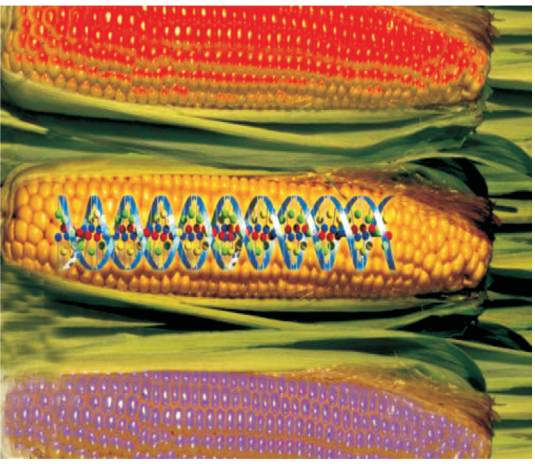
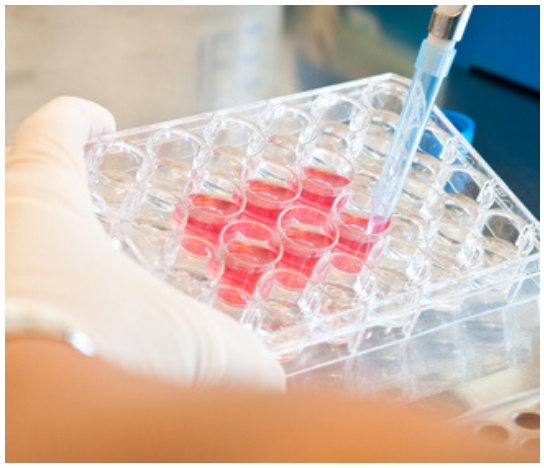
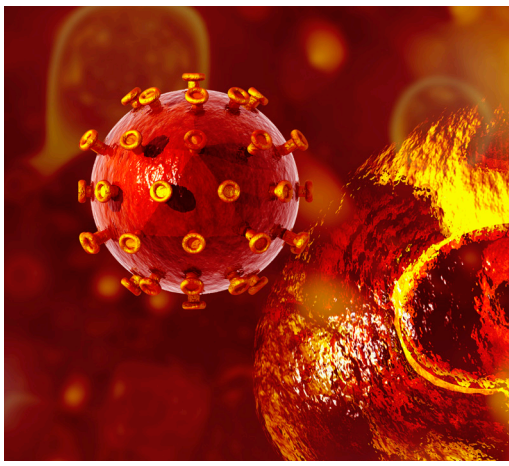
SBIRI

Small Business Innovation Research Initiative

Pooling Skills | Creating Possibilities

Edited by
Dr. Suchita Ninawe
Scientist 'F' (SBIRI Programme Officer)

Guided by
Dr. George John
Sr. Adviser (SBIRI Incharge)

October 2012

सत्यमेव जयते

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Department of Biotechnology

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Government of India

Foreword

Dr. M.K. Bhan
Secretary
Department of Biotechnology
Government of India

The Small Business Innovation Research Initiative (SBIRI) was conceptualized by the Department of Biotechnology (DBT) for the Indian Biotech Sector. SBIRI drew several inputs from the very successful Small Business Innovation Research (SBIR) program of the US. This was the first of its kind, early stage, innovation focused Public Private Partnership (PPP) initiative of the DBT. It facilitated innovative, risk taking by small and medium companies and the coming together of the private industry, public institutions and the government under one umbrella to promote the research and innovation in the Indian Biotech Sector. As a unique institutional mechanism, SBIRI has consistently prioritised early stage funding for high risk innovative research and extended support for product development and commercialization. Apart from this, SBIRI has filled a gap in that knowledge and leads developed through long years of research in public institutions can now be supported towards product development and commercialization with active participation of private industry. Before SBIRI came into being as DBT's flagship initiative to foster innovation in the small and medium scale enterprises in Indian biotech landscape, unlocking the potential of these organizations in the Biotech Sector was not getting the attention it deserved.

