	DST	35.0	2003-09
	PI	Novel Biotechnologicalprocesses for Production of High Value Products from Rice Straw and Bagasse	ICAR	105.0	2009-13
	PI	US-India Consortium of Development of Sustainable Advanced Ligno-cellulosic Biofuel Systems	DBT	88.0	2013-18
Atul Narang	PI	Unraveling the mechanism of glucose-mediated lac expression	DST	42.0	2010-14
D. Sundar	PI	Towards modifying nature's DNA recognition system for highly	Lady Tata Memorial Trust, Mumbai	38.2	2011-16
	PI	Betraying the parasite's redox system: Studies on spermidine	DBT	16.2	2011-14
	PI	Program Support for Computational Genomics	DHR-ICMR	30	2011-14
	PI	Metabolic engineering for production of terpenoids	DBT	24.81	2013-16
	PI	National Bioscience Award for Career Development	DBT	9.0	2013-16
	PI	DuPont Young Professor Award 2013	DuPont, USA	75,000 US$ per year	2013-16
	Co-PI	MicroRNAs and AU rich elements (ARE): Deciphering the	DBT	22.19	2011-14
	Co-PI	Unraveling the mechanism of glucose-mediated lac expression	DST	40.3	2011-14
	Co-PI	Yield enhancement strategies for production of therapeutic	DBT	21.51	2011-14
	PI	Molecular Tools for Targeted Genome Engineering	DBT	53.05	2006-13
	PI	Development of database and software tools for identifying zinc	DIT	37.07	2007-10
	PI	Molecular Recognition of DNA by Zinc Finger Proteins	DST	17.92	2006-09
	PI	Production of terpenoids in normal and transformed cell, organ	DBT	27.67	2007-10

	PI	Ribozyme-mediated antiviral activity directed to mung bean	DBT	29.98	2009-12
Shilpi Sharma	Co-PI	Hairy root cultivation for mass scale production of Shikimic acid (Raw material for the drug for Avian Flu.	ICMR	35	2010-12
	Co-PI	Mass scale multiplication of PG PR and development of formula tion of consortium formulations with suitable carriers.	ISCB	59.66	2008-12
	PI	Isolation and screening of potential microbial inoculants from rhizosphere of a medicinally important weed, Cassia occidentalis.	DBT	12.12	2009-13
	PI	Impact of synthetic- and bio-pesticides on functional diversity of agricultural soil	SERB, DST	23.3	2012-15
	PI	*In vitro* assessment of the effects of commercially available nutraceuticals and oligosaccharides as prebiotics on the human gut microflora	SERB, DST	23.3	2013-15
	PI	Efficacy and Risk assessment of bioinoculants in *Cajanuscajan*: Impact on plant growth, rhizospheric microbial diversity and genes involved in N turnover	DBT	49.21	2013-16
Ritu Kulshrestha	PI	Functional dissection of microRNAs frequently deregulated in solid cancers	DST	13.92	2010-13
	PI	MicroRNAs and AU rich elements (ARE): Deciphering the regulatory loop	DBT-RGYI	22.19	2011-14
	PI	Molecular Mechanisms of Hypoxia Resistance in Glioblastoma: Role of MicroRNAs	DBT	65.97	2011-14
	PI	Investigating moduclation of miRNA expression in hypoxia-stem cell niche	DST-UKIERI	15.32	2013-14
	Co-PI	Surface enhanced Raman Scattering (SERS) based sensing and imaging systems for early diagnosis of breast cancer	DBT	74.25	2013-16
Ravikrishnan Elangovan	PI	In Vitro Reconstruction of Muscle Contraction	DST	22.7	2012-15
	PI	Development of a Novel Magnetic Tweezer to Measure Torque in Bacterial Flagella Motor	DBT	30	2013-16
	PI	Direct Detection of Enteric Fever in Blood by Evanescent Wave Optical Illumination	DBT	83.19 l	2013-16

Preeti Srivastava	PI	Improved biodesulfurization of crude oil : optimization of conditions and characterization of genes	DBT	41.77	2011-14
	PI	Chromosome dynamics in *Rhodococcuserythropolis*	DST	47.57	2013-16

3.10 Industry consultancies

Faculty	Title of Project	Industry	Amount (Rs in Lacs)	Duration
M.N. Gupta	Separation of pectinases	Advanced Enzymes Tech. Ltd.	1.6	2008-09
	Biocatalyst designs and process optimization for biotransformation	VB Medicare Pvt. Ltd.	5.0	10/2008-10/2010
	Development of processes for isolation of nucleic acids, enzymes related to nucleic acids and kits related to above	VB Medicare Pvt. Ltd.	5.0	10/2008-10/2010
	Development of processes for purification of antibodies from biological fluids including fermentation broths and kits related to the above	VB Medicare Pvt. Ltd.	5.24	10/2009-10/2010
	Immobilized lipase for fatty acid ethyl ester synthesis.	Novozyme, Denmark	5.5	9/2009-2/2010
	Solubilization of proteases from *Bacillus licheniformis*.	Novozyme, Denmark	6.0	9/2009-9/2010
T.R.Sreekrishnan	Evaluation of AMT membrane modules for biogas purification in context to application in India.	Applied Membrane Technology Inc., USA	10	
	Evaluation of polyethylene septic tank	Reliance Industries Ltd.	4.6	
	Development of state of the art biological process with monitoring and control mechanism for coke oven effluent treatment	RDCIS, SAIL	25.23	
V.S Bisaria	Production of Rhizobium biofertilizer	TERI, New Delhi	5.61	2013
AK. Srivastava	Pilot scale trials of Plant Stem cells (suspension culture) using Bio-reactors	Himalaya Drug company, Bangalore	5.0	May 2013 to April 2014

3.11 New areas of research which are different from the faculty's PhD thesis area.

1. Application of molecular microbial tools in design and control of waste treatment systems
2. Human therapeutic production in *Pichiapastoris*.
3. Regeneration of corneal tissue.
4. Secondary metabolite production from plant cell cultures
5. Mass production of Secondary metabolites from plant cell /hairy root cultures using novel bio-reactors
6. MicroRNA research in cancer biology.
7. Genome engineering.
8. Plant-microbe interactions and applications.
9. Point of care diagnostics
10. Fate and treatment of emerging pollutants
11. Antibiotic resistance in the environment

3.12 Methodology for (i) identifying obsolescence in research areas, and (ii) identification of new areas for future research.

New areas of research are identified on the basis of both Institute level interaction and departmental level discussions. Interdisciplinary activities interfacing at engineering and biological sciences are highly encouraged.

3.13 Number of large interdisciplinary projects (within department's areas, and across the institute).

Faculty Name	Joint PhD student (within department)	Joint Project (within department)	Joint PhD student (outside department)	Joint Project (outside department/institute)
M.N.Gupta	0	3	0	0
T.R.Sreekrishnan	1	4	4	5
A.K. Srivastava	1	1	0	1
V.S. Bisaria	2	5	0	0
P.K. Roychoudhary	2	0	0	1
Prashant Mishra	0	4	4	1
Saroj Mishra	4	4	1	1
Subhash Chand	0	0	0	0
Sunil Nath	2	1	0	0
G.P. Agarwal	1	2	0	0
Atul Narang	0	1	0	1
D Sundar	0	3	0	3
Shilpi Sharma	4	3	0	0
Ritu Kulshrestha	2	1	1	2
Ravikrishnan E	2	1	2	1
Preeti Srivastava	2	0	0	0
Ziauddin Ahammad	1	0	5	0

Appendix 3a

M.N. Gupta

2009

1. Majumder, A.B., Ramesh, N.G., Gupta, M.N. (2009) A lipase catalyzed condensation reaction with a tricyclic diketone-yet another example of biocatalytic promiscuity. *Tetrahedron Letters* 50, 5190–5193.
2. Raghava, S., Singh, P.K., Ranga Rao, A., Dutta, V., Gupta, M.N. (2009) Nanoparticles of unmodified titanium dioxide facilitate protein refolding. *Journal of Materials Chemistry* 19, 2830-2834.
3. Raghava, S., Gupta, M.N. (2009) Tuning permeabilization of microbial cells by three phase partitioning. *Analytical Biochemistry* 385, 20-25.

2010

1. Dalal, S., Gupta, M.N. (2010) Purification and characterization of a peroxidase isozyme from Indian turnip roots. *Journal of Agriculture and Food Chemistry* 58 (9) 5545-5552.
2. Raghava, S., Gupta, M.N. (2010) Purification and characterization of an alcohol dehydrogenase with an usual specificity towards glycerol from *Thermus thermophilus*. *Bioresource Technology* 101, 2544-2557.
3. Majumder, A.B., Gupta, M.N. (2010) Stabilization of Candida rugosa lipase during transacetylation with vinyl acetate. *Bioresource Technology* 101, 2877-2879.

2011

1. Solanki, K., Gupta, M.N. (2011) Simultaneous purification and immobilization of Candida rugosa lipase on superparamagnetic Fe3O4 nanoparticles for catalyzing transesterification reactions. *New Journal of Chemistry* 35 (11), 2551- 2556.
2. Solanki, K., Gupta, M.N. (2011) A chemically modified lipase preparation for catalyzing the transesterification reaction in even highly polar organic solvents. *Bioorganic Medicinal Chemistry Letters* 21 (10), 2934-2936.
3. Majumder, A.B., Gupta, M.N. (2011) Increasing catalytic efficiency of Candida rugosa lipase for the synthesis of tert-alkyl butyrates in low-water media. *Biocatalysis and Biotransformation* 29 (6), 238- 245.

2012

1. Rather, G. M., Mukherjee, J., Halling, P. J. and Gupta, M.N. (2012) Activation of Alpha Chymotrypsin by Three Phase Partitioning is Accompanied by Aggregation. *PLoS ONE* 7, e49241.
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Ritu Kulshreshtha

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1. Pasquale Fasanaro, Simona Greco, Maria Lorenzi, Mario Pescatori, Maura Brioschi, Ritu Kulshreshtha, Cristina Banfi, Andrew Stubbs George A. Calin, Mircea Ivan, Maurizio C. Capogrossi, and Fabio Martelli (2009) An integrated approach for experimental target identification of hypoxia-induced mir-210. *Journal of Biological Chemistry*. 284:35134-43
2. Crosby M, Kulshreshtha R, Ivan M, Glazer PM (2009) MicroRNA Regulation of DNA Repair Gene Expression in Hypoxic Stress. *Cancer Research*, 69:1221-9.

2010-2011

1. Vaz C, Ahmad HM, Sharma P, Gupta R, Kumar L, Kulshreshtha R, Bhattacharya A. (2010) Analysis of microRNA transcriptome by deep sequencing of small RNA libraries of peripheral blood. *BMC Genomics* 11:288
2. Moskwa P, Buffa FM, Pan Y, Panchakshari R, Vischioni B, Gottipati P, Abdelmohsen K, Camps C, Ragoussis J, Kulshreshtha R, Weinstock DM, Parker A, Pezzella F, Gorospe M, Sharma RA, Helleday T, Harris AL, Chowdhury D. (2011) miR-182-mediated down-regulation of BRCA1 impacts on the DNA damage response and breast cancer therapy. *Molecular Cell* 21;41(2):210-20

2011-12

1. Srikantan S, Abdelmohsen K, Lee EK, Tominaga K, Subaran SS, Kuwano Y, Kulshrestha R,Panchakshari R, Kim HH, Yang X, Martindale JL, Marasa BS, Kim MM, Wersto RP, Indig FE, Chowdhury D, Gorospe M. (2011) Translational control of TOP2A influences doxorubicin efficacy. *Mol Cell Biol*. 31(18):3790-801.

2012-13

1. Saxena S, Tandon B, Sharma S, Chameettachal S, Ray P, Ray AR, Kulshreshtha R. (2013) Combined miRNA and mRNA signature identifies key molecular players and pathways involved in Chikungunya virus infection in human cells. *PloS One*, DOI: 10.1371/journal.pone.0079886.
2. Vaz C, Ahmad HM, Bharti R, Pandey P, Kumar L, Kulshreshtha R, Bhattacharya A. (2013) Analysis of the microRNA transcriptome and expression of different isomiRs in human peripheral blood mononuclear cells. *BMC Res Notes*. 6:390.
3. Sharma S, Verma S, Vasudevan M, Samanta S, Thakur JK, Kulshreshtha R. (2013) The interplay of HuR and miR-3134 in regulation of AU rich transcriptome. *RNA Biology*, 10(8):1283-90
4. Nagpal N, Ahmad HM, Molparia B, and Kulshreshtha R (2013) MicroRNA-191, an estrogen responsive microRNA, functions as an oncogenic regulator in human breast cancer. *Carcinogenesis* 34(8):1889-99.

Ravikrishnan Elangovan

2010

1. L. Fusi, M. Reconditi, M. Linari, E. Brunello, R. Elangovan, V. Lombardi and G. Piazzesi. (2010) The mechanism of the increase in resistance to stretch of isometrically contracting single muscle fibres. *J. Physiol.* 588:495-510

2011

1. S. Nath, R. Elangovan. (2011) New perspectives on photosynthetic phosphorylation in the light of a torsional mechanism of energy transduction and ATP synthesis" *Journal of Bioenergetics and Biomembranes*. 43(6): 601-10.

2012

1. R. Elangovan, M. Capitanio, L. Melli, F. SaverioPavone, V. Lombardi, and G. Piazzesi (2012) An integrated in vitro and in situ study of kinetics of myosin II from frog skeletal muscle" by J Physiol. 590(5): 1227-42.

2013

1. Soni U, Pal A, Singh S, Mittal M, Yadav S, Elangovan R, Sapra S. (2013) Simultaneous Type-I/Type-II Emission from CdSe/CdS/ZnSe Nano-Heterostructures. *ACS Nano* 8(1):113-23

Preeti Srivastava

2011

1. Srivastava, P., Singh, P., Narayanan, N. and Deb, J.K. (2011) Physiological and biochemical consequences of host plasmid interaction: a case study with Corynebacteriumrenale, a multiple cryptic plasmid containing strain. *Plasmid* 65:110-117

2013

1. Singh, P. and Srivastava, P. (2013) An improved protocol for electroporation in members of the genus Gordonia. *J. Microbiol. Methods* 95: 114-116.
2. Jain, A. and Srivastava, P. (2013) Broad Host Range Plasmids. *FEMS Microbiol Lett.* 348: 87-96.
3. Equbal, J., Srivastava., P., Agarwal, G.P. and Deb J.K. (2013) Novel expression system for *E. coli* and *Corynebacterium acetoacidophilum* based on T7 RNA polymerase dependent promoter. *Appl. Microbiol Biotechnol.* 97: 7755-7766.

Ziauddin Ahammad

2010

1. Ahammad, S. Z.; Gomes, J. and Sreekrishnan, T. R. (2010), A comparative study of two high cell density methanogenic bioreactors. *Asia-Pacific Journal of Chemical Engineering*, 6: 95–100.

2011

1. Ahammad, S. Z.; Gomes, J.; Sreekrishnan, T. R. (2011), A mathematical model for the interactive behavior of sulfate reducing bacteria and methanogens during anaerobic digestion. *Water Environment Research* 83(9), 791-801.

2012

1. Ahammad, S. Z.; Yakubu, A.; Dolfing, J.; Mota, C. and Graham, D. W. (2012), Feasibility tests for treating shampoo and hair colorant wastewaters using anaerobic processes. *Water Science and Technology* 65(2), 303-308.

2013

1. Ahammad, S. Z.; Davenport, R. J.; Read, L. F.; Gomes, J.; Sreekrishnan, T. R. and Dolfing, J. (2013), Rational immobilization of methanogens in high cell density bioreactors. *RSC Advances* 3, 774–781.
2. Ahammad, S. Z.; Zealand, A.; Dolfing, J.; Mota, C.; Armstrong, D. V. and Graham, D. W. (2013), Low-energy Treatment of Colourant Wastes using Sponge Biofilters for the Personal Care Product Industry. *Bioresource Technology* 129, 634-638.
3. Ahammad, S. Z.; Bereslawski, J. L.; Dolfing, J.; Mota, C.; Graham, D. W. (2013). Anaerobic–aerobic sequencing bioreactors improve energy efficiency for treatment of personal care product industry wastes. *Bioresource Technology* 139, 73–79.

Innovation, Design and Development

Executive Summary: <u>Innovation, Design and Development</u>

A total of **6 patents** have been filed of which **5** have been granted. Institute wide innovation grants have been availed by **14** students in the department. Teams mentored by the faculty compete in **1** event of which **1** are international. Effective translational research requires close collaboration with the industry. To foster this collaboration, we are considering joint Masters project with industry. We are open to other suggestions.

4. Innovation, Design and Development

4.1 No. of students who have been funded for innovating (TePP, PRISM, etc.).

Students who were funded through under the Undergraduate Research Opportunity Program (UROP) - Summer Undergraduate Research Award (SURA) are listed below:

Year	Students	Project Title	Faculty Mentor
2009	Bhuvan Molparia (2007BB50013) Kanav Goyal (2007CS10167)	Computational prediction of DNA recognition by zinc finger proteins	Dr. D. Sundar
2010	Krishna Choudhary (2008BB50015) Kriti Gupta (2008BB50016)	Towards understanding of molecular interactions between zinc finger proteins and DNA	Dr. D. Sundar
2011	Shruti Singla (2009BB50038) Kanika Khanna (2009BB50012)	Finding genes in eukaryotic genomic DNA	Dr. D. Sundar
2012	Aayushi Jain (2010BB50001)	Transposon-aided capture method for the isolation of plasmids in water metagenome	Dr. Preeti Srivastava
2013	Komal Saini (2011BB50025) Nikita Gupta (2011BB50031)	Study of structural changes in DNA configuration upon binding to zinc finger proteins	Dr. D. Sundar
2013	Anirudh Mittal (2011BB50004) Anshika Gupta (2011BB50005)	Isolation of microorganisms for viscosity reduction of heavy crude oil using carbon source as coronene	Dr. Preeti Srivastava

Students who were funded under the Technology Development Project Initiation Award for Students (TDP-IAS) are listed below:

Year	Students	Project Title	Faculty Mentors
2010	Vibhuti Agrawal (2006BB50029) Nishant Shrivastava (2007BB50021) CSS Pavan (2008BB50011)	Elicitor controlled product release in an immobilized bacterial flow system	Dr. D. Sundar Dr. Atul Narang

4.2 and 4.3 Technology developed and transferred

The technology for mass cultivation of biofertilizers (*Pseudomonas* spp) developed by a team consisting of Prof. VS. Bisaria, Dr. Vikram Sahai and Dr. Shilpi Sharma of the department has been licensed to two Indian industries, viz., Nagarjuna Chemicals and Fertilizers Limited, Hyderabad and Pest Control of India, Bangalore on November 02, 2012 for a license fee of Rs. one crore each under non-exclusive agreement. The process of Technology Transfer is in progress.

Number of patents filed and patent granted as a fraction of patents filed.

1) An improved process for fluidized flow bioreactor and apparatus thereof, Patent Application No. 1479/Del/99. Accepted. (Inventors: TR. Sreekrishnan and Atul Gupta).
2) A 1200 Liter Vertical Solid-State Bioreactor for the Conversion of Lignocellulosic Residues to Animal Feed, Indian Patent application filed by Department of Biotechnology, Ministry of Science and Technology, Govt. of India (application processed through DBT, Govt. of India) (Inventors: James Gomes, TR. Sreekrishnan and VS. Bisaria)
3) A Process for Enhanced Production of Bioactive Compound, Indian Patent Application Number 1266/DEL/2007 (on use of co-culture for production of podophyllotoxin), Application No. 1266/Del/2007. (Inventors: VS. Bisaria, AK. Srivastava, A. Baldi, A. Jain and N. Gupta)
4) Bioreactor and uses thereof (Development of a suitable bioreactor system for azadirachtin production by hairy roots of *Azadirachta indica* Appl. No. 148/Del/2010 (Inventors: AK. Srivastava ,VS. Bisaria and Smita Srivastava)
5) Development of Process for Antimicrobial Textiles, Provisional Patent No: 1679 /DEL/ 2004/ dated September 06, 2004 (Inventors: Mangala Joshi, Roli Purwar and Prashant Mishra)
6) A Novel Variant of L-Asparaginase and its use thereof. Provisional patent filed. (Inventors: Bishwajit Kundu, Saurabh Bansal and Prashant Mishra)

Innovations of products, processes, designs, etc. in the department.

