DEPARTMENT OF MICROBIOLOGY

Departmental Brochure

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(2016-17)

DEPARTMENT OF MICROBIOLOGY

YEAR OF ESTABLISHMENT : 1984

DEGREES OFFERED : M.Sc. (Microbiology)
M.Phil. (Biotechnology)
Ph.D. (Microbiology)

INTRODUCTION

The Department of Microbiology runs a two year full time program leading to award of Masters of Sciences (M.Sc.) degree in Microbiology. The program includes four semesters of course work including a dissertation during which students are provided training to conduct research. The students are offered basic and advanced level courses in Microbial diversity, Microbial physiology, Virology, Immunology, Enzymology, Environmental microbiology, Microbial pathogenicity, Molecular biology, Microbial genetics, Recombinant DNA technology, Industrial and food microbiology. As a part of their curriculum students deliver seminars on various scientific topics. Second year students work on projects under the supervision of the different faculties and submit a dissertation at the end of their training.

The Department of Microbiology participates in M Phil Course in Biotechnology which is jointly run by the Departments of Microbiology, Biochemistry, Biophysics and Genetics. The department also enrolls students for a PhD degree in Microbiology. The faculty in the department currently includes five Professors, one Associate Professor and two Assistant Professors. Each faculty member manages and runs his/ her laboratory independently where research is carried out in different areas of basic and applied Microbiology. The faculty members have national as well as international collaborations to leverage the scientific advantage and develop mutually beneficial scientific interactions.

The department has two broad areas of research: ***'Industrial, Food and Environmental Microbiology'*** and ***'Molecular Biology and Pathogenesis of Microbial Infections'***. In the broad area of Industrial, food and environmental microbiology, the specific research interests of the department are in the areas of production of industrially important microbial enzymes, biofuels, bioactive compounds and carbohydrates, meta-genomics, structure function analysis and molecular modification of enzymes, lignocellulose biodegradation, ethanol production from lignocellulose, molecular biology of lignin degradation, carbon sequestration using heterotrophs, bioremediation, gene expression and bioprocess engineering. Collaboration with industries for research is an important thrust in the Department.

In the broad area of Molecular biology and pathogenesis of microbial infections, the specific areas of research interest include molecular epidemiology of emerging water-borne pathogens like *Yersinia enterocolitica* and *E.coli*, and mechanism of antibiotic resistance with special focus on β-lactamase; understanding host pathogen interactions; microbial genomics and proteomics. The research interests also include investigations into DNA replication and chromatin modifications in the protozoan parasite *Leishmania donovani* (the causative agent of kala-azar); investigating toxin-antitoxin loci in mycobacterial species; understanding molecular pathogenesis of viral infections associated with cancer using Epstein barr virus and Hepatitis C virus as models to investigate viral causes of cancers.

MSc (Microbiology)

Admission criteria for MSc (Microbiology) : Both entrance test & Merit based
Number of seats : Twelve (6 by merit, 6 by entrance)

Eligibility for admission :

Eligibility	Course requirements	Marks requirement
For Entrance Based	BSc (General) or BSc (Honours) or an equivalent undergraduate degree in any branch of life sciences/ medical sciences/ any branch of biology	60% or above marks in qualifying exam
For Merit Based	B Sc (Hons.) in Microbiology from the University of Delhi (after 10+2+3)	60% or above marks in qualifying exam

Distribution of seats under different reservation categories will vary every alternate year by following roster:

Year	Mode of admission	General	OBC	SC	ST	Sub-Total	Total
2016-17	Merit	3	1	1	1	6	12
	Entrance	3	2	1	0	6	
	Sub-Total	**6**	**3**	**2**	**1**	**12**	
2017-18	Merit	3	2	1	0	6	12
	Entrance	3	1	1	1	6	
	Sub-Total	**6**	**3**	**2**	**1**	**12**	

MSc (Microbiology) Program description

TWO YEAR FULL TIME PROGRAMME

The M.Sc. Microbiology Program is of two years duration and is divided into two parts, Part I and Part II. Each part is of one year duration and consists of two Semesters. In semester one, students are required to study four theory papers of 100 marks each, and one practical paper of 200 marks which is based on these four theory papers. In semester two also, students are required to study four theory papers of 100 marks each. These include one Interdisciplinary paper in addition to one practical paper of 200 marks. Semester three comprises of four theory papers of 100 marks each and one practical paper of 200 marks. Semester four consist of only one Interdisciplinary theory paper of 100 marks and dissertation. There will be no practical exam in this Semester. The dissertation is for 500 marks for which student are required to start working from the beginning of Semester three and continue till the end of the Semester four. For dissertation, the students are evaluated by continuous assessment, dissertation/ thesis, its presentation and viva-voce. This evaluation is done at the end of fourth Semester.

All theory, practical and dissertation will have 30% marks reserved for Internal Assessment (IA). Each theory examination will be of three hours durations and practical examination will be for (8+8 hours) spread on two days. Teaching time allotted to each paper shall be 4 period for theory and 3-4 period for practical per week.