Looking back at the seven year journey since the launch of SBIRI, even the most conservative assessment will acknowledge the significant contribution of SBIRI in promoting innovation in the Biotech Sector. The SBIRI team at DBT has come out with this important compilation of the outcome of the completed projects that have resulted in product development and commercialization and of those where the outcome was in the form of promising research findings that have a promise of being commercialized. This publication is a tribute to the contributions made by all stakeholders from private industry and public sector institutions as well as the scientists who worked on various committees constituted to steer various elements of SBIRI. I take this opportunity to congratulate the SBIRI Team at DBT for their excellent programme management and high integrity. This report will help upcoming biotech entrepreneurs to get a glimpse of the experiences so far, the success achieved and challenges ahead, and overall trust in the soundness of the government initiative. This wide trust is necessary to strengthen SBIRI as a programme in the coming years by mobilizing more robust participation of the targeted stakeholders and greater involvement of the government in the biotech and other sectors.

M.K. Bhan

Acknowledgements

Indian Biotech Sector has witnessed rapid growth during the last decade through innovation, product development and technology indigenization. Launched by DBT in 2005,the Small Business Innovation Research Initiative (SBIRI)has worked as an enabling platform for the target organizations to realize their potential in terms of product and process development and taking them to the market. The scheme is steered by Apex Committee of SBIRI (ACS) which comprises of representatives from various ministries &departments and Technical Screening Committee (TSC) comprising of eminent scientists. The projects supported under the scheme have resulted in prominent outcomes in the form of some products, already in the market and some promising research leadsseeing a ray of hope for commercialization. The success of SBIRI is credited to many individuals, private sector and public partners.

I feel privileged that I have been associated with SBIRI right from its inception as Programme Officer andMember Secretary of the ACS&TSC. I can say with conviction that success of SBIRI is owed to commitment and contributions ofall those who have been involved with SBIRI in various ways, direct and indirect.

Dr MKBhan, who took over as Secretary, DBT in March 2004, always felt that a partnership between government and the private sector is a must for giving impetus to innovation and high risk research in the country for achieving required levels of growth in the biotech sector. His encouragement led to the outline of a PPP programme that later came to become SBIRI. Team SBIRI gratefully acknowledges his continued guidance and supervision as Secretary, DBT & Chairman, ACS and also as an accomplished scientist in his own right. His inspiring leadership has been a constant source of strength for all those involved with SBIRI in various roles.

Being the first of its kind PPP initiative which was much different from regular DBT programmes, the formulation of SBIRI required an enormous effort. This included preparing various guidelines for its implementation and obtaining necessary approvals. The intellectual contributions and advice provided by Dr. K.K. Tripathi, Adviser, Shri U.N. Behera, former Joint Secretary (Admn) and Shri K.P. Pandian, former Financial Adviser at DBT in the run up to the launching of SBIRI are acknowledged with gratitude.

Prof G Padmanaban, an outstanding biotech professional, worked tirelessly as Chairman of TSC& Co-chair of ACS. His vast experience in biotech research as well as close interaction with industry helped us to implement this scheme in PPP mode so successfully. I express my whole-heartedly thanks to him.

As members of ACS, Dr N K Ganguly, Ex-DG, ICMR and DrV S Chauhan, Director, ICGEB contributed their scientific knowledge which helped the Committee to take right decisions in selecting the projects. Representation of various concerned Ministries/ Departments on ACS gave a sense of having a collective decision of the Government on each project supported. As a part of TSC, many distinguished experts from various research disciplines contributed by helping evaluate more than 1000 proposals and monitoring the funded

projects with full enthusiasm. A major share of SBIRI success goes to them.As a Member-Secretary of SBIRI Committees, I express my sincere thanks to all.

Various scientists in different fields of biotechnology put their hard-work in assessing and mentoring the proposals/ projects in-depth during on-site visits to the companies, the very important steps in implementation of this scheme. I appreciate the contributions of the experts of Site-visit Teams & Project Monitoring Committees and extend my earnest thanks to them.