- Pharmaceutical biotechnology based on plant and animal cell culture technology (anticancer molecules Podophyllotoxin, Bio-pesticides Azadirachtin, Urokinase (blood clot dissolving factors).
- Large-scale (1200 L) plant for solid state cultivation for lovastatin production.
- Industrial Enzymes: Lipases (designer lipids and other speciality chemicals), proteases (detergents), xylanases (animal feed, pulp and paper), β-glucosidases (glycoconjugates, biomimetics).
- Development of novel expression system for industrially important therapeutics.
- Industrial projects in Bio-pesticides, bio-fertilizers production.
- Recognized as a leader in Bioprocess Development of ethanol from renewable feedstock (ligno-cellulosics). This resulted in setting up of pilot plant facility for ethanol with help from MNES.
- Waste Treatment Technologies Developed – Hybrid Anaerobic Reactor - Pilot plant operating at Delhi Milk Scheme (Patel Nagar, Delhi) treating dairy industry wastewater.
- Technology developed for pre-bleaching of Kraft pulp - High xylanase production on cheap raw materials, Very low cellulase activity, Has been cultivated at 300 Liters

- Online computational servers and databases for analyzing high-throughput genome data

Availability and access to students' workshops, "tinkering laboratories" so that they may pursue their own ideas.

- All the teaching and research laboratories
- Computation Laboratory
- Bioinformatics Laboratory

No. of students/teams who have competed in national / international competitions and outcome.

- iGEM team of 2010 and 2013 (International Synthetic Biology Competition, USA) – Bronze Medal. The iGEM 2010 team was mentored by Drs. D. Sundar and Atul Narang; the iGEM2013 team is being mentored by Drs. VS Bisaria, Preeti Srivastava and Shilpi Sharma.

- *Academic Research by Undergraduate Students* (National event hosted by IIT Kanpur in 2010) – our team was represented by Bhuvan Molparia and Kanav Goyal - Innovation Award

- One of the recent PhD student alumni (year 2011) from the department Dr. Abhinav Grover who is currently an Assistant Professor in Jawaharlal Nehru University (JNU, New Delhi), received the following competitive awards in recognition of the quality of his PhD work in the department–

    - Shortlisted for Innovative Young Biotechnologist Award (2014)
    - INSA Medal for Young Scientists (2013)
    - ICAR Jawaharlal Nehru Award (2013) - for outstanding PhD Thesis
    - DST INSPIRE Faculty Award (2012)
    - UGC Faculty Recharge Award (2012)
    - Bioclues Innovation and Research Development (BIRD) Award (2012)

R&D Environment

Executive Summary: R&D Environment

Space available, on the average, is **20 ft^2** for a Masters Student and **20 ft^2** for a Ph.D. candidate. The average faculty attends **5.5** national and **1.4** international conferences over five years. The average Ph.D. candidate attends **0.6** conferences over five years. Over the last five years, **0** Master's and **0** Ph.D. theses has been in co-supervision with researchers outside the unit. The number of conferences organized in the last five years has been **5**. We expect to see increasing collaboration with outside units since other engineering departments in the Institute have hired several faculty members with biological background (EE, ME, ChE, CBME). Increased attendance in international conferences is desirable, but rests upon better availability of funding.

5. R&D environment

5.1 No. of post-doctoral scholars hired in the department during the last 5 years and their durations, from (i) abroad, (ii) on project, and (iii) others and outcomes.

Sl.	Postdoctoral Scholar	Faculty Mentor	Duration	Source of Funding
1	Dr. Punitha Mishra	VS Bisaria D. Sundar	2008 - 2010	DBT-Research Associateship
2	Dr. Stefan Oehler	Atul Narang	2012 - continuing	IIT Delhi / IRD
3	Dr. Anita Srivastava	Saroj Mishra	2012 - continuing	IIT Delhi / IRD
4	Dr. Humayra Bashir	Saroj Mishra	2012 - continuing	DST Women Scientist
5	Dr. Zain Khan	TR Sreekrishnan	2013 - 2014	DST Women Scientist
6	Dr. Varsha Sharma	AK Srivastava	2013 - continuing	DBT-Research Associateship
7	Dr. Swati Mishra	AK Srivastava	2013 - continuing	DBT-Research Associateship
8	Dr. Bhawna Madan	Prashant Mishra	2013 - continuing	DST Women Scientist
9	Dr. Sonam Grover	D. Sundar	2013 - continuing	Sponsored Project
10	Dr. Sayantari Ghosh	Atul Narang	2014 - continuing	DBT-Research Associateship

5.2 No. of foreign students enrolled in (i) Masters, and (ii) PhD programmes.

None

5.3 No. of Indian and foreign faculty/researchers who have spent a sabbatical in the department.

None

5.4 Sabbatical taken by faculty and where spent (during the last 5 years).

Sl.	Faculty Member	Period	Assignment
1	Prof. VS. Bisaria	01-12-2008 to 30-11-2009	Visiting Professor Kobe University, Japan
2	Prof. Sunil Nath	29-07-2013 to 01-06-2014	Visiting Professor Technical University of Denmark & Helmholtz Centre for Infection Research, Germany
3	Prof. GP. Agarwal	01-01-2014 to 31-12-2014	To write a book and a review paper

5.5 Number of seminars (education and research separately) given by the faculty (i) in the department, (ii) in other departments, (iii) at other institutions.

The details are provided in Appendix 5a on page 96.

5.6 No. of faculty/researchers/scholars invited by the department for giving (i) seminars, (ii) spending at least a week in the department.

The details of speakers who visited the Department to deliver a lecture in the Deparmental Seminar Series during 2008-2013 are already listed under Section 1.3(g) on page 22.

5.7 No. of faculty/researchers who visited the department on their initiative for giving (i) seminars, (ii) spending at least a week in the department.

- The details of faculty/researchers who visited the Department on their own during 2008-2013 are listed under Section 1.3(g).
- *Prof. John Villadsen* of the Department of Chemical and Biochemical Engineering, Technical University of Denmark was a Visiting Professor in our Department for a month in November 2011. He delivered lectures on Industrial Bioreactors and provided new ideas to improve mass transfer and mixing. He is the co-author on the popular book entitled '*Bioreaction Engineering Principles'* published by Springer Verlag (3rd edition published in 2011)

5.8 Adequacy of research infrastructure.

By and large, adequate research infrasturure exists in the department or is in process off purchase. However, many of the equipments are now old and need to be replaced. The Institute supports the research infrastructure in the departments by creating central facilities units. These include state-of-the-art facilities of mass spectrometry, computational facilities, Atomic force microscopy, SEM, TEM, microscopy, nanofabrication facility etc. The Dept. also puts in proposals to DST/DBT for infrastructure/Centre of Excellence grant. These have resulted in purchase of some major facilities.

5.9 Adequacy of technical staff – existing numbers and competency areas; competency areas in which there is a shortage.

The department currently has the following technical staff whose competency areas are listed in the table below:

Sl.	Name of the Employee	Designation	Competency area
1	Mr. Bhagwan Singh	Technical Superintendent	Biochemistry and Microbiology laboratory for UG/PG courses
2	Ms. Renu Sethi	Technical Superintendent	Microbiology and enzyme technology
3	Mr. Mukesh Anand	Technical Superintendent	chromatography and other analytical instruments
4	Mr. Sant Ram	Junior Technical Superintendent	Autoclave and reactor maintenance
5	Mr. Shanti Prakash Rana	Junior Technical Superintendent	Bioprocess laboratories
6	Mr. Rajeev Kumar Dahiya	Junior Technical Superintendent	Electronics
7	Mr. Sumeet Kapoor	Junior Technical Superintendent	Culture maintenance
8	Mr. Kishan Chand	Senior Laboratory Assistant	Waste water treatment
9	Mr. Anish Raju	Junior Laboratory Assistant	Microbiology, Bioreactor Operation & maintenance

The strength of technical staff has come down in number over the past 5 years due to superannuation of some departmental technical staff members, who had experience in the domain of electrical and mechanical maitenance. In addition to these areas, we currently have shortage of technical staff to man the biology labs and a few UG/PG teaching laboratories.

5.10 Work space available for (a) Masters students, (b) Ph.D. students, (c) project staff, (d) post doctoral scholars.

	In square feet
Research Labs	16,263
Teaching Labs	3,347
Pilot Plant	4,800

5.11 No. of national conference/workshops/seminars attended by PhD students (*total and per student for 5 years*).

Total number attended by all the PhD students : 51
Number per student : 1

5.12 No. of international overseas conference/workshops/seminars attended by PhD students (*total and per student for 5 years*).

Total number attended by all the PhD students : 25
Number per student : 0.53

A partial list of PhD students who have attended International Conferences during the past five years are listed below:

Sl	PhD student	Entry Number	Conference	Venue	Dates
1	Mohit Naresh	2005BEZ8150	International Conference on Materials for Advanced Technologies	Singapore	June 2009
2	Abhinav Grover	2008BEZ8219	International Conference on Bioinformatics (InCoB)	Waseda University, Tokyo, Japan	Sep 2010
3	Abhinav Grover	2008BEZ8219	Asia Pacific Bioinformatics Conference (APBC)	Incheon, Korea	Jan 2011
4	Saurabh Bansal	2006BEZ8148	International Conference on Drug discovery & Theraphy	Dubai, UAE	Feb 2011
5	Abhinav Grover	2008BEZ8219	PepCon 2011 (Protein and Peptide Conference - Young Scientist talk)	Beijing, China	Mar 2011
6	Kankana Kundu	2008BEZ8280	International Conference on FEMS2011	Switzerland	June 2011
7	Surajbhan Sewda	2009BEZ8096	International Microbial Fuel Cell Conference	Netherlands	June 2011
8	Satyendra Singh	2009BEZ8510	6th IWA Specialist Conference on Membrane Technology for Water & Wastewater Treatment	Aachen, Germany	Oct 2011

9	Shweta Kamthan	2007BEZ8174	International Conference of Advance in Biotechnology	Singapore	Mar 2013
10	Nivedita Patra	2008BEZ8220	International Conference on Chemical and Process Engg (ICCPE)	KL, Malaysia	June 2013
11	Dhara Thakore	2009BEZ8512	International Conference on Chemical and Process Engg. (ICCPE)	KL, Malaysia	June 2013
12	Rashi Gupta	2009BEZ8092	International Conference on European Microbiologists	Germany, Leipzig	July 2013
13	Tenzin Kenzom	2009BEZ8511	International Conference on Environmental, Insdustrial and Applied Microbilogy-BioMicro World 2013	Spain, Madrid	Oct 2013
14	Swati Ojha	2007BEZ8173	International Conference on Environmental, Insdustrial and Applied Microbiology- BioMicro World 2013	Spain, Madrid	Oct 2013
15	Muthumareeswaran M.R.	2008BEZ8284	International Conferecnce on Membrane Science and Technology	Australia, Melbourne	Nov 2013
16	Neha Nagpal	2009BEZ8509	International Conference on Sensing and Signaling of Hypoxia: Interfaces with Biology and Medicine	USA, Colorado	Jan 2014

5.13 No. of students who have continued to Ph.D. (i) in same dept., (ii) other departments of IITD, (iii) in India, and (iv) abroad (separately for M.Tech. and B.Tech. students).

A partial list of dual degree students who have enrolled for PhD program after passing out from IIT Delhi are given below:

Sl.	Graduating Year	Student	Institution where enrolled for PhD Program
1	2008	Abhinav Grover	IIT Delhi
2	2008	Deepak Dugar	MIT, USA
3	2009	Anshul Rana	Stanford, USA
4	2009	Sucheta Arora	UT Austin, USA
5	2009	Vasudha Srivastava	Johns Hopkins University, USA
6	2009	Saumya Jain	University of Arizona, USA
7	2010	Ritesh Aggarwal	IIT Delhi
8	2010	Aditi Sharma	Georgia Tech, USA
9	2010	Gaurav Dugar	University of Wuerzburg, Germany
10	2011	Pushap Chawla	IIT Delhi

11	2011	Anveshika Aditya	IIT Delhi
12	2011	Vikas Pandey	IIT Delhi
13	2011	Suneer Verma	UCSD, USA
14	2011	Vibhuti Agarwal	MIT, USA
15	2011	Dhananjay Beri	Dartmouth College, USA
16	2011	Ankur Garg	Columbia University, USA
17	2011	Anuj Karpatne	University of Minnesota, USA
18	2012	Vivek Dwivedi	MIT, USA
19	2012	Bhuvan Molparia	The Scripps Research Institute, USA
20	2012	Bhavna Tandon	Rice University, USA
21	2012	Sumedha Roy	Duke University, USA
22	2012	Ankita Thawani	Purdue University, USA
23	2012	Sohail Gupta	Stanford-India Biodesign Program
24	2013	Tanvi Saxena	MIT, USA
25	2013	Radhika Giri Rao	Iowa State University, USA
26	2014	Shruti Singla *	Cambridge University, UK
27	2014	Kanika Khanna *	University of Wisconsin, USA
28	2014	Shachi Mittal *	University of Illinois UC, USA University of Minnesota, USA

* have received offers for 2014 Fall PhD admission

5.14 No. of projects with co-guide from industry

None

5.15 No. of students who have spent time in industry as part of thesis/project work (give number and duration).

All students of the dual degree program are required to spend 58 days in the industry as a part of Industrial training program. A representative list of industries where our students underwent training in Summer 2013 are listed below:

Company Name
Anthem Biosciences Bangalore
ARAHC Gurgaon
Biocon Ltd., Bangalore
CPB India Pvt Ltd., E-54, sector-A, 5&6, Tronica City , Loni, Ghaziabad.
Dabur Research Foundation
Daichii Sankyo Gurgaon
GE Technology Centre Pvt. Ltd., John F Welch Technology Centre, Bangalore
Genova Biotech, Pune
Globus Spirits
Indian Oil Corporation Ltd , New Delhi
Lab India
Nestle India Limited

NextGen PMS Pvt. Ltd., Bangalore
Novozymes South Asia Pvt. Ltd., Bangalore
Novrartis
Piramal Healthcare
Provimi, Bangalore
Ranbaxy Lab Limited
Reliance Life Sciences Pvt. Ltd., Mumbai
Sericare Pune
Serum Institute of India Ltd, Pune
Virchow Biotech Private Limited, Hyderabad
Whirlpool Pune
Wokhardt Aurangabad

5.16 Self assessment reports of the department/centers/schools if any.

(a). The review of the PG teaching program that is partially supported by the Departmetn of Biotechnology (DBT), Govt of India is reviewed annually. As part of this Committee, several experts from academic and from leading biotech give their inputs and suggestions to improve the program. The minutes of the previous DBT Advisory Committee meeting are available in *Appendix 9a*.

(b). The inputs for Institute Annual report are sent to the Director's office each year. Certain sections of this departmental report also become part of the Director's Convocation Report of that particular year.

(c). All the faculty members are required to submit a self-assessment report annually to the Institute. This report is reviewed by a Review Committee constituted by the Director for each department.

5.17 Placement of M.Tech. and PhD graduates in technical careers.

Placement of PhD students graduated from the department during 2008-2013

Sl.	PhD Student Alumni	Passing Year	Supervisor (s)	Current Position and Affiliation
1	Parul Gupta	2008	Tapan K. Chaudhuri	Senior Scientist Dr. Reddy's Lab Hyderabad
2	Mukesh Goel	2008	TR. Sreekrishnan	Assistant Professor PRIST University Thanjavur, Tamilnadu
3	Ashish Baldi	2008	AK. Srivastava VS. Bisaria	Professor & Principal ISF College of Pharmacy Chandigarh
4	Anand Ghosalkar	2008	Vikram Sahai	Staff Technologist Praj Industries, Pune
5	Smitha Srivastava	2009	AK. Srivastava	Assistant Professor IIT Madras
6	Bhawna Madan	2009	Prashant Mishra	DST Women Scientist IIT Delhi
7	Ashwani Mathur	2009	Subhash Chand	Assistant Professor Jaypee Institute of Information Technology Noida

8	Mohammad Asif Shah	2009	Saroj Mishra Tapan K. Chaudhuri TP. Singh (AIIMS)	Lecturer, Kashmir University
9	Alok Kumar Malaviya	2009	James Gomes	Principal Investigator DuPont Knowledge Centre Hyderabad
10	Anjali Madhavan	2009	VS Bisaria	Scientist Mitsui Chemicals R&D Singapore
11	Ziauddin Ahammad	2009	TR. Sreekrishnan James Gomes	Assistant Professor IIT Delhi
12	Meenu Chhabra	2009	Saroj Mishra TR. Sreekrishnan	Assistant Professor IIT Jodhpur
13	Bhawana Agarwal	2009	Sunil Nath	Research Associate Medical College of Wisconsin, USA
14	Roohi Gupta	2009	Prashant Mishra Aditya Mittal	Postdoctoral Fellow Fox Chase Cancer Centre, Philadelphia, USA
15	Vinod Kumar	2010	VS. Bisaria Vikram Sahai	Postdoctoral Fellow University of Nottingham, Loughborough, UK
16	Richa Baranwal	2010	Saroj Mishra	Scientist, National Institute of Biologicals MOHFW, Noida
17	Rajib Nayak	2010	James Gomes	Deceased
18	Mohit VS Naresh	2011	Aditya Mittal Prashant Mishra	Senior Scientist Dr. Reddy's Lab Hyderabad
19	Raju Shankaryan	2011	Prashant Mishra	Assistant Professor Mata Vaishno Devi Univ Katra, J&K
20	M.V.R.K. Sarma	2011	VS. Bisaria Vikram Sahai	Postdoctoral Fellow Lund University, Sweden Has been offered a *Scientist* position @ CSIR-CFTRI, Mysore
21	Abhinav Grover	2011	D. Sundar VS. Bisaria	Assistant Professor JNU
22	Saurabh Bansal	2011	Biswajit Kundu Prashant Mishra	Assistant Professor Jaypee University, Solan
23	Sucharita Sen	2012	PK. Roychoudhary	
24	Motipalli Ramesh	2012	TR. Sreekrishnan	Deputy Director MoEF, Govt. of India
25	Kankana Kundu	2013	TR. Sreekrishnan Shilpi Sharma	
26	Guneet Kaur	2013	AK. Srivastava Subhash Chand	Postdoctoral Fellow VITO, Belgium
27	Surajbhan Sevda	2013	TR. Sreekrishnan	Postdoctoral Fellow Qatar University, UAE

Placement of PhD students graduated from the department during 2003-2007

Sl.	PhD Student Alumni	Passing Year	Supervisor (s)	Current Position and Affiliation
1	Preeti Srivastava	2003	JK. Deb	Assistant Professor IIT Delhi
2	Mohsen Nosrati	2004	TR. Sreekrishnan	Assistant Professor Tarbiat Modares University Tehran, Iran
3	K. Narsaiah	2004	GP. Agarwal	Scientist ICAR-CIPHET, Ludhiana
4	Salony	2005	Saroj Mishra	Research Fellow Massachusetts General Hospital, USA
5	Ritu Mehta	2004	Sunil Nath	
6	Vibha Bansal	2005	PK. Roychoudhary	Assistant Professor University of Puerto Rico at Cayey
7	Nidhi Gupta	2005	PK. Roychoudhury JK. Deb	Assistant Professor Jaypee Institute of Information Technology Noida
8	Ruchi Shukla	2005	Subhash Chand AK. Srivastava	Deputy Manager Tata Chemicals Ltd. IC
9	Pranita Roy	2005	Saroj Mishra	Assistant Professor Amity University, Noida
10	V. Saravanan	2005	TR. Sreekrishnan	Scientist (Biofuels) Shell Global Solutions Netherlands
11	Gunjan Prakash	2006	AK. Srivastava	Scientist DBT-ICT Centre for Energy Biosciences Institute of Chemical Technology, Mumbai
12	Ritu Sareen	2005	Prashant Mishra	Postdoctoral Fellow University of Münster Germany
13	Snehasis Jana	2005	JK. Deb	Scientist Sai Advantium Pharma Ltd Pune
14	Subhankar Paul	2006	Tapan K. Chaudhuri	Associate Professor NIT Rourkela
15	Shilpa Sharad Khaparde (Shilpa Khaparde Chapadgaonkar)	2006	PK. Roychoudhury	Assistant Professor Manav Rachna International University Faridabad
16	Ushasri Chilakamarthi	2006	JK. Deb Sunil Mukherjee (ICGEB)	Research Associate CSIR-CCMB Hyderabad
17	Kavita Arora	2007	Subhash Chand BD. Malhotra	Assistant Professor JNU
18	Shlipi Khanna	2007	AK. Srivastava	Scientist, BIRAC DBT, New Dlehi
19	Mili Prabhakar	2006	Subhash Chand	

20	Rupali Walia	2007	JK. Deb	Postdoctoral Fellow University of Calgary Canada
21	Ranjita Biswas	2007	VS. Bisaria	Postdoctoral Fellow Oak Ridge National Lab Tennessee, USA

5.18 Inter-disciplinary work -: (i) joint thesis guidance by faculty across groups within a department, or across departments/centres, (ii) Proposals submitted and funded – PI-CoPI and their group/department affiliations.

The details of inter-displinary work are available as part of Section 3.13 on page 58.