FACULTY

Name	Qualification	Designation	E-mail Address	Phone (011-)
Prof. T.Satyanarayana	M.Sc., Ph.D.	Professor & Head	tsnarayana@gmail.com	24157163
Prof. J.S. Virdi	M.Sc., Ph.D.	Professor	virdi_dusc@rediffmail.com	24157164
Prof. R.C. Kuhad	M.Sc., Ph.D.	Professor	kuhad85@gmail.com	24157368
Prof. Rani Gupta	M.Sc., Ph.D.	Professor	ranigupta15@yahoo.com	24157165
Dr. Swati Saha	M.Sc., Ph.D.	Associate Professor	ss5gp@yahoo.co.in	24157380
Dr. Y.P. Khasa	M.Sc., Ph.D.	Assistant Professor	yogi110@gmail.com	24157369
Dr. Rajeev Kaul	M.V.Sc., Ph.D.	Assistant Professor	rkaul@south.du.ac.in	24157328

TECHNICAL STAFF

Name	Qualification	Designation	E-mail Address	Phone (011-)
Mrs. Meena Singh	Graduation	Technical Assistant	aneemsingh1@yahoo.com	24157240
Mr. Mustafa Hussain	Graduation	Lab Assistant	mustafa.hussain955@gmail.com	24157240
Mr. Madan Lal	Matric	Lab Attendant	madanlal5561@gmail.com	24157240
Mr.Satish Kumar	Higher Secondary	Lab Attendant	satishkanojia_i4u@yahoo.com	24157240
Mr. Akhtar Hussain	Graduation	Lab Attendant	akhtat7huss@yahoo.com	24157240
Mr. Vikram	-	Safai Karamchari	---	-

Prof. T. SATYANARAYANA

AREA OF RESEARCH: Applied and Industrial Microbiology

RESEARCH ACHIEVEMENTS:

An ideal starch saccharification process has been developed by using thermostable α-amylase, amylopullulanase and glucoamylase of *Geobacillusthermoleovorans* and *Thermomucorindicae-seudaticae*. Acidic α-amylase of the acidophilic bacterium *Bacillus acidicola* was produced and characterized. The genes encoding starch hydrolyzing enzymes have been cloned, characterized and found them useful in starch saccharification and bread making.

Xylanolytic enzymes produced by *Geobacillusthermoleovorans*, *G. thermodenitrificans* and *Bacillus halodurans* have been produced and characterized, and the genes encoding the enzymes have been cloned and characterized. They are useful in hydrolyzing xylan component of agro-residues and in pulp bleaching. A metagenomic xylanase was obtained from metagenome of soil-compost sample. The xylanase gene was cloned in *Escherichia coli* and *Bacillus subtilis*. The mutein generated by introducing arginines in place of serine/threonine on the surface of the protein exhibited higher thermostability than the metagenomic xylanase.

Phytases of the unconventional yeast *Pichiaanomala* and thermophilicmould*Sporotrichum thermophile* have been produced and characterized. The phytases are useful as food and feed additives in poultry and aquaculture, dephytinizing soymilk, wheat flour and seed cakes, and in promoting plant growth. The genes encoding phytases have been cloned, expressed and characterized.

Carbonic anhydrase of *Bacillus pumilus* and *Bacillus halodurans* have been produced, characterized and have been shown to be useful in carbon sequestration. The genes encoding genes have been cloned and sequenced. A novel psychrotolerant strain of *Bacillus* was isolated from a soil sample collected from Leh and described as *Bacillus lehensis* sp. nov. This is a source of cold tolerant alkaline protease which is useful as detergent additive, in silk fibre degumming, biocontrol of nematodes and silver recovery from used x-ray films. The protease gene was cloned and expressed. A process has been developed for manufacturing Asavas and Arishta range of Ayurvedic tonics using yeast strains in collaboration with Dabur Research Foundation.

Publications:

1. Joshi, S. and **Satyanarayana, T**. 2013. Characteristics and applications of a recombinant alkaline serine protease from a novel bacterium *Bacillus lehensis*. Biores. Technol. 131: 76-85.
2. Mehta, D. and **Satyanarayana, T**. 2013. Dimerization mediates thermo-adaptation, substrate affinity and transglycosylation in a highly thermostablemaltogenic amylase of *Geobacillusthermoleovorans*. PLoS One e73612: 1 – 13.
3. Verma, D. and **Satyanarayana, T.** 2013.Cloning, expression and characteristics of a novel alkalistable and thermostablexylanase encoding gene (Mxyl) retrieved from compost-soil metagenome. PLoS One 8(1): e52459: 1 – 8.
4. Nisha, M. and **Satyanarayana, T**. 2013. Characterization of recombinant amylopullulanase (gt-apu) and truncated amylopullulanase (gt-apuT) 0f the extreme thermophile *Geobacillusthermoleovorans* NP33 and their action in starch saccharification. Appl. Microbiol. Biotechnol. 97: 6279-6292.
5. Verma, D. and **Satyanarayana, T**. 2012. Cloning, expression and applicability thermo-alkali- stable xylanase of *Geobacillusthermoleovorans* in generating xylo-oligosaccha-rides from agro-residues. Bioresource Technol. 107: 333-338.

Prof. R. C. KUHAD

AREA OF RESEARCH: Lignocellulose Microbiology and Biotechnology

RESEARCH ACHIEVEMENTS:

Pioneering contributions have been made in the field of microbial conversion of lignocellulosic materials, using microorganisms and their enzymes, into value added products; lignocellulolytic enzymes (xylanase, laccase, cellulase and pectinase).

- The processes for production of **xylanase (Patent no. IN984/DEL/2008)and laccase** have been developed and both have been evaluated in bleaching of paper pulp at pilot scale. **Process for bleaching of paper pulp** has been filed for patenting **(Patent No. IN/DEL/2013)**
- The process for **production of a high level alkaline pectinase** for application in bioretting of plant fibers has also been developed.
- After a long effort of more than two decades, a process for **bioconversion of wheat straw in nutritionally rich and digestible animal feed by solid-state fermentation** has been developed. The fermented feed produced has been evaluated both *in vitro* and *in vivo* conditions. The evaluation of the feed revealed that **the fermented feed was able to replace almost 50% of the concentrate and resulted in higher body weight gain(Patent No. IN4039/DEL/2012)**
- For last more than one decade, we have been concentrating on **bioconversion of plant materials (lignocellulosics) into bioethanol**. Among several interventions during the development of the bioethanol production process, the important one is the generation of high concentration sugar syrup. Using the designed process, **the sugar concentration in the syrup was improved up to 5 folds (Patent No. 1348/DEL/2011).**
- Recently we have **successfully produced laccase and pectinase recombinants**. Moreover efforts are continued to study application of laccase in producing pharmaceutical compounds following green ways.