Dr George John, Senior Adviser,DBT has always been a hands-on mentor for the SBIRI team. His directions helped to strengthen bondsbetween stakeholders of the PPP arrangement in a fair and transparent mode. I am indebted to Dr John for his motivation and encouragement throughout these years. It is notable that 28 scientists from different divisions of the department participated in different committees of SBIRI, an unprecedented level of inter-divisional involvement in any DBT program, making SBIRI a symbol of unity of purpose in DBT. Hard-work and sincere efforts of Dr Kalaivani Ganesan and Dr M S Shashi Kumar, as apart of SBIRI Divisionis remarkable. I am thankful to all my colleagues for their total support.

Theimplementation of SBIRIhasbenefitted immensely from persistent efforts of a team of Ms Anita Sharma, Manager, under the guidance of DrPurnima Sharma, MD, Biotechnology Consortium India Ltd, the SBIRI Management Agency.

Last, but not the least I would like to put on recordmy thanks to Sachin, Sandhya, Deepanshu, Babita, Pradeep, Sherly, Sonali and Neetu for their assistance in compiling the contents.

This publication is a consolidation of experiences in SBIRI over last seven years and is based on the special exhaustive review of 55 projects conducted by TSC. The inputs provided by the industry in response to our comprehensive questionnaire are highly appreciable. Their incredible cooperation and prompt responses helped us in finalizing this publication. The projects covered here are broadly categorized under Agriculture & Allied Areas, Health-care, Industrial Processes & Products and Instrumentation & Devices. The information captured in this publication outlines the products and research leads generated through SBIRI funding and will be useful for private as well as public sector in biotechnology. It is documented in easy-to-read form and therefore, will act as a catalyst to encourage students to become entrepreneur.

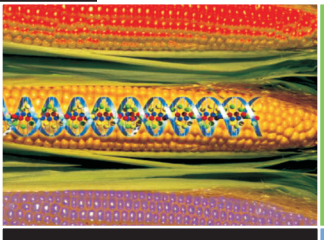
Your comments and suggestions will play a crucial role in determining the path forward for SBIRI with whatever modifications that may be deemed necessary.

Suchita Ninawe

Contents







SBIRI

A Learning Process in Lab to Land Transfer

G. Padmanaban

It is, perhaps, not well known that despite the downward trend in global technology in terms of production and profits, Biotechnology is growing at about 20% on an average in India. Biotechnology caters to a wide range of areas including, health and disease, food and agriculture, environment and industry and growth in each sector is variable, but still significant. The Small Business Innovation Research Initiative (SBIRI) was started in 2005 by the Department of Biotechnology with a view to support R&D in small and medium scale industries, both for establishing proof of principle of an innovative idea or establishing the workability after having established the proof-of-principle or scaling up production to the pilot plant scale. The scheme which is in operation in the U.S. has been adapted to the Indian condition with grant and loan components to the industry. It is useful to compare this scheme with another government sponsored support mechanismavailable to industry to promote R&D. The New Millennium Indian Technology Leadership Initiative (NMITLI) of the Council of Scientific and Industrial Research (CSIR) follows a top-down approach to support projects obtaining top grades in technical assessment in each round of exercise. The aim is to generate globally competitive products and processes. There are also other schemes of the government which support pilot-scale production, establishment of infrastructure etc. While, these are important initiatives, SBIRI follows a bottom-up approach to scout the field and encourage even potential entrepreneurs with bright ideas to embark on R&D, leading to applications. Innovation is difficult to define, especially in the Indian context. Does it apply only to the development of new innovative products and processes? What about import substitution or making a useful product more affordable? In the context that India needs to take care of the poor in substantial numbers, affordability of a product becomes as important as an

Prof. G. Padmanaban, NASI-CHAIR/ Distinguished Biotechnologist, Indian Institute of Science, Bangalore

innovative new product that may or may not be affordable at the present stage of development. The Technical Screening Committee as well as the Apex-Committee, over the years,have become alive to divergent demands of the country in encouraging and supporting projects under this scheme. Thus, filing an IND application for a new drug molecule to treat cancer is as relevant as scientifically validating an ayurvedic preparation to treat diabetes. Standardizing a bio-pesticide consortium becomes as relevant as pyramiding genes to obtain transgenic plants to combat biotic and abiotic stresses. Making wealth from waste, be it production of value added products or generation of energy resources, needs tremendous innovation of the practical kind that needs support. Development of a simple, affordable diagnostic is as relevant as developing sophisticated biomedical instrumentation. These are but a few examples of the scope of the projects dealt under this scheme.