Appendix 5a

Seminars given by faculty (2008-2013)

M.N.Gupta

Date	Name of Institution and Address	Title	Occasion
June, 2008	Department of Chemistry, University of Strathclyde, Glasgow, Scotland	Smart polymers in separation and refolding of proteins	As a visiting scientist under UKIERI project
November, 2008	Osmania University, Hyderabad, India	Stimuli-responsive polymers in biotechnology	3rd International Congress on Bioprocesses in Food Industries (ICBF-2008)
Feb 14, 2011	Faculty of Science, JamiaHamdard, Delhi	Enzymes and biotechnology	Enterpreneurship and skill development (ESDP) organised by Micro, Small and M Enterprise Development Institute (MSME of India
March 30, 2011	AIIMS, New Delhi	Breakdown of an old paradigm called Structure-Activity Relationship in Proteins	symposium titled “Current Trends in Structural Biology 2011”
May 12, 2011	VigyanPrasar, New Delhi	Chemistry and Clean Technologies	Round Table Discussion on National Technology Day-2011at VigyanPrasar Representing President, NASI
Nov 12, 2011	IIT Delhi	Research Eco-systems: Looking at yesterday to improve our tomorrow	Golden Jubilee workshop on "Taking Research at IIT Delhi to New Heights: Perspectives and Approaches"
Jan 12, 2012	India International Center Annexe, New Delhi	Latest Developments in Chemistry Research	Special lecture organized by Merck-Millipore Celebrating year of Chemistry
Feb 20, 2013	AIIMS, New Delhi	Protein Aggregation: An Evil or a Blessing in Disguise	Symposium on Current Trends in Structural Biology 2013
	IIT Delhi	Precipitation, (micro-)crystals and aggregates of proteins Their structure and function	Symposium on Biocatalysis-2013

		from the perspective of applied biocatalysis	
February 2013	Sri Venkateswara College, DU, Delhi	Understanding enzymes and how to work with these biocatalysts	Special Lecture
Sept 17, 2013	Rudeishiem, Germany	Challenges in reporting of data in (applied) biocatalysis	6th International Beilstein Symposium on Experimental Standard Conditions of Enzyme Characterizations
Dec 6, 2013	IIT Delhi	Precipitates, Aggregates and Nanomaterials in Applied Biocatalysis	Symposium on Bioprocessing 2013
Dec 16, 2013	Indian Habitat Centre, New Delhi	Enzyme Promiscuity: Biochemical and Biotechnological Perspectives	International symposium Asian Congress of Biotechnology 2013; Keynote Lecture

T.R.Sreekrishnan

Title of Lecture/ Lecture Series	**Date, Place and programme where lectures delivered**
Stabilization of Wastewater Treatment Sludges Using Auto-Heated Aerobic Thermophilic Digestion Process	Workshop in connection with the IITD-EPSRC Project "Environmental Engineers of Tomorrow: Developing a shared tool box through collaboration". IIT Delhi, 12th September, 2008
Developments in Biological Treatment of Textile Effluents	Workshop on Treatment and Reuse of Textile Industry Effluents, IIT Delhi, 12th December, 2008.
Modelling of Biological Treatment Processes	Theme Workshop on Emerging Trends in Environmental Biotechnology, National Institute of Technology, Surathkal, 14th January, 2009.
Energy neutral biological processes for waste stabilization.	Workshop in connection with the IITD-EPSRC Project "Environmental Engineers of Tomorrow: Developing a shared tool box through collaboration". University of Glasgow, 24th March, 2009.
Biological Processes for Molasses Wastewater Treatment: Challenges in Scale-up.	Workshop on "Innovative technologies for the remediation and reuse of wastewater from molasses distilleries", The Energy and Resources Institute (TERI), New Delhi, 15 April 2009.
Developments in Biological Waste Treatment Processes	National Conference on Biotechnology and the Environment, National Institute of Technology Durgapur, Durgapur. 4th October, 2010.

Developments in Environmental Biotechnology	National Workshop on Recent Advancements in Biotechnology and Biochemical Engineering, Institute of Engineering and Science, IPS Academy, Indore, 22nd October, 2010.
"Bioreactors" (Lecture Series)	National Workshop and Seminar on "Sustainable Energy and Green Environment" (SEGE10), 4th to 6th December, 2010, Trivandrum.
"Different Reactor Configurations for Biogas Production"	Training Programme on 'Biogas Production, Purification and Bottling Technology and Electricity Generation', 14-16 February, 2011, IIT Delhi.
"Recent Developments in Biological Treatment of Waste Waters"	Training Programme on Biotechnology Treatments of Biological Waste and Waste Waters", 28 February – 2 March, IIT Delhi.
Removal of Toxic Organics from Waste Waters by Biological Treatment"	Plenary Lecture at the International Conference on "Recent Advances in Chemical Engineering and Technology (RACET-2011)", 10-12 March, 2011, Kochi.
"Modelling of Pollution Control Systems"	AICTE/MHRD sponsored Short-term course on "Environment Management in Process Industries", 5-9 June, 2011, National Institute of Technology, Jalandhar.
"Solid Waste Management"	AICTE/MHRD sponsored Short-term course on "Environment Management in Process Industries", 5-9 June, 2011, National Institute of Technology, Jalandhar.
Biochemical Engineering solutions for environmental issues in India	Lecture delivered at Newcastle University, U.K., 7th June, 2012.

A.K. Srivastava

Date	Name of Institution & Address	Title	Occasion
18-19 Jan, 2008	IMS Engineering College, Ghaziabad	Biochemical Engineering challenges in the overproduction of fermentation products", on "Emerging trends in Biotechnology	Invited lecture in National conference – cum – Seminar
12-17 Oct, 2008	13th International Biotechnology Symposium, Dalian, China	Model based integrated plant cell cultivation for mass production of bio-pesticides (Azadirachtin)	Oral paper presented
18-20 Nov, 2008	49th Annual conference and International Symposium on Microbial Biotechnology: Diversity, Genomics and Meta genomics, University of Delhi, Delhi	Bioprocess Engineering Challenges in the biopolymer production	Invited oral presentation

4-6th Nov, 2011	International conference on chemistry of phytopotentials: Health, Energy and Environmental perspectives (CPHEE 2011), Dayalbagh Educational Institute, Dayalbagh, Agra 282110	In vitro bioreactor Plant Cell cultivation as a novel technique for mass production of Bio-pesticide (Azadirachtin)	Invited Lecture
23 Jan, 2012	Recent Trends in Plant Biotechnology and Transgenics" at Thapar University Patiala	Production of secondary metabolites by plant cell/hairy root cultures in bioreactor	Invited lecture in a workshop
Feb 18, 2012	Department of Botany, Dayalbagh Educational Institute, Agra	*In-vitro* production of secondary metabolites	Invited lecture
Mar 23, 2012	National workshop on Medicinal Plants- Scientists, Grower and Industry Interaction, Organized by Society for Conservation and Resource Development of Medicinal Plants, INSA N. Delhi	Mass Scale production of plant secondary metabolites by Plant cell/hairy root cultivation in bioreactors	Invited Lecture
16-17 Mar, 2013	Jaypee Institute of Information Technology, Noida (U.P.)	Innovative methods for mass production of Bio-pesticides in International conference on Bio-products and the Omics revolution	Invited lecture
April 6, 2013	Department of Botany, Dayalbagh Educational Institute, Agra	Mass scale production of Plant secondary metabolites using bioreactor plant cell and hairy root cultivation	Invited lecture
Nov 21-24, 2013	"International conference on Environment Health and Industrial Biotechnology" (Biosangam 2013), Motilal Nehru National Institute of Technology, Allahabad -221004 (U.P.)	Biotechnological methods of Bio-pesticide production from neem" in the session "Biotech Products and Process Development" and Chairman "Bio-energy and Bio-nanotechnology" Session at	Invited plenary lecture
Nov 21-23, 2013	International conference on Environment Health and Industrial Biotechnology (Biosangam 2013) at Motilal Nehru National Institute of Technology, Allahabad (U.P.) India	"Biotechnological methods of bio-pesticide production from neem" (Biotechnology Products and Process Development Session)	Invited plenary lecture. Also Chairman of "Bio-energy and Bionano-technology" session
Dec 19-24	H.B. Technological Institute, Kanpur	Design and analysis of Immobilized enzymes" in the faculty development program on "Advances in enzyme production and their industrial application	Invited Key note lecture

V.S. Bisaria

Date	Name of Institution & Address	Title	Occasion
May - 2010	Tokyo, Japan	Process Optimization for Enhanced Production of Cell Biomass and Metabolites of Fluorescent Pseudomonad R81	International conference on biotechnology & bioengineering
Oct - 2010	SongdoConvensia, Incheon, South Korea	Development of non-sterile inorganic carrier- based formulations of fluorescent pseudomonad for agronomical applications	Korean Society for Biotechnology & Bioengineering
May - 2011	Shanghai, China	Bioprocess Strategies for Mass Multiplication of and Metabolite Synthesis by Plant Growth Promoting Pseudomonads for Agronomical Applications	Asian Congress on Biotechnology
Oct - 2011	SongdoConvensia, Incheon, South Korea	Enhanced Production of Fluorescent Pseudomonad R81 and its Metabolites for Agronomical Applications	Korean Society for Biotechnology & Bioengineering
June - 2012	Washington, DC	Mass Multiplication of Fluorescent Pseudomonad R81 and Synthesis of its Metabolites for Agronomical Applications	16th Green Chemistry and Engineering Conference
Sept - 2012	Daegu, Korea	High Cell Density Culture of Fluorescent Pseudomonad R81 and Synthesis of its Metabolites for Agronomical Applications	15th International Biotechnology Symposium (IBS-2012)

Prashant Mishra

Date	Name of Institution & Address	Title	Occasion
11-15 Nov, 2009.	IASE University, Sardarshahr, Rajasthan	Bionanotechnology and protein engineering approach for the formulation of proteinaceous drugs	National Workshop on 'Current Advancement in Biotechnology and Bioinformatics'
Feb 4-6, 2010	Rajiv Gandhi ProudyogikiVishvavidyalaya, Bhopal	Biodegradable nanoparticles for the delivery of pharmaceutical peptides and Proteins	National Conference on Cellular and Molecular Medicine
10 Dec, 2011	Toyo University, Japan	Delivery of Protein based Nanopharmaceuticals	9th International Symposium on Bioscience and Nanotechnology

3 Aug, 2011	IIT Delhi	Protein based pharmaceuticals: Issues related to stability and delivery	IITD-Toyo University Workshop
15th Oct 2011	Central Institute of Agricultural Engineering Bhopal	Enzyme Engineering and Technology in Food Processing	NAIP Sponsored Training on Non-thermal, Non-chemical Processing and Membrane Technologies for Food systems
22th Oct 2011	Rohtak	Biomolecular Engineering approach for Food Processing	Association of Microbiologist India
15th Dec 2011	Rajiv Gandhi ProudyogkiVishwavidyalaya , Bhopal	Biomolecular Nanotechnology	Invited Talk

G.P. Agarwal

Date	Name of Institution & Address	Title	Occasion
February 2011	Chemical Engineering Department, AC College, Chennai	Membrane Separation Technology	Indo-Europe Workshop cum Conference

Atul Narang

Date	Name of Institution and Address	Title	Occasion
Oct, 2008	University of Nottingham	Microbial gene regulation in diauxic and non-diauxic growth	Invited seminar
Oct, 2008	University of Aberdeen	Same as above	Invited seminar
Nov, 2008	Imperial College	Same as above	Invited seminar
Mar, 2009	American Physical Society	Same as above	Invited talk at annual conference
May, 2009	American Society of Microbiology	Same as above	Invited talk at annual conference
July, 2009	Lewis-Sigler Institute, Princeton Univ	Same as above	Invited seminar
Dec, 2010	Bose Institute, Kolkata	Same as above	Invited seminar
Feb, 2011	INSA	Same as above	Workshop on systems biology
Feb, 2012	Society of Math Biology	Same as above	Invited talk in annual conference

D. Sundar

Sl	Date	Name of Institution and Address	Title	Occasion
1	Jun 16, 2008	IIT Delhi	Modern approaches in manipulation of a genome	Short Term Course on Recent Process Biotechnology Advances
2	Jun 18, 2008	National Botanical Research Institute (NBRI), CSIR, Lucknow	Designing of synthetic transcription factors for future genetic engineering	Invited Lecture
3	Nov 22, 2008	Mahatma Gandhi Institute of Medical Sciences, Sevagram, Maharashtra	Designer DNA-binding proteins for human therapeutics	11th Workshop on "Medical Informatics and Biomedical Communication"
4	Dec 20, 2008	IIT Madras	Interrogating DNA-protein interactions for controlling gene expression at will.	77th Annual Meeting of the Society of Biological Chemists of India (SBC)
5	Jan 05, 2009	96th Indian Science Congress (2009) held at North Eastern Hill University (NEHU) Shillong	Precision engineering of the genome	Special Young Scientist Session – Frontiers of Science" organized by the Department of Science & Technology (DST), Govt. of India
6	Feb 04, 2009	North Eastern Hill University (NEHU) Shillong	Genome Surgery	Special Lecture at the "XXth Annual Bioinformatics Coordinators Meeting" organized by the Department of Biotechnology (DBT), Govt. of India"
7	Mar 14, 2009	SRM University Chennai	Getting a handhold on designing proteins for human therapeutics	"National Seminar on "Bioinformatics Applications in Medical Sciences"
8	Apr 13, 2009	Homerton Grammar School, Faridabad	Human Genome Project	Invited Lecture
9	Sep 17, 2009	Supercomputing Facility for Bioinformatics and Computational Biology (ScFBio), Indian Institute of Technology (IIT) Delhi	A decade of genome informatics	"Training Program in Bioinformatics and Computational Biology"
10	Oct 09, 2009	International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi	Genome informatics and genome engineering	"Workshop on Applications of Structural and Computational Biology in Biomedical Research"

11	Oct 31, 2009	Sri Venkateshwara College New Delhi	Introduction to Genomics & Proteomics	Invited Seminar
12	Dec 22, 2009	JamiaHamdard New Delhi	Analysis and prediction of DNA-binding proteins	“International Symposium on Aromatic and Medicinal Plants (AROMED)”
13	Feb 24, 2010	Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow	Engineering secondary metabolite production in plants by modern approaches	“Two day workshop & Hands-on training on bioinformatics application in computer-aided drug design"
14	Mar 28, 2010	Holy Family Hospital, Lady Tata Memorial Trust, Mumbai	Towards modifying nature’s DNA recognition system for highly specific genome editing	Invited Lecture
15	Sep 04, 2010	SCFBio, IIT Delhi	Genomics – Introduction and scope	Invited Seminar
16	Sep 06, 2010	University of Jammu, Jammu	Analysis and prediction of DNA-binding proteins	Invited Seminar
17	Oct 08, 2010	University of Kerala, Thiruvanthapuram	Getting a handhold on designing proteins for potential applications in human therapeutics	Invited Seminar
18	Oct 27, 2010	IIT Delhi	Targeted genome engineering	Indo-Swiss Bioinformatics Symposium
19	Dec 11, 2010	IIT Delhi	Tools for probing DNA-protein interactions to aid in targeted genome engineering	Indo-Japan Symposium on Bioinformatics
20	Feb 24, 2011	Biotech Park, Biotechnology City, Lucknow	Getting a handhold on designing proteins for human therapeutics	National Workshop on In silico drug discovery based on integration of bioinformatics and chemoinformatics
21	Feb 26, 2011	National Bureau of Animal Genetic Resources (NBAGR), Karnal	Getting a handhold on designing proteins for targeting unique address in a genome	National Training Program on Bioinformatics for Animal Genomics and Proteomics under the National Agricultural Innovation Project (NAIP) of ICAR
22	Mar 26, 2011	Tata Memorial Centre Mumbai	Towards modifying nature’s DNA recognition system for highly specific genome editing	Invited Lecture
23	Mar 29, 2011	Sri Venkateshwara College New Delhi	Introduction to Genomics & Proteomics	Invited Seminar
24	May16, 2011	JamiaMiliaIslamia, New Delhi	Getting a handhold on designing proteins for therapeutics	Invited Seminar for Teachers Refresher Course

25	Oct 13, 2011	GB Pant University of Agriculture and Technology, Pant Nagar	Getting a handhold on designing proteins for therapeutics	Invited Seminar
26	Nov 05, 2011	Guru Nanak Dev University, Amritsar	Getting a handhold on designing proteins for human therapeutics	Invited Lecture
27	Feb 02, 2012	University of Jammu	Prediction of recognition helices for C2H2 zinc fingers: application in genome modification including human therapeutics	National Symposium on "Bioinformatics: Challenges in the post genomic era"
28	July 31, 2012	IIT Delhi	Molecular tools for targeted genome engineering	National Conference on Bioinformatics
29	Nov 28, 2012	University of Hyderabad	Getting a handhold on designing proteins for human therapeutics	Indo-German Symposium on Systems Biology, University of Hyderabad
30	Jan 07, 2013	100th Indian Science Congress, Kolkata	Molecular tools for targeted genome engineering	Prof. Umakant Sinha Memorial Award Lecture at the 100th Indian Science Congress
31	Jan 10, 2013	Indian Agricultural Statistical Research Institute (IASRI), New Delhi	Genome sequence analysis – Gene finding in eukaryotes	Training Program on Statistical Approaches for Genomic Data Analysis, NAIP program on 'Establishment of National Agricultural Bioinformatics Grid for ICAR'
32	Feb 19, 2013	Alagappa University Karaikudi	Getting a handhold on designing proteins for human therapeutics	National Symposium on "Recent Trends in Structural Bioinformatics and Computer-aided Drug Design (SBCADD2013)"
33	Feb 26, 2013	SRM University Chennai	Precision genome engineering with programmable DNA-binding proteins	International Conference on New Generation Bioinformatics (ICNGB-13)
34	Apr 09, 2013	Teri University, VasantKunj New Delhi	Precision genome engineering with programmable DNA-binding proteins	Symposium on Challenges of Bioinformatics in Biotechnology
35	May 23, 2013	Amity University, Noida	Engineering Genomes	Faculty Development Program on Innovation and commercialization of technologies in Life Sciences
36	July 01, 2013	DuPont Knowledge Center, Hyderabad	Precision genome engineering with programmable DNA-binding proteins	New Frontiers in Industrial Biotechnology – Seminar Series

Shilpi Sharma

Date	Name of Institution and Address	Title	Occasion
Oct 2012	CFTRI, Mysore	RNA: better molecular tools for assessing microbial diversity	Short term training in Molecular Biology techniques in Microbiology
29.01.2012	Palamuru University, Mahabubnagar	Bioinoculants: The Larger Picture	National Seminar on Microbial Diversity-Potential Application
09.12.2011	University of Kerala, Trivandrum	Accessing the black box of microbial diversity in waste water treatment	ICCFRE 2011, Annual International Convention of National Environmentalists' Association
03.07.2011	Barkatullah University, Bhopal	Bioinoculants in rhizosphere – Unraveling the mystery	International Conference on Microorganisms in Environmental Management and Biotechnology
22.03.2011	Amity University, Noida	Efficacy and risk assessment of bioinoculants in agriculture	Indian - German Workshop in the frame of the program "Initiation and Intensification of Bilateral Cooperation".
07.02.2009	Department of Botany and Microbiology, GurukulKangri University, Haridwar	Genomics and Transcriptomics as tools in selection and application of bioinoculants	workshop onMicrobial fermentation and Bioinoculant preparation for organic farming

Ritu Kulshrestha

Date	Name of Institution and Address	Title	Occasion
Nov 7, 2009	JNU, Delhi	Hypoxic regulation of microRNAs: implications for cancer biology	UGC Resource Network Program
2009	Bose Institute	Same as above	Invited Lecture
2009	IISER Kolkata	Same as above	Invited Lecture
Feb 8-11, 2010	FfortRaichak Resort, Kolkata	Same as above	Young Investigator Meeting
Dec 2013	Keele University, UK	Investigating modulation of miRNA expression in the hypoxic stem cell niche	Mercia Stem Cell Alliance
Jan 2014	IIT Chennai	miR-191: An oncogenic microRNA in breast cancer	International conference On cancer biology, Cancercon, 2014

Ravikrishnan Elangovan

Date	Name of Institution and Address	Title	Occasion
Dec 15, 2010	University of Florence Italy	An integrated in vitro and in situ study of kinetics of myosin II from frog skeletal muscle	Was visiting University of Florence for research purpose.
Apr 19, 2013	NCBS, Bangalore	Development of Magnetic Tweezer	ICTS-NCBS-MBI organized conference on "mechanical manipulations and responses at the scale of cells and beyond

Preeti Srivastava

Date	Name of Institution and Address	Title	Occasion
May 9, 2013	Amity University, Noida	Chromosome segregation in bacteria	Faculty Development Program

Ziauddin Ahammad

Date	Name of Institution and Address	Title	Occasion
March 2009	Glasgow University, UK	H2S free biogas production	Departmental Lecture Series
Oct 2010	L'Oreal HO Paris, France	Energy efficient treatment technology for PCP industries	Innovator meet
April 2011	Edinburgh University, UK	Anaerobic treatment of PCP wastewaters	Water Professionals meet
Oct 2012	Jamia Milia University, India	Advances in wastewater Treatment Technologies	Departmental Lecture Series

Saroj Mishra

Date	Name of Institution and Address	Title	Occasion
3-11-2009	Devi Ahilya University, Indore	Enzyme mediated bioremediation	5th World Congress of Cellular and Molecular Biology
5-12-2009	BHU, Varanasi, UP	Novel glycosyl hydrolase family 3 engineered BGL I from *Pichia etchellsii* for synthesis of oligosaccharides	Biotech Resarch Society of India (BRSI) - Annual conference

17-9-2010	Palacongress, Rimini, Italy	Combined treatment for treatment of industrial waste waters	International Biotechnology Symposium
13-11-2010	Madurai Kamaraj University, Tamil Nadu	Enzyme mediated bioremediation (subject area)	Biotech Resarch Society of India (BRSI) - Annual conference
16-5-2011	Portugal	Mutagenesis of BGLI of Pichia etchellsii for improvement of organic solvent tolerance phenotype	9th Carbohydrate BioengineeringMeeting
3-7-2011	Barkatullah University, Bhopal	Application of laccases in treatment of textile waste water treatment	International conference on microorganisms in environmental management and biotechnology
3-10-2013	Facultitad of Medicine Complementus e University, Madrid, Spain	Synthetic potential of cell bound glycosylhydrolases in alkyl glycoside and oligosaccharide synthesis	BioMicroworld – International Conference Conference
18-11-2013	MD University, Rohtak, Haryana	Expression and characterization of high redox laccase of *Cyathus bulleri* produced in *Pichia pastoris*	54th AMI conference
26-11-2013	Pune	Synthetic potential of cell bound glycosylhydrolases in glycoconjugate synthesis.	Biotech Resarch Society of India (BRSI) - Annual conference
6-12-2013	IIT Delhi	Cloning and enhancing production of a broad substrate specificity β–glucosidase of *Pichia etchellsii* through pH and feed substrate control in *Pichia pastoris*	Bioprocessing India 2013
17-12-2013	New Delhi	Expression and control of codon optimized granulocyte colony stimulating factor in *Pichia pastoris*	Asian Congress on Biotechnology (ACB-2013)
15.1.2014	Indian Institute of Science (IISc) Bangalore	Oligosaccharide synthesis using engineered β-glucosidase I of *Pichia etchellsii* in presence of co-solvnts	27th International Carbohydrate Symposium
21-01-2014	National Institute of Immunology, New Delhi	Oligosaccharide synthesis using engineered β–glucosidase I of *Pichia pastoris* in presence of co-solvents	Indo-German workshop on Chemical Biology of Infectious Diseases

Outreach / External Stakeholder engagement

Section 6

Executive Summary: <u>Outreach / External Stakeholder engagement</u>

Educational outreach has been in the form of **12** short term courses, **2** NPTEL courses, mentoring **0** programs in other IIT's. The number of **books** with sale more than 1000 units authored by faculty is **1**.