Publications:

1. Gupta R, Kumar S., Gomes J. and **Kuhad R.C.** (2012). Kinetic study of batch and fed-batch enzymatic saccharification of pretreated substrate and their subsequent fermentation to ethanol. ***Biotechnology for Biofuels*** 5:16
2. **Kuhad, R.C.,** Gupta, R., Khasa Y.P. and Singh A. (2010). Bioethanol production from *Lantana camara* (red sage): Pretreatment, saccharification and fermentation.***Bioresource technology.***101: 8348-8354.
3. Kidwai, M., Poddar, R., Diwanian S. and **Kuhad, R. C.** (2009). Laccase from basidiomycetous fungus catalyzed synthesis of substituted 5-deaza-10-oxaflavin via Domino reaction. ***Advance Synthesis and Catalysis.*** 351:589-595.
4. **Kuhad, R. C.**, Singh, A. and Eriksson, K. E. L., (1997). Microorganisms and enzymes involved in the degradation of the plant fibre cell walls. Special issue on 'Biotechnology in pulp and paper industry' for ***Advances in Biochemical Engineering/Biotechnology***. Vol. 57: 45-125.
5. **Kuhad, R.C.,** Singh, A. (1993). Lignocellulose biotechnology. Current and future prospects. ***Critical Reviews in Biotechnology***13:151-172

Prof. RANI GUPTA

AREA OF RESEARCH: Microbial enzymes and Industrial Applications

RESEARCH ACHIEVEMENTS:

A novel bifunctionalkeratinase enzyme from *Bacillus licheniformis* has been characterized in detail. Its applicability for rapid conversion of chicken feather to feather meal has been documented. It has also been used as an ungual enhancer to prepare an enzyme based formulation for increased drug delivery. In addition, biochemical and molecular characterization of keratinases from *Bacillus pumilus* had also been documented. Chitin conjugates of the same have been demonstrated to degrade prion like protein, Sup 35NM under ambient conditions. Molecular characterization of keratinases from *Bacillus* sp. has also been done to establish the effect of pro-sequence on thermostability and substrate specificity of enzyme. Further, a novel keratinase from *Pseudomonas aeruginosa* has also been documented for the first time. Redox mechanism underlying the degradation of recalcitrant proteins like has been deciphered. Coupled action of γ-glutamyltranspeptidase-glutathione and keratinase has been shown to effectively degrade feather and Sup 35NM. In addition to the above, novel yeast lipases have been described. Six lipases from *Yarrowia lipolytica* have been characterized in detail. Lipase genes from *Trichosporon* sp. have been isolated, sequenced and characterized for the first time.

Publications:

1. Rajput R,Verma VV, Chaudhary V and Gupta R (2013), A hydrolytic γ-glutamyltranspeptidase from thermo-acidophilic archaeon*Picrophilus torridus*: binding pocket mutagenesis and transpeptidation, *Extremophiles*, 17(1), 29-41.
2. Gupta R, Sharma R and Beg Q (2013), Revisiting microbial keratinases: Next generation proteases for sustainable biotechnology, *Crit Rev Biotechnol.*, 33(2), 216-228.
3. Sharma R and Gupta R (2012), Coupled action of γ-glutamyltranspeptidase-glutathione and keratinase effectively degrades feather keratin and surrogate prion protein, Sup 35NM, *Biresour technol*, 120, 314-317.
4. Rajput R, Tiwary E, Sharma R and Gupta R (2012), Swapping of pro-sequences between keratinases of *Bacillus licheniformis* and *Bacillus pumilus*: Altered substrate specificity and thermostability, *Enzyme Microb. Technol.*, 51, 131-138.
5. Kumar S, Arora N, Bhatnagar R, and Gupta R (2009), Kinetic modulation of Trichosporonasahii MSR 54 lipase in presence of organic solvents: Altered fatty acid specificity and reversal of enantioselectivity during hydrolytic reactions, J. Mol. Catal. B: Enzym, 59, 41–46.

Prof. J.S. VIRDI

AREA OF RESEARCH:
Microbial comparative genomics; Emerging water-borne pathogens; Molecular epidemiology of water-borne pathogens

RESEARCH ACHIEVEMENTS:

Yersinia enterocolitica is an important food- & water-borne enteric pathogen. The major objective of Prof. Virdi's research has been to understand public health significance of *Y. enterocolitica* in India, following first outbreak in Tamil Nadu in 1996. Epidemiological studies carried out in Prof. Virdi's laboratory have unequivocally shown presence of this enteric pathogen in India. *Y. enterocolitica* has been detected in wastewater, river water, pork, pigs (reservoir) and diarrheic human patients. All strains from India have been authenticated byWHO *Yersinia* Reference Lab at Pasteur Institute (Paris). Notable among Indian strains are serotypes O: 6,30 and O: 6,30-6,31 which have been reported to be associated with outbreaks of gastroenteritisin other parts of the world. The Indian strains showed unique antibiotic resistance profile, variable expression

of β- lactamase and resistance to arsenite. The study of the pathogenicity-related genes showed that Indian strains harbored enterotoxin genes. Molecular characterization using variable number tandem repeats (VNTRs), 16S-23S intergenic spacer region-PCR, repetitive genomic elements (REP/ ERIC)-based genotyping revealed that only two clonal groups of *Y. enterocolitica* were prevalent in India. The distribution of several virulence-associated genes correlated well with the clonal groups rather than the source of isolation. Genomic analysis using VNTRs, multilocus restriction typing (MLRT) & multilocus enzyme electrophoresis (MLEE) revealed that clinical strains of *Y. enterocolitica* originated from environmental strains by genetic change and adaptation. These studies also showed that the Indian and the European strains have been evolving differently. Current work is focused on delineating further genomic differences between clinical and non-clinical strains by suppression subtractive hybridization (SSH) and immune response to the two clonal groups identified. Further work is also focused on understanding molecular epidemiology and evolution of *Yersinia enterocolitica* using mutilocus sequence typing (MLST) and whole genome sequencing.

Publication:

1. Dhar MS, Gupta V, **Virdi JS**. (2013). Detection, distribution and characterization of novel superoxide dismutases from *Yersinia enterocolitica*Biovar 1A. **PLoS One.** 8 (5):e63919.
2 Mallik S and **Virdi JS (2010).** Genetic relationships between clinical and non-clinical strains of *Yersinia enterocolitica* biovar 1A as revealed by multilocus enzyme electrophoresis and multilocus restriction typing. **BMC Microbiology, 10:158.**
3 Bhagat N and **Virdi JS (2009).** Molecular and biochemical characterization of urease and survival of *Yersinia enterocolitica* biovar 1A in acidic pH *in vitro.* **BMC Microbiology,** 9: 262.
4 Mittal S, Mallik S, Sharma S and **Virdi, JS** (2007) Molecular characteristics of β-lactamases and their genes (*blaA* and *blaB*) in *Y. intermedia* and *Y. frederiksenii.* **BMC Microbiology**. 7: 25.
5 Bhagat N and **Virdi JS** (2007). Distribution of virulence-associated genes in *Yersinia enterocolitica* biovar 1A correlate with clonal groups and not the source of isolation. **FEMS Microbiology Letters** 266: 177-183.

Dr. SWATI SAHA

AREA OF RESEARCH: DNA replication and chromatin modifications

RESEARCH ACHIEVEMENTS:

Eukaryotic DNA replication involves the licensing and activation of multiple origins. Origins are licensed by the assembly of pre-replication complexes (pre-RCs) in G1 phase, by the ordered loading of multiple proteins. At G1/S, pre-RCs are transformed into pre-initiation complexes, and in S phase DNA synthesis commences. The components of pre-RCs are conserved from yeast to mammals, with the basic mechanisms of DNA replication being similar. However, based on the annotated genome sequences while the replication machinery of trypanosomatid nuclear DNA appears to largely resemble that of higher eukaryotes, several key players are absent. We took the approach of beginning the study of DNA replication in *Leishmania* by characterizing the *Leishmania* orthologs of known replication proteins. The idea is to eventually use these as bait to fish out novel *Leishmania* proteins involved in the process using a proteomics approach. The three proteins we have focused on are ORC1, MCM4, and PCNA. The genes for these proteins have been cloned, antibodies raised to the recombinant proteins, and their expression patterns in *Leishmania* analyzed at different stages of the organism's life cycle as well as cell cycle. We have demonstrated the existence of replication factories in *Leishmania*, and shown that PCNA can be used as a marker for these replication factories. Using a proteomics approach combined with a genetic approach we have found MCM4 and PCNA to interact, and found this interaction to be important for cell survival. This is the first time any of the MCMs2-7 have been found to interact with PCNA. Our work on all these three proteins has been published in international peer-reviewed journals.

We are also actively engaged in investigating the role of various histone modifications in *Leishmania* biology. We have begun with targeting histone acetylations, which have been shown to regulate replication, transcription and repair in higher eukaryotes.

Publication:

1. Arora, J, Goswami, K, &**Saha, S**. (2014). Characterization of the replication initiator Orc1/Cdc6 from the archjaeon*Picrophilustorridus*.*JBacteriol*. **196**: 276-286.
2. Kumar, D, Kumar D &**Saha, S.** (2012).A highly basic monopartite sequence at the N-terminal region is essential for targeting the DNA replication protein ORC1 to the nucleus in *Leishmaniadonovani. Microbiology.***158:** 1775-1782.
3. Kumar, D, Minocha, M, Rajanala, K. &**Saha, S.** (2012).The histone H4 lysine 14 acetylation in *Leishmaniadonovani* is mediated by the MYST family protein HAT4. *Microbiology.***158:** 328-337.
4. Minocha, N, Kumar, D, Rajanala, K, &**Saha, S.** (2011). Characterization of *Leishmaniadonovani* MCM4: expression patterns and interaction with PCNA. *PLoS One* **6(7):** e23107.
5. Kumar, D, Minocha, M, Rajanala, K. &**Saha, S.** (2009).The distribution pattern of proliferating cell nuclear antigen in the nuclei of *Leishmaniadonovani*.*Microbiology***155:** 3748-3757.

Dr. YOGENDER PAL KHASA

AREA OF RESEARCH:

Bioprocess Engineering, Fermentation Technology and Industrial Biotechnology

RESEARCH ACHIEVEMENTS:

The laboratory is focused on the production of different industrially important enzymes and therapeutic proteins for clinical applications. Presently we are working on cloning, expression of Asparaginase hIL-3, hIL-7, scFv against hGM-CSF in yeast expression system, *Pichia pastoris.* Cloning of hGM-CSF under different signal sequences and fusion partners has been done for soluble and extracellular expression. The initial bioprocess optimization of hIL-3, hIL-7 in *E.* coli showed promising results. The scale up studies at bioreactor level is in progress for gram level protein production. Scale up studies using optimized parameters in *Pichia* system produced 200 g/L of cell biomass (WCW) at 5L fermentor volumes. Kinetic analysis of growth and product formation will be done by running continuous stirred tank reactor experiments. Purification and formulation of different therapeutic molecules are in process. The biological activity of clinically important biomolecules will be done using cell culture experiments.

Publication:

1. **Khasa YP,**Khushoo A and Mukherjee KJ **(2013)**. "Enhancing toxic protein expression in *E. coli* Fed batch culture using kinetic parameters: hGM-CSF as a model system"***Journal of Bioscience and Bioengineering,*** 115:291–297**.**
2. **Khasa YP**, Khushoo A,Tapryal S,Mukherjee KJ **(2011).** Optimization of human Granulocyte Macrophage-colony stimulating factor (hGM-CSF) expression using native asparaginase and xylanase gene's signal sequences in *Escherichia coli.* ***Appl Biochem Biotechnol,*** 165:523-537.

3. **Khasa YP,** Conrad S, Sengul M, Plautz S, Meagher MM and Inan M **(2011).** Isolation of *Pichia pastoris PIR*-gene family and their utilization for cell surface display and recombinant protein secretion. ***Yeast,*** 28: 213–226.
4. **Khasa YP**, Khushoo A, Srivastava L and MukherjeeKJ **(2007).** Kinetic studies of constitutive hGM-CSF expression in continuous culture of *PichiaPastoris*. ***Biotechnology Letters*.** 29:1903-1908.
5. **Pal Y**, Khushoo A and Mukherjee KJ **(2006).** "Process optimization of constitutive human granulocyte macrophage colony stimulating factor (hGM-CSF) expression in Pichiapastoris fed batch culture".***Applied Microbiology and Biotechnology,*** 69: 650-657.

Dr. RAJEEV KAUL

AREA OF RESEARCH: Tumor Virology

RESEARCH ACHIEVEMENTS:

Our lab is presently working to study biology of cancers mediated by viruses. Tumor viruses have provided relatively simple genetic systems, which can be manipulated for understanding the molecular mechanisms of the cellular transformation process. A growing body of information in the tumor virology field provides several prospects for rationally targeted therapies. However, further research is needed to better understand the multiple mechanisms utilized by these viruses in cancer progression in order to develop therapeutic strategies. The major focus of our lab is to investigate virus host interactions using various tools including cell culture system and mice models. Primarily, we study two human tumor associated viruses, one Epstein Barr Virus (EBV) and other Hepatitis C Virus (HCV). In particular, we are using genetic, genomic, proteomic and biochemical approaches to identify viral pathways involved in these cellular events to develop mechanistic models for transformation by viruses.

Tumor associated viruses provide a unique opportunity to understand the role played by viral proteins in transformation and to identify pathways critical for tumorigenesis and metastasis. A clear understanding of the pathways most critically involved in tumor formation and progression and the consequences of altered cell behavior in the tissue micro-environments will provide nuggets of information which will help us in formulating better therapeutic approaches. It is likely that a combination of therapeutic agents targeting multiple signal transduction pathways will be needed for maximum therapeutic benefits. Our lab is presently working to study biology of cancers mediated by viruses. Tumor viruses have provided relatively simple genetic systems, which can be manipulated for understanding the molecular mechanisms of the cellular transformation process. A growing body of information in the tumor virology field provides several prospects for rationally targeted therapies. However, further research is needed to better understand the multiple mechanisms utilized by these viruses in cancer progression in order to develop therapeutic strategies. In particular, we are using genetic, genomic, proteomic and biochemical approaches to identify viral pathways involved in these cellular events to develop mechanistic models for transformation by viruses.

Latest Publications:

1. Jaya Gandhi, Nivedita Gaur, Lohit Khera, Rajeev Kaul*, Erle Robertson* (*Co-corresponding authors). 2015. COX-2 induces lytic reactivation of Epstein Barr Virus through Prostaglandin E2 by modulating the EP receptor signalling Pathway. *Virology.* 2015. Jun 4;484:1-14
2. Prerna dabral, Lohit Khera, **Rajeev Kaul**. 2014. Host Proteins associated with Hepatitis C Virus encoded NS4A. *Virus Disease*. 2014. 25(4): 493-496.
3. Nivedita Gaur, Jaya Gandhi, Erle S Robertson, Subhash C Verma, **Rajeev Kaul**. 2014. Epstein Barr Virus latent antigens EBNA3C and EBNA1 modulate epithelial to mesenchymal transition of cancer cells associated with tumour metastasis.

Tumor Biology. 2014 Dec 13

4. Jaya Gandhi and **Rajeev Kaul**. 2011. Cyclooxygenase-2 and hepatocellular carcinoma: the proteomics of association. Journal of Proteins and Proteomics. 2011 July-Dec 2(2):81-97

5. Jie Lu, Masanao Murakami, Subhash C. Verma, Qiliang Cai, Sabyasachi Haldar, **Rajeev Kaul**, Mariusz A. Wasik, Jaap Middeldorp and Erle S. Robertson. 2011. Epstein-Barr Virus nuclear antigen 1 (EBNA1) confers resistance to apoptosis in EBV-positive B-lymphoma cells through up-regulation of Survivin. *Virology*. 2011 Feb 5;410(1):64-75.