6. Outreach / External Stakeholder engagement

6.1 Educational

(a) Workshops/Short term courses – topical research for disseminating research of IITD.

The following workshops/short term courses were organized by the Faculty of the Department:

T. R. Sreekrishnan
• Training programme on "Biotechnology treatments of biological wastes and wastewaters", 28th Feb.-2nd March, 2011, IIT Delhi. • Short course on "Recent developments in environmental biotechnology", 10th October, 2011, IIT Delhi.

D. Sundar
• Short Term Course on Bioinformatics, thrice during 2008-2013. • Two-day International Conference (Indo-Swiss Bioinformatics Symposium) organized during October 26-27, 2010. This conference was organized jointly with the prestigious Swiss Institute of Bioinformatics (SIB) and was sponsored by the Department of Biotechnology (DBT), Govt. of India, Embassy of Switzerland in New Delhi and the SIB. • Two-day International Conference (Indo-Japan Bioinformatics Symposium) organized during December 10-11, 2010. This conference was organized jointly with the National Institute of Advanced Industrial Science and Technology (AIST), Japan and was sponsored by the Department of Biotechnology (DBT), Govt. of India and AIST, Japan. • Indo-UK Workshop on 'Next Generation Sequencing and Data Analysis for Microbial Applications' along with Newcastle University, UK organized during March 29-30, 2012. The objective of this workshop was to foster an understanding of the concepts and application of next generation sequencing (NGS) to the biology of engineered systems. This workshop was supported by the Engineering and Physical Sciences Research Council (EPSRC), UK. • Asian Congress on Biotechnology (ACB-2013) organized during December 15-19, 2013. ACB-2013 was organized by us under the aegis of Asian Federation of Biotechnology (AFOB) (www.afob.org), which was formed in October 2008. ACB-2013 was the second congress in series after the first one was held successfully at Shanghai, China in May 2011. ACB with enlarged scope is a follow-up of the earlier reputed APBioChEC (Asia Pacific Biochemical Engineering Conference) which were held biennially during 1990 to 2009. The purpose of ACB-2013 was to bring together leading professionals from academia, industry and government to discuss and develop breakthrough technologies for global sustainability and to foster collaborations.

Ravikrishnan Elangovan
Workshop on Biocatalysis was organized by **Prof. Saroj Mishra**, **Prof. Subash Chand**, Dr. Ravikrishnan Elangovan and **Dr. Praveen Kaul** during February 8-9, 2013. Off all the applications received, only 40 participants with prior experience in enzyme engineering were selected. There were 20+ invited lectures given by eminent researchers in the field of Biocatalysis.

Ziauddin Ahammad
• Indo-UK workshop on Aspiration Raising: Environmental Engineers for Tomorrow at IIT Delhi, 13th September 2008. • Indo-UK workshop on molecular biology application in Environmental Engineering at IIT Delhi, 15-27 February' 09. • Coordinator of Indo-UK Bioinformatics Workshop on Next Generation Sequencing and Data Analysis for Microbial Applications in Environmental Engineering at IIT Delhi held during March 29-30, 2012. • Short course on "Advance Process Monitoring Tools for Biological Wastewater Treatment", September 30, 2013, IIT Delhi.

(b) Workshops/Short term courses – educational methods (teaching, learning resources, pedagogy).

None

(c) Learning, research material on the website.

Educational Tool Development (Virtual Lab on Modeling & Simulation of Bioprocesses)

Prof. A.K. Srivastava has developed a Virtual Lab (http://iitd.vlab.co.in/?sub=63) for "*Bioreactor Modeling and Simulation*" to educate the theory and practice of Bioprocess Engineering for UG/PG students of Biochemical Engineering and Biotechnology. Presently it has 19 experiments which encompasses the Microbial Batch, Fed-batch and Continuous cultivation, Plant / Animal cell cultivation, Complex and intriguing culture metabolism of Acetone-Butanol-Ethanol fermentation and Propionic acid fermentation

(d) Science & technology for public information – on website.

The research papers and departmental reports are made available in the faculty webpages of the department. The department also enthusiastically participates in the Institute Open House Festival, where the departmental facilities and research output are on display for the benefit of public.

(e) Courses taught to students of other IITs/NITs/Other institutions.

Profs. G. P. Agarwal and Prashant Mishra	
On popular demand from students of Biotechnology from all over India, a program entitled "Practical Summer Training in Biochemical Engineering and Biotechnology" was conducted. 24 students of (M. Sc., B. Tech. and M. Tech.) of Biotechnology registered for this practical summer training after making a payment of Rs. 12000/- each. The registration fee was kept high so that the cost of running the program did not burden the department financially. Prof. G.P. Agarwal and Dr. Prashant Mishra were the coordinators of this program. Half the faculty of the department helped in conducting 12 experiments in biotechnology to illustrate the basic concepts of biotechnology. The unique feature of the program was that learning by doing experiment was emphasized. This way it was possible to explain some engineering principles through experiments which would be	May 19 to June 27, 2003 (6 weeks)

difficult while teaching in lecture class to pure science students. It was run under aegis of IRD, IIT Delhi.	
The 'Practical Summer Training in Biochemical Engineering and Biotechnology' course was continued for the second year. The period of the training was reduced from 6 weeks to 5 weeks. The registration fee of the training was Rs 12,500 per student. The number of students who participated was 20. Coordinator: Prof. G.P. Agarwal and Dr. Prashant Mishra. It was run under aegis of CEP, IIT Delhi.	June 1 to July 2, 2004 (5 weeks)
Third 'Practical Summer Training in Biochemical Engineering and Biotechnology' course was continued for third year with 33 students. Fees: Rs. 12,500 per student Coordinator: Prof. G.P. Agarwal and Dr. Prashant Mishra. It was run under aegis of CEP, IIT Delhi.	May 24 to July 2, 2005
Fourth 'Practical Summer Training in Biochemical Engineering and Biotechnology' course was continued for fourth year in running with 30 students. Fees: Rs. 15,000 per student Coordinator: Prof. G.P. Agarwal and Dr. Prashant Mishra. It was run under aegis of CEP, IIT Delhi.	May 17 to June 27, 2006
Fifth 'Practical Summer Training in Biochemical Engineering and Biotechnology' course was continued for fifth year with 35 students. Fees: Rs. 15,000 per student Coordinator: Prof. G.P. Agarwal and Dr. Prashant Mishra	June 20 to July 21, 2007
Sixth 'Practical Summer Training in Biochemical Engineering and Biotechnology' course was continued for sixth year with 23 students. Fees: Rs. 20,000 per student Coordinator: Prof. G.P. Agarwal and Dr. Prashant Mishra. It was run under aegis of CEP, IIT Delhi.	May 13 to June 14, 2008

(f) Courses taught via NKN.

None

(g) Courses developed for NPTEL.

Sl.	Faculty	Course Name	Status
1	Subhash Chand	Enzyme Science and Engineering	Already available
2	Saroj Mishra	Protein Science and Engineering	Under preparation

(h) Books, monographs, study material made available outside IITD.

None

(i) Experiments developed and made available to other institutions.

Dr. D. Sundar *has developed in-house the following Internet Computing Servers and Databases*

(1) ZifBASE : A database of zinc finger proteins and associated resources
(http://web.iitd.ac.in/~sundar/zifbase)
(Published in BMC Genomics 10(1): 421 (2009)

(2) Zif-Predict: A web-server for predicting zinc fingers and its target site
(http://web.iitd.ac.in/~sundar/zifpredict)
(Published in Genomics, Proteomics and Bioinformatics 8(2): 122-126 (2010)

(3) Zif-Predict-IHBE: zinc finger prediction based on interfacial hydrogen bond energy
(http://web.iitd.ac.in/~sundar/zifpredict_ihbe)

(4) Helix generator: a program to generate a text file containing an alphabetically sorted list of all possible 20~4(= 1.6 lakh) recognition helix sequences.
(http://web.iitd.ac.in/~sundar/zifpredict_ihbe)

(5) HelixDNAinteraction: a program to read the coordinates of all atoms in the recognition helices and triplets from a Zif268-based PDB structure and generate a list of protein-DNA atom pairs at the interface which were closer than 350 pm with their distances.
(http://web.iitd.ac.in/~sundar/zifpredict_ihbe)

(6) HBond Energy Calculator: a program to calculate IHBE using the distance data generated by the HelixDNAinteraction program.
(http://web.iitd.ac.in/~sundar/zifpredict_ihbe)

(7) Mangroves-DB : A database of mangroves of Pondicherry region of South India
(http://web.iitd.ac.in/~sundar/mangroves)

(8) Flora-DB: A comprehensive checklist of flora of Pondicherry region of South India
(http://web.iitd.ac.in/~sundar/floradb)

(j) Seminars live/via NKN, web to other institutions in India/abroad

None

(k) Reach out to schools, NCERT, KVs, etc. (e.g. K-12 programmes).

None

(l) Mentoring of other institutions, e.g. new IITs, NITs, universities, etc. including faculty mentoring, curriculum development, laboratory development, etc.

A. K. Srivastava
Supervised Mr. Amritanshu of Amity University Noida under "Summer Research Fellowship program for M.Tech/ME students" 2013 for six weeks. Project Supervisor of casual student Ms. Sweta Chandra M.Sc. (Biotechnology) of Amity University Noida on a project entitled "Production of biopolymer using centrifugal impeller bioreactor" for the period 1st January 2013 to 30th June 2013.

Saroj Mishra
Member of Board of Studies of UP Technical University and Mata Vaishno Devi University, Katra, J&K

D. Sundar
As part of the "*Summer Faculty Research Fellow Program*" under the "Continuing Education Program" of IIT Delhi, the following faculty members from other Institutions got an opportunity to interact and work with the research group of Dr. D. Sundar and got exposure to the field of bioinformatics. The objective of this program was to facilitate and orient the faculty fellows to undertake research: (1). Mr. Atul Nag, Lecturer in Bioinformatics from Sambalpur University Institute of Information Technology, Sambalpur, Orissa (2011) (2). Mr. Akil Z. Surti, Lecturer in Gujrat Technological University, Ahmedabad, Gujrat (2012) (3). Ms. Akansha Gupta, Lecturer in IMS Engineering College, Ghaziabad, UP (2012) (4). Mr. Saurabh Jain, Lecturer in JMIT, Radaur, Yamuna Nagar, Haryana (2013) Similarly, Ms. M. Shivani Virajitha of the Department of Biotechnology at NIT Warangal pursued her "IIT Delhi Undergraduate Summer Fellowship Program" training in bioinformatics in the laboratory of Dr. D. Sundar in 2013.

Shilpi Sharma
Member of curriculum revision committee for B.Tech (Biotech), NIT Allahabad in the workshop held in March 2012

6.2 Industry collaboration

(a) No. of students (Ph.D./Masters) directly linked to industry funded projects.

2 (Ms. Ranjita Biswas & Mr. Ashwani Gautam mentored by Prof. Saroj Mishra

(b) No. of industry staff/engineers who have taken a regular course(s) for entire semester.

None

(c) Technology transfer to companies, entrepreneurs, local and other governments/government agencies, NGOs (separately).

M. N. Gupta
An Efficient Biocatalyst Design: A Method for Preparation of Crosslinked Protein Coated Microcrystals [Patent Appl. No. 2046/DEL/2006 dated 18.09.2006] *Technology transferred (on non exclusive basis) to Hi Tech Biosciences, Pune by FITT (2013)*

(d) Continuing education/courses for industry.

The department routinely conducts several training courses where participants from industry also participate. Some of the courses already offered are listed under Section 6.1a.

(e) Faculty secondment to industry.

None

(f) Research projects undertaken with industry as partner.

T. R. Sreekrishnan
The project "Development of state of the art biological process with monitoring and control mechanism for coke oven effluent treatment" was taken up with funding from the R&D Centre for Iron and Steel, Steel Authority of India Limited (SAIL). The process was developed at 50 litres per day capacity in the Departmental laboratories. The process was scaled up to 1000 litres per day scale and this pilot plant is currently under erection at RDCIS-SAIL premises at Ranchi

A. K. Srivastava
PI of the continuing project entitled "Pilot scale trials of Plant Stem cells (suspension culture) using Bio-reactors" in collaboration with Himalaya Drug company, Bangalore for one year w.e.f. 1 May 2013.

Preeti Srivastava
Improved Biodesulfurization of crude oil with IOC R &D, Faridabad

M. N. Gupta
Bioprospecting for Alcohol Dehydrogenases for Chiral Synthesis; DBT; 2012-2015. Multi-institutional Project: PIs from other institutes: Prof. Wangikar (IITB); Dr. Shilpa Wagh (Industry Partner, Sco Molecules India Pvt. Ltd., Pune]

(g) Laboratories, equipment, etc. provided by industry for use in UG / PG teaching laboratories and student projects.

None

(h) Seminars/workshops held with industry by the department.

None

6.3 Professional

(a) Service as Board, Senate, selection committee member at other IITs, NITs, and Universities.

T. R. Sreekrishnan
1. Member, Board of Studies, Centre of Energy and Environment, TERI School of advanced studies. 2. Member, Board of Studies in Engineering, University of Kerala. 3. Member, Board of Studies (Post-graduate), University of Kerala. 4. Member, Board of Studies (Biotechnology), B.R.Ambedkar National Institute of Technology, Jalandhar. 5. Member, Faculty Selection Committee, GGS Indraprastha University, Delhi 6. Member, Faculty Selection Committee, NIT Jalandhar 7. Member, Faculty Selection Committee, NIT Warangal

A. K. Srivastava
1. Member Board of Studies, Biotechnology, UPTU, Lucknow (2008-09) 2. Member Board of Studies, Guru Nanak Dev University Amritsar (2008-till now) 3. Member Board of Studies, Chemistry Dept., Dayalbagh Educational Institute Agra (2005-06) 4. Member Board of Studies, Biotechnology Dept., JIIT, Noida (2011-till now) 5. Member, Faculty Selection Committee, IIT Roorkee

V. S. Bisaria
1. Member, Selection Committee for Faculty, IIT Kharagpur

Saroj Mishra
1. Member, Faculty Selection Committee, Institute of Chemical Technology, Mumbai 2. Member, Faculty Selection Committee, IIT Guwahati 3. Member, Faculty Selection Committee, IIT Roorkee

M. N. Gupta
• Member, Committee for the selection/ promotion of faculty/ scientists for numerous institutes/ Universities including National Institute of Immunology, Delhi; Institute of Genomics and Integrative Biology (CSIR), New Delhi; Central Salt and Marine Research (CSMRI) (CSIR), Bhavnagar; National Institute of Technology, Patna; National Institute of Technology, Calicut; National Institute of Technology, Jaipur; AMU, Aligarh; Jamia Hamdard, New Delhi; Thapar Institute of Engineering and Technology, Patiala; University of Pune, Pune; Jaypee Institute of Technology, Noida; AKG Engineering College, Noida; Rani Durgavati Vishwavidyalaya, Jabalpur; Devi Ahilya Vishwavidyalaya, Indore etc. • Member, Selection Committee for selection of faculty at National Institute of Immunology, New Delhi held on 21st December, 2010. • Member, Selection Committee for selection of scientists at Indian Institute of Petroleum, Dehradun held on 11th July to 12th July, 2011. • Member, Selection Committee for faculty at NIFTEM (National Institute of Food Technology Entrepreneurship and Management), Ministry of Food Processing Industries (MoFPI), GOI held on 30th August, 2011. • Member, Selection Committee for the post of Assistant Professor in NIFTEM (National Institute of Food Technology Entrepreneurship and Management), Ministry of Food Processing Industries (MoFPI), GOI held on 3rd October, 2011. • Member, Selection Committee for selection to the post of Assistant Professor for the

Department of Chemistry at Deenbandhu Chhotu Ram University of Science and Technology Murthal (Sonepat) held on 9th December, 2011.

- Member, Selection Committee for short listing of candidates for faculty positions in Chemistry (Professor, Associate Professor, Assistant Professor) under UGC- Faculty Recharge Programme at Old CRS building, Aruna Asif Ali Marg, JNU Campus, New Delhi on 20th December, 2011.
- Member, Selection Committee for selection of retired professors at NIFTEM (National Institute of Food Technology Entrepreneurship and Management), Ministry of Food Processing Industries (MoFPI), GOI held on 29th December, 2011.
- External Expert in the CSIR Assessment Committee constituted in the area of "Chemical Science & Chemical Engineering" held at the National Chemical Laboratory, Dr. Homi Bhabha Road, Pune on 25th September, 2010.

(b). Service as Ph.D. thesis examiner at other institutions.

T. R. Sreekrishnan

Served as Ph.D Thesis Examiner for IIT Bombaty, IIT Madras, IIT Roorkee, IIT Guwahati, Anna University (Chennai), Jawaharlal Nehru Technological University (Hyderabad), Dayalbagh Educational Institute, Agra

A. K. Srivastava

Served as Ph.D Thesis Examiner for Massey University Palmerston North (New Zealand), Universiti Putra Malaysia (Malaysia), TERI University (New Delhi), Pune University, IIT Madras, Dayalbagh Educational Institute, Agra

V. S. Bisaria

Served as PhD Thesis Examiner for IIT Kharagpur, IIT Madras, Delhi University, NIT-Rourkela, Madras University, JNU, University Putra Malaysia

Saroj Mishra

Served as PhD Thesis Examiner for IIT Kharagpur, IIT Guwahati, IIT Madras, Delhi University, Anna University (Chennai), Institute of Chemical Technology (Mumbai); University of Kerala, Rajiv Gandhi Technical University (Bhopal)

M. N. Gupta

- External examiner of Ph.D. viva at Indian Institute of Science, Bangalore held on 10th December, 2010.
- External examiner for evaluation of M.Sc. dissertations including oral examination in discipline of Animal biochemistry, National Diary Research Institute, Karnal , Haryana, India, 20th July 2011.