6. Abhik Saha, **Rajeev Kaul**, Masanao Murakami and Erle S. Robertson. 2010. Tumor viruses and cancer biology: Modulating signaling pathways for therapeutic intervention. *Cancer Biology and Therapy*, 2010 Nov 29; 10(10):961-78

SIGNIFICANT RESEARCH PROJECTS CARRIED OUT AT THE DEPARTMENT:

Title	Funding Agency	Ongoing/ Sanction	Grant (in Lacs)
Process Engineering and industrial exploitation of important hydrolases	**DBT**	Completed	54.00
Enzyme mediated food processing	**Ministry of Food Processing**	Completed	64.50
Enzymatic conversion of indigenous non-conventional oils and fats for bio-disel production	**MNRE**	Completed	22.63
Biotechnology for Leather: Towards cleaner processing	**CSIR**	Completed	103.57
Microbial cellulose: A sustainable alternative to conventional fibers: Process development, scale up, purification & potential applications	**CSIR**	Completed	22.00
Butanol: A sustainable alternative fuel: production, process optimization, purification, scale up and evaluation	**DBT**	Completed	54.78
Production of Shikimic acid: a potential candidate for developing drug formulation for swine and avian flu	**ICMR**	Completed	68.78
Carbon sequestration using heterotrophic bacteria	**DBT**	Completed	25.00
Applicability of cell-bound phytase of *Pichiaanomala*	**DBT**	Completed	30.00
Phytase of *Pichiaanomala*	**ICAR**	Completed	22.00
Metagenomics for xylanase	**DBT**	Completed	48.00
Preparation And Screening of DNA Library From Wood Decaying Soils and Termite Mounts For Novel Lignocellulolytic Enzymes	**DBT**	Completed	86.11

Evaluation of xylanases and laccases at pilot and mill scale in pulp and paper industry	**DBT**	Completed	46.03
Process Development for Ethanol Production from Lignocellulosic Biomass	**DBT**	Completed	51.19
Process development and application of Pectinase for retting of plant fibres	**DBT**	Completed	32.28
Novel lipase from yeast strains isolated from petroleum sludge: Lipase production, purification and characterization with respect to their catalytic utility	**CSIR**	Completed	20.00
Characterization of keto-reductases from newly isolated yeasts strains: Application in production of enantiopure phenyl ethanol.	**UGC**	Completed	12.00
Bio-surfactant from newly isolated yeasts strains: Fermentation, downstream processing, characterization and its application.	**DBT**	Completed	17.00
Biochemical and molecular characterization of an enantioselective lipase from Trichosporonashaii MSR-54	**CSIR**	Completed	16.00
Subtilisin-GGT, a novel keratinolytic complex for prospective ungula drug delivery: Expression and protein-protein interation	**DU/DST-PURSE Grant**	Completed	42.00
Biochemical and molecular characterization of an enantioselective lipase from Trichosporonashaii MSR-54	**CSIR**	Completed	20.00
Genome-wide cloning, expression and purification of toxin and antitoxin proteins of *Mycobacterium tuberculosis* for development of reagents and studying the physiological role of these proteins.	**DBT**	Completed	80.0
Joint Indo-Finland RFBR "Butanol from sustainable sources"	**DST**	On going	34.12
Joint Indo-Russian Enzymatic Transformation of Fucodians as a base for Drug Design, structural and functional investigations from Indian and Russian seaweeds	**DST**	On going	40.36
Cloning and expression of amylopullulanase of *G. htermoleovorans*	**DST-PURSE**	Ongoing	24.07
Cloning and expression of phytase encoding gene of *P. anomala* in *Pichia pastoris*	**UGC**	Ongoing	13.27

Acidic amylase of *Bacillus acidicola*	**DST**	Ongoing	33.31
Cloning and expression of phytase of *Sporotrichum thermophile*	**DBT**	Ongoing	23.25
Carbon monoxide dehydrogenase of Actinobacteria	**DBT**	Ongoing	30.65
Optimization of cellulase production from *Thermoascusauranticus* RCK 2011, a thermophilic fungus and its application in cellulose hydrolysis	**UGC**	Ongoing	10.51
Development of Pretreatment strategies and bioprocess for improved production of cellulolytic enzymes and ethanol from crop byproduct for demonstration at pilot plant	**MNRE**	Ongoing	148.47
Development of seaweeds biorefinery and pilot demonstration of bioethanol production	**DBT**	Ongoing	34.47
Enzymatic synthesis of theanin: A nutraceutical using microbial GGT	**MoFPI**	Ongoing	23.00
Biotechnological potential of keratinolytic bacteria from selected biotopes in manipur	**DBT**	Ongoing	19.44
Utilization of peptidomimetics to design small molecules from a novel P1 peptide, their interaction with beta amyloid oligomers by *in-silico* and *in-vitro* approaches, and its efficiency in clearing beta amyloid load by *ex vivo* model of Alzheimer's disease	**DBT-BIRAC**	Ongoing	22.00
Comparative genomics of β-lactamase genes including *in-silico* analysis to identify sequences for β-lactamase inhibitors.	**ICMR**	Ongoing	35.00
Role of probiotic lactic acid bacteria in modulating antibiotic susceptibilities of enteric pathogens	**ICMR**	Ongoing	40.00
Characterization of the DNA replication proteins Cdc6/ORC1 and MCM in the archaeon*Picrophilustorridus*	**DST**	Ongoing	39.00
Functional characterization of histone acetyltransferases HAT2 and HAT3 in the protozoan parasite *Leishmaniadonovani*	**DBT**	Ongoing	62.00
Functional characterization of histone acetylase HAT4 in *Leishmaniadonovani*	**CSIR**	Ongoing	27.00
Mechanism of EBV latency control by inflammation	**DBT**	Ongoing	40.00
Hepatitis C Virus& expression of cox-2	**DBT**	Ongoing	55.00