D. Sundar

Served as PhD Thesis Examiner for IISc (Bangalore, 2012), TIFR (Mumbai, 2009), UP Technical University (Lucknow, 2009), CSIR-IICT (Hyderabad, 2012, 2014), Anna University (Chennai, 2013), University of Kerala (2013), CSIR-IICB (Kolkata, 2014)

Preeti Srivastava

Served as PhD thesis examiner for Kanpur University

(c). Service as technical expert on committees – MHRD, DST, DSIR, DRDO, Pan-IIT initiatives, other ministries, state and local governments.

T. R. Sreekrishnan
Served as technical expert on committees constituted by Delhi State Pollution Control Committee, Central Pollution Control Board, Ministry of Environment and Forests , Ministry of New and Renewable Energy sources, Department of Science and Technology

A. K. Srivastava
• Chairman, Selection committee for National Overseas Scholarship for the scheduled castes (SC) for past three years on behalf of Ministry Social Justice & Empowerment (MSJE) • Task Force Member, Ministry of Food Processing Industries Panchsheel Bhawan New Delhi (2008- till now) • Expert Selection Committee for External Scholarships MHRD, New Delhi e.g. Commonwealth Scholarship, Japanese, Mexican Govt, Turkish Government, Sri Lanka Government etc. (2005-till now) • Consultant Interdisciplinary and Multi-Institutional National project entitled "Synthetic Biology and metabolic Engineering of Azadirachtin biosynthesis pathway" Chief Co-ordinator - Director Indian Institute of Chemical Biology, Kolkata • Member PAN IIT 2007 team from IIT Delhi alumni meeting in Santa Clara, California USA during 6-8 July 2007, Interacted with potential faculty member for possible induction in IIT Delhi, New Delhi

G. P. Agarwal
• Chairman, Selection committee for National Overseas Scholarship for the scheduled castes (SC) during 2005 to 2013 (8 years) on behalf of Ministry Social Justice & Empowerment (MSJE) • Member, Selection committee for National Overseas Scholarship for the scheduled tribes (ST) during 2005 to 2006 (1 year) on behalf of Ministry of Tribal Affairs. • Member, International Programme Approval Committee (IPAC) of DBT, GOI during for 3 years (July 2003- June 2006). • Member, Programme Advisory Committee (PAC) on chemical engineering of Science and Engineering Research Council (SERC), Dept. of Science and Technology New Delhi for 3 years (during May 2004 to May 2007) • Member, DBT, GOI, Task Force on "Basic Research in Modern Biology" for 3 years (during Sept. 2006 – August 2009). • Member, DBT Task Force on "Biotech Product and Process Development" for 3 years (during Sept. 2008 - Aug. 2011). • Member, Technical Screening Committee of Small Business Innovation Research Initiative (SBIRI), DBT, GOI duringSept. 2005 – February 2013 (7 and half years)

V. S. Bisaria
• Member, Task Force on Secondary Agriculture and on Metabolic Engineering of Plants, Department of Biotechnology (DBT), Govt. of India • Member, Advisory Board, Innovative Bioproduction Kobe Project (2010-12) • Member, Peer Review Committee for evaluation of academic and research activities of Department of Biotechnology, IIT-Kharagpur, April 2013.

- Chairman, Project Advisory Committee for ICAR Project "Whey to Biofuel - Enhanced bioethanol production by stress tolerant and metabolically engineered yeast from whey" being carried out at NDRI, Karnal (2013-2015).
- Member, Advisory Committee, appointed by UGC for evaluation of Department of Food Technology and Biochemical Engineering, Jadavpur University as a Centre for Advanced Studies-1 (CAS-1) (2009-12).
- Reviewer of "Enzyme Technology" subject under the project '*Developing Suitable Pedagogical Methods for Various Classes, Intellectual Calibers and Research in e-Learning'*, which was a part of the National Mission Project on Education through ICT, sponsored by the MHRD and coordinated by IIT Kharagpur (2010-2012).
- Reviewer of Plant Biotechnology Web Course of NPTEL for IIT Guwahati (Apr- Sept. 2012)
- Editor, Journal of Bioscience and Bioengineering
- Member, Editorial Board for the following journals - Process Biochemistry, Journal of Chemical Technology & Biotechnology and Proceedings of Indian National Science Academy
- Vice-President, Asian Federation of Biotechnology (AFOB)
- Editor for the book entitled "Bioprocessing of Renewable Resources to Commodity Bioproducts" to be published by Wiley in April 2014 (Co-Editor - Akihiko Kondo)
- Life member of Indian Institute of Chemical Engineers (IIChE), Association of Microbiologists of India (AMI), Biotech Research Society of India (BRSI)

Saroj Mishra

- Member, Committees of MHRD, DBT, CSIR, Ministry for Tribal Affairs
- Member, Three Task Forces of DBT
- Member, One Task Force of DST

M. N. Gupta

- Member, panel of judges for National Scientific Debate Competition- International Year of Chemistry – 2011 in Kendriya Vidyalaya on 24th December, 2011.
- DBT task force meeting for monitoring project at JNCASR (Jawaharlal Nehru Centre for advanced Scientific Research), Bangalore on 14th Jan'2012.
- Member, Editorial Board Meeting for Proceedings of the INSA (Indian National Science Academy) held at INSA, New Delhi on 30th Jan'2012.

<u>Memberships of expert committees of Government Funding agencies/ Industry etc</u>.

- Member, Expert Committee on Utilization of Scientific Expertise of Retired Scientists Program (Department of Science & Technology, Govt. of India) (2005-09).
- Member, Task Force on Application of Biotechnology for Biodiversity Conservation & Environment (Department of Biotechnology, Govt. of India) (2006-09).
- Member, Screening cum selection Committee for DBT-CREST Awards (Department of Biotechnology, Govt. of India) (2011- till date).
- Chairman, DBT expert committee for review of multi-institutional network/ coordinated projects on carbon sequestration (2008).
- Chairman, DBT expert committee for proposal related to biodegradable plastics/ biopolymers (2008).
- Member, DBT expert committee for review of coordinated projects in environmental metagenomics (2008).
- Member, Advisory Committee on nanotechnology of Jubilant Organosys (2005-2006).
- Member of DBT expert committee for overseas fellowships DBT (Govt. of India),

New Delhi held on 11th Feb., 2011.

- Expert Committee Member of National Review and Coordination Meeting (NSNT-2011) of NANO Mission Council held on 25th to 27th February, 2011 at IIT Delhi.

Ritu Kulshreshtha

Project Review: DBT

BIG-BIRAC grant review (FITT, IITD)

D. Sundar

- Member, Expert Committee for CSIR – SRF/RA Selection Committee in the area of *Trans-disciplinary Research* and *Life Sciences*; (2010 – till date)
- Member, Expert Committee for CSIR – SRF/RA Selection Committee in the area of *Engineering*; (2013 – till date)
- Member, Expert Committee for DBT – BCIL Selection Committee for Bioinformatics Industrial Training Program (BIITP); (2011 – till date)
- Member, Expert Committee for DBT – BCIL Selection Committee for Biotechnology Industrial Training Program (BITP); (2011 – till date)
- Member, Expert Committee for Lady Tata Memorial Trust (LTMT), Mumbai – JRF/SRF/RA Selection Committee in the area of Trans-disciplinary Research and Life Sciences; (2011 – till date)
- Member, Peer Team of DBT – BCIL for monitoring companies hosting Biotechnology and Bioinformatics Industrial Training Program Trainees; (2010 – till date)
- Member of PRSG (Project Review and Steering Group) of Technology Incubation and Development of Entrepreneurs (TIDE) scheme of DIT, Govt. of India (2010 – till date)
- Member, Bioinformatics National Certification Exam (BINC), DBT, Govt. of India (2006 – till date)
- Observer, Bioinformatics National Certification Exam (BINC-2013) for the Delhi Centre, DBT, Govt. of India (2013)
- Executive Committee Member for Asia Pacific Bioinformatics Network (APBioNet) – International Conference on Bioinformatics (InCoB); (2007 – till date)
- Program Committee Member for Indo-Japan Bilateral Meeting– Department of Biotechnology (DBT), Govt. of India; (2010 – till date)
- Program Committee Member for Asian Young Researchers Conference on Computational and Omics Biology (AYRCOB) supported by Genome Big Bang Centre of Excellence of University of Tokyo; (2009 – till date)
- Reviewer of grant applications submitted to Department of Biotechnology (DBT), Govt. of India, Department of Information Technology (DIT), Govt. of India, Department of Science & Technology (DST), Govt. of India, Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy, Govt. of India (2006 – till date)

(d). Technical expert on policy, regulatory, laws, standards committees.

A. K. Srivastava

Member of curriculum development committee for M.Tech Biotechnology program JIIT, Noida.

Assisted AICTE in the recognition of Private Institutions in B. Tech Biotechnology program. (2005-2006).
Also assisted AICTE in accreditation of Engineering Institutions (2005-2006) Visited HBTI Kanpur as member of expert committee constituted by advisor.

G. P. Agarwal

- Member of curriculum development committee of B. Tech. in Biotechnology at IIT Guwahati during for 2 years (2000-2002).
- Chairman of a committee formed by chairman, AICTE for development of model B. Tech. Curriculum in Biotechnology for 2 years (September 2002 to August 2004).
- NBA, under the aegis of AICTE, accreditation visit to private engineering college as Chairman of the expert committee constituted by advisor, NBA for the following colleges:
  i. Vel Tech Engineering College, Chennai during Jan 5 to 7, 2007 for two UG programmes.
  ii. GokarajuRangaraju Institute of Engineering and Technology (GRIET), Hyderabad for one UG programme during April 10 to 12, 2008
  iii. Sudharshan Engineering College (SEC), Pudukottai (District) during March 13 to 15, 2009 for 4 UG Programmes.
  iv. Sri BalajiChokalingam Engineering College, Tiravannamel (District) during April 17 to19, 2009 for four UG Programmes.
  v. Institute of Engineering and Technology, Alwar, during May 22 to 24, 2009 for 2 UG Programmes.
  vi. R V Engineering College, Bangalore – 560059 during January 21 to 23, 2011
  vii. Haldia Institute of Technology (HIT), Haldia, West Bengal during July 22 to 24, 2011
  viii. Government College of Engineering & Leather Technology (GCELT), Kolkata-700 098, West Bengal during September 23 to 25, 2011
  ix. Institute of Technology and Marine Engineering (ITME) during August 24 to 26, 2012.
  x. College of Engineering & Technology, Durgapur, West Bengal during28th to 30th September, 2012
  xi. PES Institute of Technology, Bangalore, Karnataka during 2 to 4th November, 2012
  xii. Heritage Institute of Technology, Kolkata, West Bengal during 5 to 7th April, 2013

(e). Member of Board/Advisory Board of public and private sector corporations.

M. N. Gupta

Memberships of expert panels at International level:

- Member, Nature (UK) Reader panel (2008-09)

(f). Positions (e.g. Director, Vice Chancellor, etc.) held by faculty on lien.

None

6.4 Contribution to national development goals

(a) Projects undertaken and their outcome.

V. S. Bisaria

Application of biofertilizers for increased and sustainable food production: As an outcome of the contributions by research partners involved in Biofertilizer networked project sponsored by Indo-Swiss Cooperation in Biotechnology (ISCB) during 2001-2012, a biofertilizer consortium product has been developed and validated in different regions of Indo-gangetic planes in the states of UP, UK, Rajasthan, Bihar, Punjab and Haryana for their application in sustainable and low input agriculture. IIT Delhi developed a mass scale production process for the PGPR while TERI, New Delhi developed production process for the AMF. The other partners worked on issues related to development of molecular identification tools and participated in validation trials and data analysis. The use of the biofertilizer product effectively enhanced the productivity of food crops such as wheat, and increased the nutritional value of both wheat and rice in extended field trials. The work assumes significance in view of the fact and increased realization amongst Government agencies, environmentalists and end users that biofertilizers are to be used increasingly to reduce application of chemical fertilizers (which have caused considerable deterioration of our environment, water bodies and soil) for sustainable development. The technology is in the process of being transferred to two Indian industries, viz., Nagarjuna Chemicals and Fertilizers Limited, Hyderabad and Pest Control of India, Bangalore

Preeti Srivastava

DBT project : Improved biodesulfurization of crude oil : optimization of conditions and characterization of genes

In this project we could successfully isolate a bacterium which could desulfurize aromatic and aliphatic organosulfurs and 76% reduction in the total sulphur content in crude oil was observed. The genes were characterized and the pathway for biodesulfurization of some model organosulfurs has been elucidated. The work has resulted in one publication.

Ritu Kulshreshtha

Sl No	Title of Project	PI	Co-PI	Funding Agency	Amount (Rs. in Lakhs)	Duration of the project	Outcome
1	Functional dissection of microRNAs frequently deregulated in solid cancers.	Self	None	DST-Fast Track	13.92	2010-2013	Publication Carcinogenesis Impact factor:5.7
2	MicroRNAs and AU rich elements (ARE): Deciphering the regulatory	Self	D. Sundar	DBT-RGYI	22.19	March 2011-March, 2014	Publication, RNA Biology Impact factor:4.93

	loop						
3.	Molecular Mechanisms of Hypoxia Resistance in Glioblastoma: Role of MicroRNAs	Self	Chitra Sarkar, AIIMS	DBT-Call for Neurosciences	65.97	Sep 2011-Sep. 2014	Ongoing
4.	Investigating modulation of miRNA expression in hypoxia-stem cell niche	Self	Nick Forsyth Keele Univ, UK	DST-UKIERI	15.32	2013-2014	Ongoing Visit to Keele Univ, Research exchange program
5	Surface enhanced Raman Scattering (SERS) based sensing and imaging systems for early diagnosis of breast cancer	Anuj Dhawan (IITD)	Self	DBT	74.25	2013-2016	Ongoing

A. K. Srivastava						
S. No	**Title**	**PIs list (with PI being first)**	**Sponsor**	**Amount (Rs. in Lakhs)**	**Duration**	**Significant Outcome (if any)**
1	"DBT Centre Of Excellence (Program support) for microbial production of designer bio polymers from renewable resources" As Coordinator	A.K. Srivastava PI Prof TR Sreekrishnan, Prof Anup Ghosh, Prof Harpal Singh	DBT, New Delhi	420.46	2012-2017	Developed a new facility in the department.
2	Production of high value therapeutic proteins using *Pichia* system	Saroj Mishra, A.K. Srivastava	IRD, IIT Delhi	100	2011-2016	
3	Bioreactor modeling and simulation (Virtual Lab)	A.K. Srivastava	MHRD N. Delhi	39.5	2010 - 2014	Developed virtual Lab http://iitd.vlab.co.in/?sub=63
4	Hairy root cultivation for mass scale production of Shikimic acid (Raw material for the drug	A.K. Srivastava PI Shilpi Sharma Co-PI	ICMR New Delhi	35	2010-2012	

	for Avian Flu)					
5	Isolation and screening of potential microbial inoculants from rhizosphere of a medicinally important weed, *Cassia occidentalis*	Shilpi Sharma PI, A.K. Srivastava Co-PI	DBT, New Delhi	10.12	2009-2012	
6	Production of terpenoids in normal and transformed cell, organ cultures and whole plants in Tea	VS Bisaria PI, Dr. A.K. Srivastava Co-PI	DBT, New Delhi	15.43	2007-2008	
7	Development of bioreactors for cultivation of hairy roots of *Azadirachta indica*	A.K. Srivastava PI, VS Bisaria Co-PI	DBT, New Delhi	30.16	2004-2007	One patent and seven international journal papers.

(b) Policy inputs – implications, visible impact on society.

None

(c) Entrepreneurship development.

T.R. Sreekrishnan and D. Sundar
Faculty Advisors/Mentors for BIRAC-sponsored grant to *M/s. Carbon Neutral Technologies Pvt Ltd*, an incubator company under FITT-IIT Delhi started by the dual degree alumni Dr. Deepak Duggar in collaboration with Dr. Abhinav Grover

6.5 Alumni engagement

(a) Regular interactions / engagement with alumni and outcomes.

Ravikrishnan Elangovan
Editor for the Departmental Newsletter cum magazine titled "*DBEB et al*" that is released annually with articles written by faculty, students & alumni. This is circulated through email and also made available on the website

(b) Contributions from alumni.

The alumni have been routinely contributing towards the placement of students for summer industrial training and have been providing constant feedback for the revision of curriculum.

6.6 Recognitions and Awards

(a) Awards to faculty.

Saroj Mishra
Lupin Biotech Fellow by Institute of Chemical Technology, Matunga, Mumbai

V. S. Bisaria
Research Exchange Award by Korean Society of Biotechnology and Bioengineering (2008)

D. Sundar	
Year	
2013	National Bioscience Award (DBT, Govt. of India)
2013	DuPont Young Professor Award (DuPont, USA)
2013	Prof. Umakant Sinha Memorial Award (Indian Science Congress)
2013	Young Scientist Award (Asian Biophysics Association, South Korea)
2012	1 of the 4 finalists for the SwarnaJayanti Fellowship of DST, Govt. of India
2012	1 of the 2 finalists for the NASI-SCOPUS Young Scientist Award
2011	Young Researcher Award (Lady Tata Memorial Trust, Mumbai)
2008	INSA Young Scientist Award (Indian National Science Academy, New Delhi)
2008	Selected as "Outstanding Young Faculty Fellow" at IIT Delhi
2008	Innovative Young Biotechnologist Award (IYBA) (DBT, Govt. of India)
2006	Young Scientist Award (Indian Science Congress)
2005	Swarna Jayanthi Award (National Academy of Sciences of India)

A. K. Srivastava
• Ist Prize for poster presentation of Ms. Afifa (Project staff) "Advances in bioprocesses for environmental safety and nutritional security" 2nd and 3rd March 2013 at HB Technological Institute, Kanpur -208002 • Best Oral Presentation award to Ms Guneet Kaur (Ph.D. Student) on National Science Day, 28th February, 2012 organized by Dept. of Science and Technology, GOI and IIT Delhi. • Best poster Award Prize Rs 1000=00 to Ms Guneet Kaur (Ph.D. student) 52nd Annual conference of Association of Microbiologists of India (AMI) AMI-2011, *International Conference on Microbial Technology for Sustainable Development* November 3 - 6, 2011. • Best Poster presentation Award to Nivedita Patra (Ph.D. student) International conference on chemistry of phytopotentials: Health, Energy and Environmental perspectives (CPHEE 2011), 4-6th November 2011, Dayalbagh Educational Institute, Dayalbagh, Agra 282110. • Best Research Paper Award to Ms Smita Srivastava (Ph.D. Student) Annual International conference on Advances in Biotechnology BIOTECH 2011, 28th February – 1st March 2011, Singapore.

Preeti Srivastava
Recipient of EMPOWER grant given by CSIR to highly innovative projects

Shilpi Sharma
1. Bronze medal at the International Genetically Engineered Machine Competition (iGEM) 2013 Asia Regional Jamboree (Faculty Mentor of team) 2. Young Scientist Grant by SERB, 2012. 3. Thesis supervisor of BOSS award 2012 recipient, Ravikumar Mehta, IIT Delhi for "Best M. Tech. thesis work in Biochemical Engineering and Biotechnology". 4. Young Scientist Award by National Environmentalists' Association, India (Dec 2011). 5. Young Scientist Award by Association of Microbiologists of India (November 2011). 6. FEMS Young Scientist Congress Grant to attend 4th FEMS Congress 2011 at Geneva, Switzerland (26th – 30th June, 2011) 7. DST and CICS Travel Grants to participate in Rhizosphere 3, Perth, Australia, 2011. 8. Sapna Laroia Memorial "Outstanding Young Faculty Fellowship", 2009 (for three years) IIT Delhi. 9. Project titled "Screening & development of bioinoculants for promotion of plant growth in agriculture." awarded grant of ` 50,000 by the IIT Delhi Alumni Association (I^2 Tech, 2010).

Ritu Kulshreshtha	
2009	Senior Research Associateship under CSIR Pool Scientist Scheme
2010	Research Funding from DST under Fast Track Scheme for Young Scientists.
2010	Selected for Oral Presentation in Young Investigator Meeting (YIM), Kolkata
2011	Research Funding from DBT (Rapid Grant for Young Investigators)
2011	Research funding from DBT (under Call for proposals in neuroscience)
2011	Outstanding Young Faculty Fellowship Award from IIT

(b) Fellows of academies, INAE, etc.

M. N. Gupta
• Fellow of National Academy of Sciences, India (2005) • Fellow of Biotech Research Society, India (2007) • Fellow of Indian National Science Academy (2014) • Affiliate, Royal Chemical Society (2013-till date)

Saroj Mishra
• Fellow of Biotech Research Society, India (2005)

D. Sundar
• Member of National Academy of Sciences, India (2011)

Governance

Executive Summary: <u>Governance</u>

Averaged over the last five years, **5 faculty board meetings** are held annually and these are on the average **attended** by **100**% of the faculty. **Faculty time utilization** has been **26**% in class, **12**% in meetings, **25**% in project management, and **37**% thesis guidance. The data show excessive time spent on project management. The new IRD IRIS system has improved matters considerably. However, there is a dire need to streamline the cumbersome purchasing process at the departmental and the Institute level.

7. Governance

7.1 Governance

(a) Organization structure – their autonomy/ terms of reference

The department consists of Faculty members, technical staff and support staff. The Head of the Department is usually appointed for a term of three years by the Director and is responsible for the academic, programmatic, administrative and financial matters of the department. The Head has several Committees formed from within the faculty to assist in the normal functioniong of the Department as described under *Section 7.1(f)* below.

(b) Planning documents developed by the department – space, faculty, staff related.

Documents related to planning of space utilization, faculty/staff recruitment, vision, etc are discussed in appropriate forums and are catalogued for proper execution. Some of the recent such planning documents were related to -

Space – The ground floor of the pilot plant that is being developed as labs for UG/PG teaching are described under Section 2.6.

Faculty – Based on the requirements of the expertise, the departmental faculty board identified specific expertise that is required for the department and the expertise desired was finalized for recruitment and advertised through the Office of Dean (Faculty) recently.

Vision – The Vision of the Department was discussed and formulated in July 2013 to reflect the constant change in the interdisciplinary field of Biotechnology.

(c) Records of discussions within the department – internal documents (meeting minutes, position papers, discussion papers, concept papers, etc.)

The record of all the important meetings is maintained in the Departmental Office and the Documentation Unit. The records of the last five years are available in the internal webpage of the department (http://privateweb.iitd.ac.in/~sundar/review).

(d) Physical resources – percentage utilization for UG PG core and electives teaching separately, UG and PG student projects, Ph.D. student research. Projections for future.

Following is the list of departmental labs where courses for UG/PG core/elective courses are conducted:

Sl. No	Laboratory	Location	UG Core	UG elective	PG	UG & PG student projects	PhD & M.S.(R)
1	Animal Cell Culture	I-32			BEL717	√	√
2	Biochemical Research	I-205				√	√
3	Biochemical Engineering	I-33				√	√
4	Bioscience I	I-321	BEL101		BEL840		
5	Bioscience II & RNA II	I-130	BEL103, BEL204, BEL412			√	√
6	Bioseparation	I-31			BEL703, BEL712		
7	BTIS - Bioinformatics	I-233A &B		BEL418		√	√
8	Computation	I-132				√	√
9	Downstream Processing	I-127				√	√
10	Enzyme Engg	I-329				√	√
11	Instrumentation	I-233				√	√
12	Metagenomics	I-128				√	√
13	Molecular Machines	I-335				√	√
14	Molecular Modelling	I-232				√	√
15	Mutation	I-205					
16	Pharmaceutical Biotech	I-25				√	√
17	Pilot Plant	I-131	BEP303		BEL850	√	√
18	Plant Cell Cultivation I	I-27				√	√
19	Plant Cell Cultivation II	I-24				√	√
20	Process	I-103				√	√
21	Protein Engg	I-206B					
22	RNA I	I-26				√	√
23	Structural Biology	I-206A				√	√
24	Waste Treatment	I-121				√	√

The requirements of a larger space for conducting the laboratory courses have already been planned and the labs that are being developed for UG/PG teaching are already described under Section 2.6.

(e) Financial resources – (i) funds provided to the department, (ii) processes of distribution, (iii) funding for focus areas, (iv) funding for UG and PG core teaching laboratories. Outcomes of funds utilization. Changes in funding pattern and funds utilization, and effects on departmental strategy.

The details of funds received from the Institute under various heads for the last 5 years are shown below:

Financial Year	Budget Code	Account Code	Initially Sanctioned Amount	Total Revised Sanctioned amount (in Rupees)
2009-2010	NPN05	NPN05/BBCE	13,68,000	22,08,000
	PLN03	PLN03/ BBCE	13,68,000	25,30,000
	PLN03/F	PLN03F/BBC		2,40,000
	PLN05	PLN05		4,50,000
	PLN03	PLN3C/BBCE		58,00,000
	PLN03/S	PLN03S/BBCE		25,000
	PLN06	PLN6R/BBCE		10,00,000
2010-2011	NPN05	NPN05/BBCE	12,81,000	24,00,000
	PLN03	PLN03/ BBCE	18,98,000	41,50,000
	PLN03/F	PLN03F/BBC		2,40,000
	PLN05	PLN05		1,61,000
	PLN03	PLN3C/BBCE		42,50,000
	PLN06	PLN6R/BBCE		22,80,000
2011-2012	NPN05	NPN05/BBCE	12,00,000	25,00,000
	PLN03	PLN03/ BBCE	13,00,000	52,00,000
	PLN03/F	PLN03F/BBC		2,40,000
	PLN05	PLN05		1,00,000
	PLN06	PLN6R/BBCE		26,95,000
2012-2013	NPN05	NPN05/BBCE	10,00,000	25,00,000
	PLN03	PLN03/ BBCE		2,06,00,000
	PLN03/F	PLN03F/BBC		2,40,000
	PLN05	PLN05		2,30,000
2013-2014	NPN05	NPN05/BBCE	12,50,000	27,50,000
	PLN03	PLN03/ BBCE	32,50,000	60,00,000
	PLN03/F	PLN03F/BBC		3,00,000
	PLN05	PLN05		9,05,000

Nomenclature of the Budget codes:

NPN05	Operational Expenses (Recurring)
PLN03	Planning grant for equipments for teaching
PLN03/C	Planning grant for capacity expansion for teaching
PLN03/F	Planning grant for Laptop / computers for faculty
PLN05	Planning grant for furniture / fixtures
PLN06R	Planning grant for equipments for new faculty

Besides the support from the Institute, the faculty periodically receive extramural funding to support their research programs as detailed under Sections 3.9 and 3.10.

Process of distribution of Institute Funds

Funds allocated under the non-plan grant (NPN05 / BBCE) are utilized for purchase of consumables, chemicals and other expenses not of a capital investment nature. The utilization of this is managed by the Head of the Department by prioritizing requirements of teaching labs followed by other requirements.

Funds received under the plan grant (PLN03 / BBCE) are utilized for purchase of equipments with the highest priority given to equipment required for the teaching labs. The equipments to be purchased are identified by the Departmental Faculty in a meeting at the beginning of each financial year.

In addition to this, the department's requirement of new furniture or refurbishing of old lab/office furniture is met through the grant PLN05. The decision regarding the furniture to be purchased is made at the beginning of every financial year in the DFB meeting.

Funds received from the institute for laptops are utilized to provide laptops to 4 faculty members each year based on their requirement and their eligibility.

Funding for focus areas

The department has received a major funding in the form of Centre of Excellence for microbial production of designer polymers from renewable resources) in the area of biopolymer production from DBT, Govt of India to the tune of **Rs. 420.46 lakhs**, which is being used to develop the infrastructure and train personnel for carrying out state of the art research in this area.

Besides, two projects (under the leadership of departmental faculty members) to the tune of Rs **100 lakhs** each, have been sponsored under 'High impact research initiative' by the Institute for a period of five years (starting from 2011) in the areas of Production of high value therapeutic proteins using *Pichia* system and Cellular assembly of human cornea.

Funding for UG and PG core teaching laboratories

In addition to the funds received from the Institute to support the teaching laboratories, the department has also been receiving partial support of its dual degree program (M.Tech part) from the Department of Biotechnology (DBT), Govt. of India through its HRD division for the past 24 years. This support helps us to manage the requirements of the teaching laboratories. Further, the faculty members through their extramural support and Consultancy grants, procure equipments that are also utilized for teaching purposes.

(f) Delegation of decision making within department. List the processes and structures for financial and academic management, and the methodology for their review.

The decision making within the department is mainly achieved through the deliberations in the Departmental Faculty Board, Research Committee, Curriculum Committee and Professorial Committee. The departmental faculty board meets typically once a month to discuss and take decisions on matters of departmental teaching, administration of

laboratory facilities, provide feedback to institute level committees, utilization of funds and any other matter referred to it by any of the members. All the departmental faculty are members of the Faculty Board.

The Departmental Research Committee (DRC) is constituted once a year by the Office of Dean Academics, based on the recommendations of Faculty Board. The DRC meets approximately 3-4 times a semester to take up matters concerning the research activities in the department. Admission to the PhD and M.S (Research) programs is also managed by the DRC, which evolves the shortlisting criteria and conducts the written examination/personal interviews to select the best candidates. The DRC also monitors the progress of research thesis work carried out by dual degree, MS (Research) and Ph.D. students. This Committee helps to maintain the overall quality of graduate education and a degree of continuity among different programs in the Department.

The Professorial Committee consists of all the faculty members of the department at the rank of Professor. This Committee has the responsibility of considering matters related to faculty selection and take decisions on departmental and faculty matters in accordance with departmental/institute policy and send their recommendations to the Office of Dean (Faculty) / Deputy Director / Director for further necessary action.

There is an Institutional Biosafety Committee that usually certifies the research projects that involve recombinant DNA work after careful examination. This Certificate is usually required to accompany any project proposal being submitted by the Departmental Faculty to various funding agencies.

7.2 Department management and operations

(a) Organization structure - mandates, flexibility, etc.

As discussed under Section 7.1a, the department constitutes different Committees and assigns responsibility to different faculty members for each academic year. A representative list showing this is included under *Appendix 7a*.

1.	Professorial Committee	HOD, Chairman All Professors, Member
2.	DRC	Prashant Mishra, Chairperson T. R. Sreekrishnan (Head) V. S. Bisaria Saroj Mishra A. K. Srivastava Atul Narang Shilpi Sharma Ritu Kulshreshtha D. Sundar (Convener)
3. (a)	Coordinators: Dual-Degree Program	T. R. Sreekrishnan, Head
(b)	Liaison with Board of Academic Programs (BAPS)	Atul Narang
(c)	Time table I/c	D. Sundar & Ziauddin Ahmmad
(d)	Coordinator: Ph.D. & M.S. (Res.) Programs	Prashant Mishra (Chairman, DRC)
(e)	Coordinator: M.Tech projects	Ritu Kulshreshtha
(f)	Matters concerning Dual Degree Programme	T. R. Sreekrishnan, Head Ritu Kulshreshtha

4.	Convener, Dept. Faculty Board.	Shilpi Sharma
5.	Training & Placement	Atul Narang
6.	Technical Services (Water, Power, Steam etc.) Additional power requirement/DG set/AC	D. Sundar Ravikrishnan Elangovan
7.	Cold Rooms	G. P. Agarwal
8.	Departmental Representatives to: BUGS BPGS ACL CUC CAIC IRD Board Alumni Affairs Safety Committee Faculty Affairs EHLSU Institutional Biosafety Committee (IBSC)	 Atul Narang Prashant Mishra Preeti Srivastava A. K. Srivastava Ravikrishnan Elangovan Saroj Mishra Ravikrishnan Elangovan Ravikrishnan Elangovan Ritu Kulshreshtha Ziauddin Ahmmad P. Srivastava (Member Secretary), Saroj Mishra (member)
9.	Seminars	Ravikrishnan Elangovan
11.	Imprest	Ziauddin Ahmmad, Ms Neelam
12.	Department / Institute Publications	T. R. Sreekrishnan Head A. K. Srivastava D. Sundar

(b) Processes for curriculum planning.

The Department is represented by one of its faculty member in the Institute level Curriculum Review Committee. The Institute level committee collects feedback from students, alumni, industry and academia for developing a revised curriculum structure and generates a concept paper. This concept paper is discussed in the departmental faculty board and its feedback is provided to Institute. Upon acceptance by the Senate of the Institute, the new course/credit structure is decided by the Departmental Curriculum Committee (DUGC) for implementation.

(c) Processes and methods for teaching resources management.

The teaching labs of the department are managed through one or more of its faculty members designated as lab in-charges. The lab in-charges make an estimate of requirement of funds for running the respective laboratories and the funding is distributed after discussions in the departmental faculty board.

(d) Guest faculty, affiliation for teaching core, elective UG & PG courses.

Very rarely guest faculty is hired for handling any lecture or laboratory course in the Department. However, scientists from academia and industry and invited to deliver some lectures in their areas of specialization in certain courses from time to time. Outside experts are invited to evaluate the projects of dual degree every semester.

(e) Faculty short-listing criteria.

The faculty applications are processed by the department as given below:

- The Professorial Committee finalizes the short-listing criteria for the *Stage - I*.
- The candidates short-listed for the Stage - I are invited to the department to deliver a seminar and interact with the faculty. The views of Faculty Board for external candidates are taken, but evaluation and short-listing approving *Stage – II* is done by Professorial Committee. A form containing the consolidated performance evaluation of the Professorial Committee is required to be submitted as part of the Application Processing Package that will be submitted to the Office of Dean (Faculty). The department, however, maintains the assessment form filled by individual faculty at all levels.
- Reference letters for all candidates available at *Stage - II* of short-listing will be reviewed by the Professorial Committee.
- Copies of peer-review publications of all short-listed candidates available at stage II in reputed journals (minimum 2 for Assistant Professors, 4 for Associate Professors and 5 for Professors) will be reviewed by the Professorial Committee and submitted along with the Application Processing Package to Dean (Faculty).
- In case of candidates *in absentia* for interview, they should have visited the department at least once personally in the recent past.

Applications of Internal Candidates

- For internal candidates (or exceptional cases of external candidates particularly from abroad) the seminar is scheduled one day before the date of interview in which experts will be invited to give their own assessment.
- For internal candidates, meetings of *Departmental Assessment Committees* are organized up to that particular academic year. For these candidates, the self appraisal reports for the last 3 years for the post of Associate Professor and for last 4 years for the post of Professor will be reviewed by the Selection Committee.
- For internal candidates, teaching feed-back by students will be given due weightage at the time of selection.

Once the short-listing at Stage – II is approved by the Director, the following is usually practiced:

- Reference letters of all the candidates called for interview are submitted to Dean (Faculty) at least 3 days before the interview date.
- One day earlier to date of the Selection Committee meeting, the Departmental Professorial Committee meeting is organized and the Head of the Department subsequently briefs the Director.

Institute-level short-listing criteria for faculty positions:

MINIMUM SHORT-LISTING CRITERIA FOR AN ASSISTANT PROFESSOR:

- Ph.D. with 3 years experience (excluding the experience gained while pursuing Ph.D.),
- First class or equivalent grade in preceding degree in respective discipline, with a consistently good academic record,
- Potential for very good teaching,
- Maximum age is 35 years for male and 38years for female candidates (to be relaxed by 5 years in case of persons with physical disability, SC and ST), and

- At least 4 refereed conference/journal papers (of which at least 2 should be in reputed journals).

MINIMUM SHORT-LISTING CRITERIA FOR AN ASSOCIATE PROFESSOR:

- Ph.D. with 6 years experience (excluding the experience gained while pursuing Ph.D.) of which at least 3 years should be as Assistant Professor or equivalent,
- First class or equivalent grade in preceding degree in respective discipline, with a consistently good academic record,
- Should have demonstrated capability for good teaching,
- At least 10 refereed conference/journal papers (of which at least 4 should be in reputed journals, out of which at least 2 in last 3 years), and
- Completed at least one sponsored R&D or consulting project as a PI, or completed two sponsored R&D or consulting projects as a co-PI**.**

MINIMUM SHORT-LISTING CRITERIA FOR A PROFESSOR:

- Ph.D. with 10 years experience (excluding the experience gained while pursuing Ph.D.) of which either.
  a. At least 4 years should be as Associate Professor or equivalent, or
  b. At least 8 years should be as Assistant Professor or equivalent (in case of Institutions where the post of Associate Professor or equivalent does not exist),
- First class or equivalent grade in preceding degree in respective discipline, with a consistently good academic record,
- Should have demonstrated excellence in teaching.
- At least 20 refereed conference/journal papers (of which at least 8 should be in reputed journals, out of which at least 3 in last 4 years),
- Should have guided independently at least one Ph.D. student, or have guided at least two Ph.D. students jointly with other faculty/researchers, and
- Completed:
  a. One sponsored R&D or consulting project as a PI, and
  b. One more sponsored R&D or consulting project as a PI, or two sponsored R&D or consulting projects as a co-PI.

Additional short-listing criteria for the department

1. Assistant Professor / Assistant Professor (contract):
   In addition to Institute-level Minimum short listing criteria, the candidate's academic background should be
   B.Tech (or equivalent) in Chemical/Biochemical Engineering

2. Associate Professor:
   In addition to Institute-level Minimum short listing criteria:
   Should have guided one Ph.D student (independent or joint supervision).

3. Professor:
   Institute-level Minimum short listing criteria, with the clause on Ph.D guidance as given below:
   For candidates with Engineering background: Should have guided at least one Ph.D student independently, plus a second independent Ph.D student guidance or two joint Ph.D student guidance.
   For candidates with Bioscience background: Should have guided at least four Ph.D students, of which at least two is independent.

(f) How collectiveness of the faculty has enhanced academic output and enhanced quality, etc.

The department has a diverse faculty profile and this is the strength of the department. Several joint projects are undertaken in areas of interdisciplinary nature. This is evident from our past record of securing joint funding and mentoring joint students as mentioned under Sections 3.2 and 3.9.

(g) Nature, quantum and quality of support from of secretarial staff, stores and inventory management, purchases, ambience, etc.

There are several technical and support staff in the department, who help in the normal functioning of the department including administration, laboratory upkeep and conducting laboratory courses and in research projects. The responsibilities are usually assigned at the beginning of each academic year by the Departmental Faculty Board. A representative list of responsibilities assigned for the current academic year (2013-2014) is given below:

Laboratory Organization		
100 - Level Floor	**Faculty incharges**	**Staff Members**
a) Bioprocess Lab. (I-103)	AK Srivastava	Mr. D. V. Sharma, A. Raju, Mr. Ratan
b) Downstream Processing Lab. (I-127)	GP Agarwal	Mr. Kishan Chand
c) Metagenomics Lab. (I-128)	TR Sreekrishnan	Mr. Kishan Chand
d) Waste Treatment Lab. (I-121)	TR Sreekrishnan	Mr. Kishan Chand
200 - Level Floor		
a) Biochem. Res. Laboratories	Saroj Mishra Prashant Mishra	Mr. Sumeet Kapoor Mr. Ram Gopal Mr. Hari Lal (half day)
d) Radioactive & Photography Lab.	Atul Narang	Mr. Mukesh Anand Mr. Ram Gopal
e) Molecular Modeling Lab (I – 232)	D. Sundar	
f) BTIS (I-233 A)	AK Srivastava	Mr. Sanjeev
g) Bioinformatics Lab (I-233 B)	AK Srivastava	Mr. Sanjeev
h) Instrumentation Labs. (I-233 C) (I-231)	GP Agarwal Ziauddin Ahammad	Mr. Mukesh Anand, Mr. Rajiv Dahiya Mr. Sanjeev
i) COE lab (I-232 A)	AK Srivastava	Mr. Mukesh Anand
j) Documentation Unit	TR Sreekrishnan (Head)	Mrs. Neera Verma Mr. Sita Ram
300 - Level Floor		
a) Enzyme Engg. Lab & Enzyme Process Lab. (I-329 & 337)	Prashant Mishra	Mrs. Renu Sethi, Sanjeev (2nd half)
b) Molecular Machines & Bioenergetics Lab	Sunil Nath Ravikrishnan E	Mr. Bhagwan Singh
c) M. Tech. Bioscience Lab. I (I-321)	Prashant Mishra	Mr. Bhagwan Singh Mr. Sanjeev (2nd half)

Pilot Plant Block		
a) Pilot Plant Floor I	Head (Coordinator), VS Bisaria AK Srivastava Atul Narang	Mr. Hari Lal (half day)
b) Pilot Plant Ground Floor	- same as above -	
Ground Level Rooms		
a) Computation Lab. (I-132)	AK Srivastava	Mr. Swaraj
b) Bioscience Lab II (I-130)	Atul Narang Ritu Kulshreshtha	Mr. Dahiya
c) RNA Laboratory-II	Ritu Kulshreshtha Atul Narang	Mr. Dahiya
d) M. Tech. BCE Lab (I-31)	Ravikrishnan E	Mr. S. P. Rana Mr. Swaraj
e) DSP Lab (I-33)	Ziauddin Ahammad	Mr. S.P. Rana Mr. Swaraj
f) Plant Cell Culture Lab. I (I-27)	AK Srivastava	Mr. S. P. Rana Mr. Swaraj
g) Plant Cell Culture Lab II (I-24)	AK Srivastava	Mr. S. P. Rana Mr. Swaraj
h) Pharmaceutical Biotech Lab (I-25)	VS Bisaria AK Srivastava	Mr. Swaraj
i) RNA Lab-I (I-26)	Preeti Srivastava	Mr. Rajeev Dahiya Mr. Swaraj
j) Animal Cell Culture Lab. (I-32)	PK Roychoudhury	Mr. S. P. Rana
Other Facilities		
a) Office Complex	Head of the Dept	Ms. Neelam, Ms. Kirti Mr. Sita Ram
b) Seminar Room	Head of the Dept	Mr. Sita Ram
c) Committee Room	Head of the Dept	Mr. Sita Ram
d) Stores	Atul Narang (Faculty in-charge)	Mr. Inderjeet (Stores Superintendent)

7.3 Faculty

(a) Faculty profile, and a critique of the same.