Viral metagenomics	**DST**	Ongoing	40.00
Generations of EBV transformed LCLs of diverse origin	**UGC**	Ongoing	14.00
Antitoxin-toxin loci of *Mycobacterium tuberculosis*: Identification and biochemical characterization	**DBT**	On-going	100.00
A system for enhanced production of recombinant proteins in Mycobacteria	**DST**	On-going	41.00
Cloning expression and bioprocess optimization of recombinant human interleukin-7 (hIL-7) in methylotrophic yeast *PichiaPastoris*	**DBT**	On-going	30.50
Bioprocess optimization of human Granulocyte Macrophage Colony Stimulating Factor (hGM-CSF) expression in *Escherichia coli.*	**DST**	On-going	25.00
Bioprocess optimization of scFv production against hGM-CSF in methylotrophic yeast, *Pichiapastoris*	**UGC**	On-going	8.45
Bioprocess development of recombinant therapeutics in *Pichiapastoris*:Human Interleukin-3 (hIL-3) as a model system	**DBT**	On-going	51.59

EXTERNAL FUNDING SOURCES FOR RESEARCH AND GRANT AMOUNT

Name of the funding Agencies:	**Total (in lacs)**
Department of Biotechnology (DBT)	**1455.36**
Department of Science and Technology (DST)	**404.03**
University Grant Commission (UGC)	**91.468**
Council of Scientific and Industrial Research *(CSIR)*	**497.34**
Ministry of Environment & Forests (*MoEF*)	**109**
Ministry of Food Processing Industries (*MoFPI)*	**94.5**
Indian Council of Medical Research (*ICMR)*	**198.78**
Indian Council of Agricultural Research (*ICAR)*	**37.78**
Ministry of New and Renewable Energy *(*MNRE*)*	**171.10**
Defence Research and Development Organization (DRDO)	**25**

Ph.D. THESIS COMPLETED IN LAST 5 YEARS:

S.No.	**Year**	**Name**	**Thesis titled**
1	2008	**Saurabh Saran**	An Alkaline Protease from *Bacillus licheniformis*: Production, Down stream Processing and Potential Applications with Special emphasis on Leather Industry

2	2008	**Gautam Kumar Meghwanshi**	A highly Alkaline, 1,3-regiospecific Lipase from *Pseudomonas aeruginosa* : Process optimization, Purification, Characterization and its Potential Industrial Applications
3.	2008	**ManjuBharadwaj**	Alkaline protease of *Bacillus lehensis*
4.	2008	**Krishna Kant Sharma**	Production, purification, stuructural properties, molecular characterization and application of laccase from *Ganoderma* sp-rckk02
5.	2008	**SarikaDiwaniyan**	Laccae from basidiomycetous fungus *Crinipellis* sp. RCK-1: Production, purification, characterization and its application
6.	2008	**Suresh Kumar**	Extracellular lipase from *Trichosporonasahii* MSR 54: Production, Characterization and its Applications
7.	2009	**KakoliDutt**	Rennet from *Bacillus subtilis*: production, biochemical characterization, scale up and its its application cheese making.
8.	2009	**Pardeep Kumar**	Glucoamylase of *Thermomucorindicae-seudaticae*
9.	2009	**Shefali Gupta**	Production, characterization, cloning and expression of pectinase from *Bacillus subtilis* RCK.
10.	2009	**Ms. Neeru Bhagat**	Detection of virulence genes and other pathogenicity - related factors in *Yersinia enterocolitica* isolated from India
11.	2010	**Pritesh Gupta**	Lipase from *Thermomyceslanuginosus* : process optimization, purification, characterization, scale up and application
12.	2010	**Tapesh Kumar Tyagi**	Studies on the novel enzyme acetoxy drugs: Protein transacetylase from mesophilic fungus *Starkeyomyces sp.*
13.	2010	**MsSarita Mallik**	Proteomic approaches to study strain diversity and arsenic-mediated multiple antibiotic resistance in *Yersinia enterocolitica* isolated from India
14.	2010	**Diwakar Kumar**	Cloning and characterization of DNA replication protein ORC1 in *Leishmania*(submitted September 2010)
15.	2011	**EktaTiwary**	Novel Bifunctional Chimeric Keratinase from *Bacillus licheniformis* ER-15 and its Biotechnological Applications
16.	2012	**Pinki Anand**	Microbial production of 1,3-propanediol: Process optimization, scale up, purification, characterization and potential industrial applications
17.	2012	**ShailendraRaghuwanshi**	Tannase from Penicilliumcharlesii: Process optimization, purification, characterization, scale up and industrial applications
18.	2012	**Bharti Rohatgi**	Chitinase of *Myceliophthorathermophila*
19.	2012	**Adarsh K. Puri**	Carbonic anhydrase of *Bacillus pumilus*
20.	2012	**Rishi Gupta**	Bioconversion of plant residues into ethanol.
21.	2012	**Richa Sharma**	Keratinases from *Pseudomonas aeruginosa*