The department has a diverse faculty profile as it can be evidenced from the research projects and outcome discussed under Sections 3 and 5. Due to recent retirements of some colleagues, the department is currently short of having faculty with specialization in Biochemical Engineering, where we have targeted future immediate recruitment.

(b) Diversity in faculty profile by: (i) gender, (ii)category, (iii) region, (iv) Ph.D. institution, (v) post-doctoral institutions worked in, (v) organizations/industry worked in, (vi) employment prior to joining the department.

The following table describes the diversity in faculty profile based on the given parameters:

Faculty	Gender	Category	Specialization	Region	PhD institution	Post doctoral institution	Organizations/industry worked in
Subhash Chand	Male	Gen	Bioprocess Engineering	Uttar Pradesh	IIT Delhi		RRL Bhubaneswar
M. N. Gupta	Male	Gen	Applied Enzymology	Delhi	Indian Institute of Science, Bangalore	MIT, USA ; University of Minnesota, USA; Universite de Technologie de Compiegne, France; Chemical Centre, Lund, Sweden.	
G. P. Agarwal	Male	Gen	Downstream Processing	Uttar Pradesh	Rice University, Houston, Texas, USA	University of Rochester, Rochester, New York, USA	Hindustan Lever Research Center, Mumbai
V. S. Bisaria	Male	Gen	Biochemical Engineering	Uttar Pradesh	IIT Delhi	SFIT-Zurich, Switzerland; Inst. of Biotech, Julich, Germany; Univ. of Minnesota, USA; Univ. of Cambridge, UK.	Osaka Univ., Japan; Kobe Univ., Japan
Saroj Mishra	Female	Gen	Recombinant DNA Technology	Delhi	City University of New York, USA	Pasteur Institute, Paris, University of California, Davis	
TR Sreekrishnan	Male	Gen	Waste Engineering	Kerala	IIT Delhi	INRS-Eau, Canada	McDowell & Co, Technical Center, Bangalore
A. K. Srivastava	Male	Gen	Biochemical Engineering/ Fermentation	Uttar Pradesh	McGill University Montreal, Canada	1. Delft University of Technology, The Netherlands	JaVita Jayant Vitamin CSIR-NCL HBTI, Kanpur

			Technology			2. Institut fur Technische Chemie, Der Universitat, Hannover (Germany) 3. Massey University, Palmerston North, New Zealand.	
Sunil Nath	Male	Gen	Chemical Engineering	Karnataka	Technical University of Braunschweig, Germany		
Prashant Mishra	Male	Gen	Biochemistry	Uttar Pradesh	Jawaharlal Nehru University, New Delhi	Massachusetts Institute of Technology, Cambridge, USA	
P. K. Roychaudhury	Male	Gen	Animal Cell Culture	West Bengal	IIT Delhi	University of California, Berkeley, USA	
A. Narang	Male	Gen	Systems biology	Delhi	Purdue University, W. Lafayette, IN	MIT, Cambridge, MA	BP Research Center, Naperville, IL; University of Florida, Gainesville, FL
D. Sundar	Male	Gen	Bioinformatics	Tamil Nadu	Pondicherry University	John Hopkins University, USA	John Hopkins University Pondicherry University
S. Sharma	Female	Gen	Environmental Microbiology	Uttar Pradesh	Ludwig Maximilians University, Munich, Germany	German Research Centre for Environmental Health, Neuherberg, Germany	NIT Allahabad

R. Kulshreshtha	Female	Gen	Molecular Biology	Delhi	Delhi University	Tufts-New England Medical Center, Boston, MA, USA, Dana Farber Cancer Institute, Harvard University	Dept of Plant Molecular Biology, Delhi University, New Delhi, India, Jawaharlal Nehru University, New Delhi, India
Ravikrishnan Elangovan	Male	SC	Single molecule biophysics, Molecular motors, Biosensors	Tamil Nadu	University of Florence, Italy	University of Florence, Italy. Tata Institute of Fundamental Research, Mumbai.	
Preeti Srivastava	Female	Gen	Bacterial genetics	Uttar Pradesh	Indian Institute of Technology, Delhi	National Cancer Institute, National Institutes of Health, Bethesda, USA	Indian Institute of Toxicology Research-CSIR, Lucknow
Ziauddin Ahammad	Male	Gen	Environmental Engineering	West Bengal	IIT Delhi	Newcastle University, UK	IIT Guwahati, Newcastle University

(c) Procedure for faculty searches.

Area of expertise decided by professorial committee based on the immediate needs of the department. In addition to the applications received in response to the advertisement brought out by the institute the departmental faculty members also contact potential candidates known to them. Based upon the academic records of the candidates they are shortlisted at Stage I of the recruitment process. Candidates shortlisted at Stage I are invited to the department for interaction with the faculty and discussion on their future academic and research vision. Based on this interaction they are again shortlisted at Stage II. Candidates shortlisted at Stage II are recommended to the selection committee chaired by the director to be called for an interview with the duly constituted selection committee.

(d) Result of faculty searches

Year of selection	Position	Number applied	Number shortlisted	Names of appointees
2009	Assistant Professor	42	7	1). Himanshu Khandelia (didn't join) 2). Ravi Krishnan Elangovan 3). Ritu Kulshreshtha
2010	Assistant Professor	375	4	1). Preeti Srivastava 2). Aparna Katoch Sapra 3). Praveen Kaul
2012	Assistant Professor	17	1	1). Shaikh Z. Ahammad

(e) Success in recruitment (data for last 5 years), and offers that the persons had from other IITs/IISc/TIFR.

Faculty (Year of joining)	Specialization	PhD institution	Post doctoral institution	Organizations/industry worked in	Offers, if any, from other IITs/IISc/TIFR.
Atul Narang (2009)	Systems biology	Purdue University, W. Lafayette, IN	MIT, Cambridge, MA	BP Research Center, Naperville, IL; University of Florida, Gainesville, FL; IIT, Delhi.	From IIT Kanpur
Ritu Kulshreshtha (2010)	Molecular Biology	Delhi University	A) Tufts-New England Medical Center, Boston, MA, USA B) Dana Farber Cancer Institute, Harvard University	A) Dept of Plant Molecular Biology, Delhi University, New Delhi, India B) Jawaharlal Nehru University, New Delhi, India C) IIT Delhi, India	-
Ravikrishnan Elangovan (2010)	Single molecule biophysics, Molecular motors,	University of Florence, Italy	University of Florence, Italy. Tata Institute of		-

	Biosensors		Fundamental Research, Mumbai.		
Preeti Srivastava (2011)	Bacterial genetics	Indian Institute of Technology, Delhi	National Cancer Institute, National Institutes of Health, Bethesda, USA	Indian Institute of Toxicology Research-CSIR, Lucknow	-
Ziauddin Ahammad (2013)	Environmental Engineering	IIT Delhi	Newcastle University, UK	IIT Delhi, IIT Guwahati, Newcastle University	-

(f) Faculty lost to other institutions post selection.

In the last five years, one of the faculty members, Dr. Praveen Kaul (Assistant Professor) quit the department to join the Biotechnology Industry Research Assistance Council (BIRAC) in 2013 as Technical Manager.

(g) Faculty time utilization – in class, in meetings, project management, Ph.D. guidance, Masters project guidance, UG project guidance.

Faculty	In class	In meetings	Project management	Ph.D. guidance	Masters project guidance	UG project guidance
Subhash Chand	50	-	10	30	10	-
MN Gupta	30	5	40	20	5	-
GP Agarwal	25	25	20	10	15	5
VS Bisaria	40	15	10	25	10	-
Saroj Mishra	20	15	25	30	10	-
TR Sreekrishnan	25	20	20	20	10	-
AK Srivastava	35	5	35	15	10	-
Sunil Nath						
Prashant Mishra	20	25	20	25	10	-
PK Roychoudhary	20	10	30	20	20	-
Atul Narang	10	10	30	30	10	10
D. Sundar	10	20	30	30	10	-
Shilpi Sharma	30	10	20	25	15	-
Ritu Kulshreshtha	20	5	25	25	25	-
Ravikrishnan E	30	10	30	20	10	-
Preeti Srivastava	30	5	15	25	20	5
Ziauddin Ahammad	40	5	10	30	15	-

(h) Level of harmony amongst department faculty.

The level of harmony amongst the departmental faculty is evident from the joint academic and research projects that are being undertaken. Even outside the academic matters, there is a great sense of togetherness among the faculty as can be seen in several social occasions. The faculty lounge in the department is usually the place where the faculty often meet over a cup of tea for discussion.

7.4 Students

(a) **Criteria for short-listing and selecting students for admission to Master's and Ph.D. programmes of past 5 years.**

Short-listing Criteria for admission to PhD program

The short-listing criteria for admission to departmental Ph.D. programme is given below. The short-listed candidates will have to appear for a written test for the second round of short listing, followed by personal interview. Final selection will be purely based on the candidate's performance in personal interview (not on performance in written examination).

Full-time candidates must have first class in all exams starting from 10+2 up to the qualifying exam and they must meet the following criteria based on the qualifying exam.

Qualifying exam	Acceptable majors	General Category	OBC (Non-creamy layer)	SC/ST & PD
B. Tech.	Biochemical Engineering / Chemical Engineering / Biotechnology	(i) B.Tech 70% or 7.5/10 CGPA (ii) Valid JRF or GATE score of min. 600 in Life Sciences or Biotechnology or Chemical Engg.	(i) B.Tech 70% or 7.5/10 CGPA (ii) Valid JRF or GATE score of min. 550 in Life Sciences or Biotechnology or Chemical Engg	(i) B.Tech 65% or 7.1/10 CGPA (ii) Valid JRF or GATE score of min. 500 in Life Sciences or Biotechnology or Chemical Engg.
M. Tech.	Biochemical Engineering / Chemical Engineering / Biotechnology/ Bioinformatics with Biotech / Pharmaceutical Biotechnology with B.Tech/B.Pharm/ M.Sc.	(i) M.Tech 70% or 7.5/10 CGPA (ii) GATE score not required	(i) M.Tech 70% or 7.5/10 CGPA (ii) GATE score not required	(i) M.Tech 60% or 6.75/10 CGPA (ii) GATE score not required
M. Sc.	Biochemistry/ Biophysics/Bioinformatics (plus Biotech in B.Sc)/ Environ Sci (with Biotech in B.Sc)/Chemistry/ Biotech / Microbiology/ Biosci/ Genetics/ Botany (with Microbiol) / Zoology (with Microbiol)/Life Sciences	(i) M.Sc. 60% or 6.75/10 CGPA (ii) GATE score 600 or valid JRF	(i) M.Sc. 60% or 6.75/10 CGPA (ii) GATE score 550 or valid JRF	(i) M.Sc. 55% or CGPA 6.25/10 (ii) GATE score 500 or valid JRF

- In respect of M.Sc. or B.Techs from IITs graduating with a CGPA of 8.0 or above, the requirement of qualification through a national examination is waived off.

- Students from CFTIs (Centrally Funded Technical Institutions - IIT's, NIT's, IIIT's, etc) having CPI/CGPA 7.00 (at 10.00 scale) at the end of 3rd year are also eligible for admission to PhD. The requirement of qualification through a national examination is waived off.

Sponsored candidates must meet all the above criteria, the only exception being that they are exempt from fulfilling national exam requirements.

Short-listing Criteria for M.S. (Research) Program

General and PH candidates

B.Tech. must be in Biochemical Engineering/Chemical Engineering/Biotechnology/Food Technology/Industrial Biotechnology.

B. Tech. (IIT) must have CGPA of ≥ 7.5. Others must have:
1. First class at the (10+2) level.
2. Minimum 70% marks or 7.5/10 CGPA in B.Tech.
3. GATE score of 500 and above in Chemical Engineering/Life Sciences/ Biotechnology.

Non-creamy layer OBC candidates:

B.Tech. must be in Biochemical Engineering/Chemical Engineering/Biotechnology/Food Technology/Industrial Biotechnology.

B. Tech. (IIT) must have CGPA of ≥ 7.5. Others must have:
1. First class at the (10+2) level.
2. Minimum 70% marks or 7.5/10 CGPA in B.Tech.
3. GATE score of 450 and above in Chemical Engineering/Life Sciences/ Biotechnology.

SC/ST candidates:

B.Tech. must be in Biochemical Engineering/Chemical Engineering/Biotechnology/Food Technology/Industrial Biotechnology.

B. Tech. (IIT) must have CGPA of ≥ 7.1. Others must have:
1. First class at the (10+2) level.
2. Minimum 65% marks or 7.1/10 CGPA in B.Tech.
3. GATE score of 450 and above in Chemical Engineering/Life Sciences/ Biotechnology.

Selection method

The selection of students for admission to the MS (Research) Program is based on personal interview of candidates shortlisted based on the above criteria.

(b) **Facilities provided to students and their maintenance/management system.**

The department provides enough room for students to do cutting-edge research and also provides them other facilities like computational laborotory, photocopying and access to some of the recent books and archived thesis/books in the Documentation Unit.

(c) **Mentoring seminars/sessions held for Ph.D. students for prospective faculty careers.**

The department has a Journal Club Series every semester where the PhD students get an opportunity to meet with the Seminar Speaker and expand their professional network. The PhD students themselves present their work in routine intervals to their peers in additional to the Student's Research Committee (SRC) that meets every semester to provide feedback and shape their interests. Such forums are expected to prepare a senior PhD student for his professional career.

Section 8

Benchmarking

Executive Summary: Benchmarking

The **closing rank in JEE** in the dual degree program was **4360** in this academic year.

8. Benchmarking

8.1 Identify departments/centres within IITD as peers.

Our departmental teaching and research is mainly focused on Biochemical Engineering and there are no other academic units within the Institute with such a focus.

8.2 Identify departments/centres/schools/divisions from other IITs, IISc, NITs, private universities as peers, and reasons/criteria there for.

- Among all the IITs (new and old), only the Department of Biotechnology at IIT Kharagpur offers UG and PG programs in *Biotechnology and Biochemical Engineering* that are comparable with our program that has a major focus on Biochemical Engineering.
- Among all the NITs, the curriculum of UG program offered by the Department of Biotechnology at NIT Warangal has major courses in Biochemical Engineering.
- No private University in the country is offering a UG/PG program in Biochemical Engineering that is comparable with our program.

8.3 Identify departments/centres from institutions in other countries as peers.

Sl.	Institution and Department	Country	QS ranking *
1	University College London Department of Biochemical Engineering	UK	4
2	Brown University Department of Chemical and Biochemical Engineering	USA	47

* Quacquarelli Symonds (QS) World University ranking 2013/2014

8.4 Define parameters for benchmarking (i) research, (ii) curriculum - separately for UG, Masters, and Ph.D. programmes, (iii) teaching-learning processes.

for curriculum	for Research	For Teaching
(b). Total Credit Requirement (i). Core Credits (j). Elective credits (k). Core credit as % of total credits (l). Number of theory courses in core curriculum (m). Comparison of core courses across the institution (n). Number and nature of laboratories (o). Thesis requirement (p). Important differences with the peers	(j). No of Masters and PhD students supported (k). No of PhD (per faculty) (l). Research Area (m). Avg Publication per faculty (last 5 yrs) (n). Publications (Journal) (o). Avg. citation of the dept (total citation since 2009)/total faculty (p). Number of sponsored projects (q). Number of consultancies (r). Number of large interdisciplinary projects	(e). Student- Teacher ratio (f). Student – TA Ratio (g). No of Lab Technicians (h). Gross Lab Space for UG/PG teaching

8.5 Perform benchmarking and report the analysis/findings for the last 5 (or 10) years.

The benchmarking report using the parameters described above is given in the following page:

(a). Benchmarking of Curriculum – in the last 5 years

Bench-marking Parameters	IIT Delhi			IIT Kharagpur			University College London, UK			Brown University, USA			NIT Warangal		
	UG	PG	PhD	UG	PG	PhD	UG	PG	PhD	UG	PG	PhD	UG	PG	PhD
Total Credit Requirement	170	48 dual degree	6 (MTech /equivalent) 20 (BTech /equivalent)	179	43 (dual degree) 91 (2 yrs MTech)	10 -20 for MTech or equivalent 20-40 BTech or equivalent	180	60	0	31 courses	DNF	DNF	198	No PG Programme	
Core Credits	101	32	16	161	69		DNF	DNF	0	18 courses			160		
Elective credits	69	16	0	18	22		DNF	DNF	0	13 courses			38		
Core credit as % of total credits	59.4	66.7	100	89.9	75.8					58			80.8		
No of theory courses in core curriculum	21	3	2-4	28	10		18	4	0	18			33		
Comparison of core courses across the institution	More stress on Biochemical Engg. Similar to curriculum of UCL			More focus on Biotechnology			More focus on Biochemical Engg.			More focus on chemical Engineering			More focus on Biochemical Engg.		

Number and nature of laboratories	5 (departmental) 2(chemical) Summer training	2 (departmental)		8 (dept) 1 (electronics) 2 (chemical) Summer training	4 (Departmental)								9 (Departmental), 2 (Chemical Engg)		
Thesis requirement	Major Project I (28 credits) Major Project II (32 credits)			Project part I and II (6 credits each) in last two semesters	Project Part I and II (20 credits each) In last two semesters										
Important differences with the peers	5 years dual degree		Course work, Oral and written comprehensive Exams	4 years Bachelor programme and 5 years dual degree	2 years Masters Programme	Course work, oral and written comprehensive	3 years Bachelor programme	Offer specialization after 2nd year on Bioprocess Management, Che	No course work, Oral comprehensive Exams						

								mical Engineering or the International Programme							

(b). Benchmarking of Resarch – in the last 5 years

Benchmarking Parameters	**IIT Delhi**		**IIT Kharagpur**		**University College London, UK**		**Brown University, USA**		**NIT Warangal**	
	PG	**PhD**	**PG**	**PhD**	**PG**	**PhD**	**PG**	**PhD**	**PG**	**PhD**
No of Masters and PhD students supported	48	46	DNF	DNF	DNF	DNF	DNF	DNF	DNF	DNF
No of PhD (per faculty)	2.8		DNF		DNF		DNF		DNF	
Research Area	Bioprocess Engineering Environmental Biotechnology, Computational Biology, Plant and Animal Cell Technology		Bioprocess development, Plant biotechnology, Environmental biotechnology		Industrial biotechnology, Macromolecular bioprocessing, Cell therapy bioprocessing		environmental remediation, biotechnology, biotransport processes, chemical nanoscience, carbon-based materials, and thermal and electrochemical energy conversion.			
Avg Publication per faculty (last 5 yrs)	11.2		28		24		13.1		9	

Publications (in Journals)	191	364	432	118	99
Avg. citation of the dept (total citation since 2009)/total faculty	72.47	DNF	DNF	DNF	DNF
No of sponsored projects	69	DNF	DNF	DNF	DNF
No of consultancies	11	DNF	DNF	DNF	DNF
No of large interdisciplinary projects	5	DNF	DNF	DNF	DNF

(c). Benchmarking of Teaching – in the last 5 years

Benchmarking Parameters	**IIT Delhi**			**IIT Kharagpur**			**University College London, UK**			**Brown University, USA**			**NIT Warangal**		
	UG	**PG**	**PhD**	**UG**	**PG**	**PhD**	**UG**	**PG**	**PhD**	**UG**	**PG**	**PhD**	**UG**	**PG**	**PhD**
Student-Teacher ratio	2.8	2.8	2.6	7.1	11.7	5.8	3	3					5.4		
Student – TA Ratio	Typically 25			DNF			DNF			DNF			DNF		
No of Lab Technicians	8			DNF			5			DNF			4		
Gross Lab Space for UG/ PG teaching	20 sq ft / student			DNF			DNF			DNF			DNF		

* DNF- Data not available in the public domain
Efforts are on to gather the complete data from the above listed Universities

Feedback systems and results

Executive Summary: Feedback systems and results

On-campus **placements** for UG and MS(R) students were **67**% and **60**% in this academic year. We are limited in our ability to improve placement in biotech companies since our students do not find their compensation packages very attractive. However, efforts will be made to improve entrepreneurship by making new UG lab available to students throughout the day.

9. Feedback systems and results

9.1 System for feedback from UG students and its results.

There is no departmental system for feedback from UG students. However, there is an institutional system for getting feedback regarding the teaching of all UG courses. This feedback is obtained on-line at the end of each semester.