			KS-1: Characterization and degradation of surrogate prion protein Sup 35NM
22.	2012	**Mr. Pradeep Kumar**	Genomic differences between clinical and non-clinical strains of *Yersinia enterocolitica* isolated from India
23	2012	**NehaMinocha**	*Leishmaniadonovani* MCM4: Characterization of expression and interaction with PCNA
24.	2013	**Swati Misra**	Development and optimization of a fermentative process for xylitol production from Candida tropicalis: scale up, purification and applications
25.	2013	**Vinod Kumar**	Rhizopusoryzae lipase: process optimization, purification, characterization, scale up and its comparative evaluation with other microbial lipases for industrially important reactions
26.	2013	**Firdaus Jahan**	Bacterial Cellulose: Production, Properties, Scale up and Industrial applications
27.	2013	**Archana Sharma**	Acidic amylase of *Bacillus acidicola*
28.	2013	**Digvijay Verma**	Retrieval of thermo-alkali-stable xylanase gene through metagenomic approach
29.	2013	**Vikash Kumar**	Xylanase of *Bacillus halodurans*
30.	2013	**Preeti Nandal**	Bioprocessing for production of inoculum and laccase from *Coriolopsiscaperata* RCK2011 and their application
31.	2013	**Deepa Deswal**	Cellulase from brown-rot fungus *Fomitopsis* sp. RCK2010 and its application in hydrolysis of ligocellulosic materials for ethanol production
32.	2013	**BhuvneshShrivastava**	Bioconversion of wheat straw in to animal feed by solid state fermentation.
33.	2013	**Mr. Mahesh S. Dhar**	Interaction of strains of two clonal groups of *Yersinia enterocolitica* with cultured cells in vitro
34.	2013	**Mr. Asani Bhaduri**	Molecular and biochemical studied on secretory proteins of Mycobacteria
35.	2013	**Devanand Kumar**	Identification and characterization of histone acetylases in the protozoan *Leishmaniadonovani*(submitted April 2013)
36.	2013	**V. Balaji**	Expression patterns induced by stress in *mycobacterium tuberculosis*: a genome-wide analysis focusing on toxin-antitoxin loci

M.PHIL. THESIS COMPLETED:

S.No.	Year	Name	Thesis titled
1.	2008	Firoz Hussain Shah	Carbonic anhydrase of*Sporotrichum thermophile*
2.	2011	Swati Singh	Comparison of various methods for extraction of proteins from bacterial cell

NUMBER OF STUDENTS RECEIVING JRF/SRF SINCE 2012: 44

Fellowship	No. of Student
CSIR	20
MNRE	03
ICMR	04
DST Project	03
DBT Project/INSPIRE	04
UGC	03
Rajiv Gandhi	01
JwaharLal Nehru Memorial	01
Single child	01
UGC Non-Net	04

SIGNIFICANT ACHIEVEMENT AND AWARDS RECEIVED BY STUDENTS:

1. Jaya Gandhi, PhD Scholar won PGIMER Young Scientist Award in Medical Virology in VIROCON-2012 organized by Indian Virological Society at IVRI Mukteswar from 8-10 Nov, 2012
2. Firdaus Jahan, Ist Position at National level for Young Indian Next Practices Award (2011) in National Fair organized by DST, Agilent Technologies, and Confederation of Indian Industries. 2011" held at New Delhi on 16th Nov., 2011.
3. GarimaRawat& Priyanka Rawat 2nd Position at National level for India Innovation Initiative (2011) award organized by DST, Agilent Technologies, and Confederation of Indian Industries. 2011" held at New Delhi on 16th Nov., 2011.

AWARDS / RECOGNITIONS RECEIVED AT THE NATIONAL AND INTERNATIONAL LEVEL BY FACULTY:

Prof. T.SATYANARAYANA

1. Dr. G.B. Manjrekar award of AMI in 2003
2. Dr. V.S. Agnihotrudu memorial award of MSI in 2009
3. Malaviya Memorial award of BRS, India

Best Paper/Poster Award

1. Two Best poster awards in BRSI conference held in 2012 at Patiala
2. Best poster award in AMI conference held at Ranchi in 2011

Prof. R.C. KUHAD

1. Fellowship of National Academy of Agricultural Sciences (2014)
2. Fellow of Biotech Research Society of India (2013)
3. AMI -Titan Biotech Award for services in Microbiology during 52nd Annual Conference of AMI at Chandigarh (2011).
4. The American Society for Microbiology Best Poster award during the International Symposium on Recent Advances in Cross-disciplinary Microbiology: Avenues and Challenges, at BIT, Mesra, Ranchi, India (2010).
5. Second Best Research Poster prize on "Microbes in Food and Fermentation" during the 50th Annual Conference of AMI at National Chemical Laboratory, Pune, India (2009).
6. Second Best Research Poster prize in an International conference on Climate Change and Sustainable Management of Natural Resources organized by ITM Universe-Gwalior (2009).

Prof. RANI GUPTA

1. Bursary award at Biotrans 2013-14.
2. Best Paper award (2000) at Annual conference of Indian Institute of Chemical Engineers (Chemcon 2000).
3. Best paper award and two consolation awards (1998) at National Seminar on Perspectives in Interfacial Areas of Chemistry and Biology.
4. Best paper award (1997) at the Annual Conference of Association of Microbiologists of India.
5. Best paper award (1994) at the National seminar on application of biotechnology in molasses based and allied industries.
6. Best paper award (1993) at the 62nd Annual Meeting of Society of Biological Chemists of India.

Prof. J.S. VIRDI

1. ICMR Y.S. Narayana Rao Award for Research in Microbiology.
2. INSA Visiting fellowship
3. University Gold Medal in Microbiology

Dr. Y.P. KHASA

1. Young Scientist Award in *"Molecular Microbiology"* 2010 by Association of Microbiologists of India (AMI).

Dr. RAJEEV KAUL

1. Awarded Indo-US Raman Research fellowship for year 2013-14