9.2 System for feedback from PG, Master's and Ph.D., students, and their outcome.

There is no departmental system for feedback from PG students. However, there is an institutional system for feedback regarding the teaching of all PG courses. This feedback is obtained on-line at the end of each semester.

9.3 System for feedback from recruiters (i) on-campus, and (b) off-campus - separately for UG and PG graduates; and the results.

There is no departmental or institutional system for getting feedback from recruiters.

9.4 Mechanism of obtaining industry feedback and the findings.

The department has a DBT-HRD grant, the renewal of which is contingent upon yearly reviews by an advisory committee consisting of distinguished members from the academy and industry. The minutes of the meetings held in 2011 and 2013 are in **Appendix 9a**.

9.5 Alumni feedback mechanism and its outcome.

There is no departmental system for feedback from alumni. However, the institute seeks feedback from alumni periodically, and this feedback is an important input into the design of the curriculum.

9.6 Placement records – Ph.D., M.Tech. and B.Tech.

Sl.	Program	Nature of Job	Described previously under a diferent Section of this document
1	Dual Degree (B.Tech + M.Tech)	In Core and Non-Core Sector	Section 1.3(h) on page 26
2	Dual Degree (B.Tech + M.Tech)	Higher studies (PhD program)	Section 5.13 on page 90
3	MS (Research)	In Core and Non-Core Sector	Section 1.3(h) on page 26
4	PhD	Professional Career	Section 5.17 on page 92

Appendix 9a

Department of Biochemical Engineering & Biotechnology
Indian Institute of Technology Delhi

The minutes of the meeting of the Advisory Committee for DBT (Govt. of India) supported PG program In Biochemical Engineering & Biotechnology.

The meeting was held on July 20, 2011 at 1000 hr in the Board Room of IIT Delhi. The list of the members present in the meeting is enclosed (Annexure-I).

After a brief introduction of the members present in the meeting, the Chairman (Director, IIT Delhi) in his opening remarks highlighted the history of the Biochemical Engineering & Biotechnology activities at the institute and acknowledged the support received from DBT for various activities. This was followed by a brief presentation By Prof. Subhash Chand (Acting Head, DBEB) summarizing the key achievements of the academic programs offered by the Department. He emphasized on the introduction of a new course: Molecular Cell Biology by the department for all the UG engineering students of the Institute, as a follow up of the recommendations of the last meeting.

During the discussion session, the members raised issues, which are summarized below:

1. Dr. Qazi stated that the budgetary projection for the Department is too low. It was clarified that the proposed budget covers only the PG part of the teaching program, which is under review here.
2. Dr. A.K. Panda (also an alumnus) remarked that the Department has been losing leadership in the R&D program in industrial biotechnology. He emphasized on a strong need for setting up a few Centers of excellence at the Department. He also suggested including a course pertaining to GMP and regulatory issues to reflect the developments in new biotechnology. It was informed that such topics are already covered in one of the existing course and a full new course lacks feasibility.
3. Shri Prashant Tewari suggested for an effective networking of the Department with Industry and to develop platforms for bench scale research.
4. Some of the members expressed a serious concern on the external grants received and publications emerging from the Department. Chairman advised the Department Head to have a re-look in the data presented and submit the updated figures in the report to DBT.

After the meeting, the external members of the Advisory committee visited some of the teaching and research laboratories and reassembled in the Committee Room, where they interacted with the PG students to determine their most pressing needs. The students mainly emphasized on the inadequate laboratory infrastructure and non-availability of some of the analytical equipment in multiple numbers. Also, some of the old equipment were often not in running condition and needing up-gradation. The Committee strongly recommended for providing adequate funds to overcome these problems and Department faculty to take an urgent action in this regard.

The meeting ended a vote of thanks to the Chair.

Subhash Chand
Professor, DBEB

Annexure-I

List of the members present:

1. Prof. Surendra Prasad (Director, IIT Delhi)	Chairman
2. Prof. M. Balakrishnan (Dy. Director Faculty, IIT Delhi)	Co-Chairman
3. Prof. Rakesh Bhatnagar (School of Biotechnology, JNU)	Member
4. Dr. G.N. Qazi (V.C. Jamia Hamdard)	Member
5. Dr. A.K. Panda (Sr. Scientist, NII)	Member
6. Shri Prashant Tewari (M.D. USV Ltd. Mumbai)	Member
7. Dr. Sharmila Mande (TCS Hyderabad)	Member
8. Dr. Suman Govil (DBT, GOI)	Member
9. Prof. Subhash Chand (DBEB, IIT Delhi)	Member
10. Prof. G.P. Agarwal (DBEB, IIT Delhi)	Invitee
11. Prof. Saroj Mishra (DBEB, IIT Delhi)	Invitee
12. Prof. A.K. Srivastava (DBEB, IIT Delhi)	Invitee
13. Prof. Sunil Nath (DBEB, IIT Delhi)	Invitee
14. Dr. Atul Narang (DBEB, IIT Delhi)	Invitee

Appendix 9a

Department of Biochemical Engineering & Biotechnology
Minutes of DBT-HRD Advisory Committee Meeting

4th April, 2013

The meeting of the DBT-HRD Advisory Committee Meeting for the session 2013-2014 was held on April 3, 2013 at 10 am in the Senate Room of IIT, Delhi. The following members were present:

Prof. S. N. Singh (Deputy Director(Operations) IITD), Chairman
Dr. G.N. Qazi, VC Jamia Hamdard University, New Delhi
Prof. M.V. Rajam (Head Dept. of Genetics, DU, South Campus, New Delhi)
Dr. Sharmila Mande, Head Biosciences Group, TCS, Pune.
Dr. A.K. Panda, Senior Scientist, NII, New Delhi
Dr. U.V. Babu, Head, R& D, Himalayan Drug Company, Bangalore
Dr. Gururaj, Research Scientist, Himalayan Drug Company, Bangalore
Dr. Manoj Singh Rohilla, Scientist, DBT, New Delhi
Prof TR Sreekrishnan, HOD, DBEB, IIT Delhi, New Delhi
Prof AK Srivastava, DBEB, IIT Delhi, New Delhi
Prof GP Agarwal, DBEB, IIT Delhi, New Delhi
Prof PK Roychoudhury, DBEB, IIT Delhi, New Delhi
Dr. Atul Narang, DBEB, IIT Delhi, New Delhi
Dr. Ravikrishnan Elongoven, DBEB, IIT Delhi, New Delhi
Dr D. Sundar, DBEB, IIT Delhi, New Delhi
Dr. Preeti Srivastava, DBEB, IIT Delhi, New Delhi

Prof. Sreekrishnan (Head, DBEB) initiated the meeting by thanking and welcoming the esteemed members of the advisory committee. This was followed by Prof. Srivastava's detailed presentation on the extensive activities of the department, which included a description of the major facilities, the vision of the department, the research profiles of the departmental faculty, the three academic programs (namely, dual-degree UG/PG, MSR, and PhD), and the program specifics (which were shown to have a particularly strong practical component). It was reported that department published 116 papers in the international journals and received a grant of ` 11.02 crores through sponsored projects and consultancy in past three years (2010-2013). 71 students graduated from the department who opted to go for jobs in biotech industries/consultancies/ business analysis /banking sectors / management / higher studies / entrepreneurship. One of the unique contributions of the department was development of virtual lab for UG/PG curriculum of biochemical engineering education in the country. The salient features of same were also demonstrated. The presentation concluded with the following suggestions to DBT for further improvement of the program:

1. Funding for purchase of equipments for teaching.
2. Funding for modernization of the pilot plant, a unique facility in India.
3. Increased recurring grant for running the postgraduate teaching and research program(s).
4. Additional DBT support by means of more slots in the continuing M.Tech program and also for the unique M.S.(R) program of the department.
5. New faculty / infrastructure support in emerging areas of biotechnology.

After the presentation, feedback was sought from the members of the advisory committee.

Dr. Qazi pointed out that, being an alumnus of the department, he has received quality training from the department during his time. All attempts should be made to maintain the same quality as this department is unique in the country. The department should strengthen the pilot plant facilities so as to provide unique “skills and training” to the graduates of the department. He stressed the need of intensive “industrial exposure” of the students of the department. He mentioned that methodologies should be evolved by the department so that students get the desired “skill set” so that they become the most sought after graduates by the industry. The department should attempt to take up such research projects which are in high demand by the industry and the society in order to increase industry academia interaction. The students should be inculcated the “fabrication culture” so that they are motivated to do things by themselves & they develop the practice oriented skills required by the industry.

Dr. Panda appreciated the efforts made by the department in the area of publications, projects and research grants. He however mentioned that there is a need of more recurring and non recurring grant to the department so that it may facilitate operation of pilot scale reactors for the adequate training of the biochemical engineers. He expressed the need of more interdisciplinary M.S. (R) course and six months industrial exposure to the students. He mentioned that the virtual labs developed by the department will be highly beneficial to the UG/PG teaching of the biochemical engineering in the country and he himself will advise his students to make use of it.

Dr. Mande expressed the need of “on-line” courses for the benefit of the society and there is need to offer these courses from established Institutes like IIT Delhi. Professor SN Singh pointed out that at the Institute level some on line courses are being offered for the country and abroad. Dr. Mande also expressed the need of restructuring of the curriculum so that it is more relevant to the societal needs. She also expressed the need to motivate the students to interact with the industry. The M.S. (R) program of the department was also appreciated by her and she expressed the need for generous DBT support for it.

Dr. Rajam expressed that M.S. (R) program should expand further and it should encompass at least a dozen specializations. He stressed that DBT should find ways and means to support such old and unique departments and further enrich them with newer equipments and generous funds. He stressed that equipment grant be increased several folds. He also expressed that department should consider initiation of integrated Ph.D. program so as to develop unique graduates with in-depth knowledge in the relevant specializations of biotechnology.

Dr. Babu expressed the need of more academia – industry collaboration so that industry can benefit from the knowledge and experience of experts.

Professor SN Singh pointed out that Industry should come forward and invest in the long term research so that a strong research base can be created in IIT’s as opposed to short term collaborations which are targeted for specific deliverables. Professor SN Singh also apprized the house that IIT Delhi is in a process of setting up a Bio-resource Park in Haryana The land has already been procured and present pilot plant facilities of the Institute will be consolidated and shifted there in due course of time.

Dr. Rohilla pointed out that the department should make up a plan for training of entrepreneurs / technicians where in the DBT can possibly supplement the resources of

the department. He also mentioned that the department should send the proposal of M.S.(R) for possible funding and support from DBT however newer research areas should be included in fresh proposals for example stem cell engineering, entrepreneurship etc.

General conclusions & summary

The committee noted the dramatic improvement in publications and funding since the previous advisory meeting held on July 20, 2011. Several committee members also complimented Prof. Srivastava on the development of the virtual Bioreactor Modeling & Simulation Lab (http://iitd.vlab.co.in/?sub=63&brch=177). However, they emphasized that the department had not yet regained the leadership that it had in the earlier years. The committee suggested that the department must introspect to see how it can regain leadership. The following recommendations can be considered to achieve this goal.

Contribute to industry: The committee suggested that the department must constantly ask if it is contributing to industry. The publications and patents must add value to the industry, which in turn should treat DBEB as the destination of choice for technology development. In particular, the department might consider focusing on targeted technology development in the areas of reaction engineering (particularly pilot plant). The DBT representative suggested that the department should organize entrepreneurial support workshops, and also submit proposal(s) for development of new teaching labs and a national level fermentation facility.

Increase intake of students in MS(R) program: The current intake of 4-5 MS(R) students per year is too low.

Increase length of industrial internship to at least 6 months: The committee was, in general, disappointed with the relatively large number of job placements in finance and management. Some members noted that the current two month internship is so superficial that it probably leads to the student's disillusionment with the industrial work. They suggested that the length of the industrial internship be increased to at least 6 months so that the student has an opportunity to appreciate the key problems of industry. This could be also done by encouraging students to do their Master's projects in the industry.

Recruit new faculty: The department should hire new faculty in rapidly developing areas of biotechnology (e.g., stem cell engineering etc).

Increase scholarship for the M. Tech. students: The current stipend of Rs. 8000 per month is so low that students prefer to take up jobs rather than engage in research. DBT must find a way to increase the stipend to make a research career competitive.

The meeting ended with a vote of thanks to the Chair.

Vision for the next 5-10 years

Executive Summary: <u>Vision for the next 5-10 years</u>

The target for **funded projects** is **30** Crores per year and an average of **3** SCOPUS **publications** per faculty per year. The projected **graduation** numbers are **12** Ph.D., **15** MS(R) and **45** B.Tech students. **Recruitment** of an estimated **4** faculty in **Bioprocess Engineering, Downstream Processing, and Systems/Computational Biology** is targeted to move the program forward in the next five years.

10. Vision for the next 5-10 years

10.1 Goals and benchmarking for future in relation to (i) curricula, (ii) research, (iii) outreach, and (iv) processes for regular internal assessment.

- The Department offers a unique blend of expertise in applied biological sciences, chemical engineering and biochemical engineering. It strives for application of this expertise to evolve various biotechnological products and services.
- The curriculum is uniquely designed to generate highly trained human resource capable of quantitative analysis of biological systems, to facilitate their role in manning modern bioprocess industries and provide an integrated approach to research and development in biotechnology.
- The curriculum for research is designed to evolve research and development programmes leading to environmentally sustainable bio-industrial products and processes e.g. in the areas of bio-energy, biopolymer, clean environment and therapeutics.
- To develop outreach programs for dissemination of knowledge via short term courses, workshops and conferences, which encompass leading global innovations in Bioprocess Technology and Applied Biological Sciences, and to facilitate participation in industrial consulting and sponsored research.

Our benchmark will consist of:

- What our alumini end up contributing to the technology in either academic and industrial sectors. We believe we have done very well so far on this score.
- Who all attend our conferences and workshops and what is their feedback? Does this lead to development of network programmes?
- Whether we are able to enhance our funding via sponsored research and consultancy at least by 20% in next 5-10 years.

10.2 Vision of curricula and teaching-learning processes - UG, PG and Ph.D.; innovations proposed.

- To familiarize our UG/PG students to research ethos and attract our (esp.) UG students to research. Both our lectures and lab courses need to shift their emphasis for achieving this. The Curriculum for 8-semester B.Tech program and the dual degree (B.Tech + M.Tech) programs are already under review for implementation soon.
- Increased student strength (especially in Ph.D. and M.S(R) programs) is targeted.
- Introduction of new courses bridging biological and engineering sciences is planned.

10.3 Areas identified for improvement in (i) curriculum, (ii) teaching-learning processes.

- The nature of biotechnology is evolving and becoming even more multi-disciplinary. Our course contents have to continuously keep pace with that. For example, synthetic biology needs blending of biology with science and engineering in different ratios! It requires that our students learn to view biological processes as electrical engineers look at circuits with biological entities as modules like resistors and capicitators.
- The department has been discussing on introduction of new PG programs : 4-semester M.Tech programs in Biochemical Engineering and Biotechnology and Environmental Biotechnology.

10.4 New areas for research and Masters programme, and industry participation in these.

Some of the **focal areas of research** of the department are:

- Bioprocess Engineering
- Cell and Molecular Biotechnology
- Downstream Processing
- Systems and Computational Biology

Within these broad areas, our research and teaching will evolve and keep pace with the new developments.

10.5 Projections for (i) funded projects, (ii) journal publications.

- It is aimed that the departmental faculty will continue to attract substantial extramural funding from Government and Industry in their areas of expertise. In addition, the department aims to have joint projects with other academic units of the Institute as well as multi-institutional projects. The department also desires to develop Centres of Excellence in specific areas where it has core strength. A Centre of Excellence in Biopolymer Production is being established at the Department, which is fully funded by the Department of Biotechnology, Govt. of India.
- The department desires that the faculty publish high quality research papers (2-3 papers per faculty per year).

10.6 Projected graduation numbers - Ph.D., M.Tech. and B.Tech.

Ph.D	= 12 per year
MS (Research)	= 15 per year
Dual Degree	= 15 per year
B.Tech	= 45 per year

10.7 Projected faculty profile, and areas for recruitment of faculty.

The Department proposes to recruit faculty in the area of Bioprocess Engineering, Cell and Molecular Biotechnology, Downstream Processing, Systems and Computational Biology. In addition, each area of teaching and research is planned to be strengthened by recruiting faculty in respective areas.

10.8 Projections for future benchmarking (for comparison after 5 years) – institutions in India and abroad, and parameters for future comparison.

- An undergraduate program in Biochemical Engineering and Biotechnology is unique to IIT Delhi. We propose to strengthen this teaching program and bring it to a top position among the few other institutions that offer such a program world-wide.
- Transfer of knowledge created in the department through technological transfer, research publications in leading journals short-term courses, workshops and conferences at national & international levels to society at large.
- Encourage participation of students in competitions on international platform
- Strengthen collaborative research programmes with internationally acclaimed institutions

- Workout newer exchange programmes and strengethen the exisiting ones for students and faculty members with Universities and Institutes of international repute having common mandates

10.9 Infrastructure and governance - limiting factors that affect achievement of benchmarks and methods to overcome these.

The major limiting factor is infrastructure upkeep. The grant available for upkeep of instruments is limited. The department also needs huge consumable grant for chemicals/biochemicals. Though, most of such needs are met by individual project grants of faculty, the UG/PG teaching and student projects need much higher support. We also need to equip our teaching labs with some instruments with costs in the medium range. The challenge is not merely in finding resources for these equipments, but being able to hire new breed of technical staff who can run and maintain such equipments.

10.10 Working with other departments/centers and institutions in teaching and research.

- The Department is already offering an open category course 'Molecular Biotechnology' for undergraduate students of other departments of the Institute.
- Several Ph.D. students have been / are being jointly supervised by faculty members of Department and other Departments/ Centers such as School of Biological Sciences, Centre for Biomedical Engineering, Civil Engineering, Chemical Engineering, Centre for Rural Development and Technology. The department also has many sponsored research projects and industrial consultancy assignments in collaboration with other departments of the institute as well as other institutions from within India and from outside India.

10.11 New initiatives that the department/centre will undertake.

The Department aims to undertake more industry relevant projects.

10.12 Outreach goals and anticipated limitations in the attainment of these.

The department aims to increase the frequency of workshops/training program and conferences. The major limitation is faculty involvement in teaching a number of courses and many student-related and other administrative responsibilities.

10.13 Mechanisms for effective changes based on feedback received and development and implementation of corrective measures.

The Department is getting regular feedback from expert committee and implementing their suggestions to improve teaching and research activities

10.14 Questions to which the department seeks answers from the Review Committee.

- How to promote industry involvement with the research activities of the deparment?
- How do you envision the future of Indian Biotech Industry?
- How you resolve the trade off between dealing with problems of national interest, often of low visibility, and high-visibility problems on "hot" topics, which may not be of much national interest?

Information in public domain

Executive Summary: Information in public domain

The department profile and information regarding projects undertaken and papers published are available on the **department webpage**. Minutes of faculty-related matters (meetings, project allotment guidelines, project titles, etc.) are maintained on an **internal webpage** accessible to all faculty and students. Minutes of Professorial Committee and Departmental Committee meetings are circulated to all faculty members by **email** and also made available on the internal webpage.

11. Information in public domain

11.1 Minutes of all meetings.

The Minutes of all the meetings held in the past five years are available in the internal webpage (http://privateweb.iitd.ac.in/~sundar/review) of the department. The minutes of the Professorial Committee, Research Committee, Curriculum Committee and Faculty Board meetings are usually circulated by email, filed in the Departmental Office as well as made available on the internal webpage of the Department. Since August 2013, the department has also been maintaining a separate website for the activities related to Departmental Research Committee (DRC) that is accessible at http://privateweb.iitd.ac.in/~sundar/drc

11.2 All reports archived in the central/department/centre libraries.

All the dual degree, MSR and PhD thesis reports are available in the Documentation Unit of the Department. The details regarding the project allotment guidelines, project titles, review committee members, synopsis/thesis submission details, etc are also maintained in the webpage of DRC for easy reference of the students and faculty. The list of thesis reports archived in the Departmental Document Unit is available in the internal webpage (http://privateweb.iitd.ac.in/~sundar/review) of the department.

11.3 Past vision documents, review documents, Standing Review Committee documents.

These documents are currently maintained in the Departmental Office and we are in the process of making available the soft copies of the recent documents in the departmental webpage.

11.4 Any other documents developed by the department, a group/section of the department.

The departmental profile is made available in the departmental webpage of the department. The information regarding the projects undertaken, papers published, etc are usually updated in the departmental webpages from time to time.

11.5 Feedback documentation and action taken on the same, and its outcome.

Currently no such document is available with the department and we shall soon work on the feedback after the current external peer review and make the report available on the departmental webpage.

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Internal Review Report	http://privateweb.iitd.ac.in/~sundar/review (available on Institute LAN only)
Department	http://beb.iitd.ac.in
Institute	http://www.iitd.ac.in