An area of concern in India has been the relevance of research in academic institutions in terms of applications. The main problem has been the lab to land transfer of the potential leads into useful products and processes. Interestingly, SBIRI has contributed significantly towards strengthening academia-industry interaction. While, the support is for R&D in the industry, often the industry has found it necessary to collaborate with an academic partner to achieve the goals. Similarly, ideas generated in academic institutions have now found takers in the industry. The academic institution partnering with the industry gets grants in the scheme and this has acted as an incentive to promote industry-academia collaboration. Interestingly, the academic community forming part of the Technical and Apex Committees has been impressed by the developments in industry and it has been a great learning process as well. The members have shown great commitment in undertaking site visits and helping the industry. This mentoring role has been widely welcomed by the industry even more than the monetary support. Another positive development has been the attraction of SBIRI for young

investigators, just passed out of academic institutions, as a launch pad to embark on innovative entrepreneurship. By and large entrepreneurs have accepted the process followed and have been enthused to modify or come up with newer ideas to get support from SBIRI, even when not successful in the first few attempts. At the same time, in every round one finds that among 40 to 50 projects, at least 50% are new entrants.

There are about 120 projects running at present and this represents around 15% of the total project proposals received. The selection process as such is described elsewhere in the document. It is, perhaps, useful to introspect at this stage as well. Compulsory DSIR recognition of the industry to receive support has both positive and negative elements and a solution needs to be found to handle deserving cases that do not fulfill the criteria. The mentoring element needs strengthening and this needs a significant increase in the pool of committed experts available. Can administrative strategies be evolved to avoid delays in some cases, whatever may be the reason? Can the loan component be modulated at some stage with the government opting for equity as an option? In my perception, 20% of the projects supported would eventually give successful products and processes. Even so, many small and medium industries find it difficult to generate investments for manufacture, although SBIRI support carries a brand value and has helped some industries to obtain investments. It may be necessary to have a scheme for this purpose with equity participation by the government. The SBIRI experience has indeed led to the initiation of Biotechnology Industry Partnership Programme (BIPP) with the mandate of a larger scale of operation on the one hand and Biotechnology Innovation Grant (BIG) on the other to support innovation at the grass-root level without a loan component. The Department of Biotechnology deserves encomiums for embarking on this innovative, pioneering scheme. The secretariat at DBT and BCIL has shown great commitment and efficiency. A sample of the projects under this scheme is presented in this document and the feed-back would help to further strengthen this scheme. ●

SBIRI

The unique experience through SBIRI

George John

The Small Business Innovation Research Initiative was a very bold step on the part of the Department of Biotechnology to promote public private partnership in biotechnology. It was a key element of a proactive approach that was being defined by Prof M. K. Bhan, the Secretary of the department for the promotion of biotechnology and to take processes and products towards their logical end point- the market. At a time when funding to the private sector was looked at with some kind of askance, the SBIRI experiment was like a fresh breeze . The scheme is now more than five years old and strong enough to stand a scrutiny of its performance.

Over the years, the SBIRI has screened about 1000 applications and funded about 120 proposals. About 60 projects have been completed. SBIRI has evolved into a robust mechanism to support public private partnerships. The support to industry was both in terms of loans and grants while the support to public institution partners was always in the form of grants. The overall guidance to the scheme was provided by the Apex Committee and the Technical Screening Committee. In addition, the site visit teams and the separate Project Monitoring Committees set up for each project provided invaluable guidance and mentoring. The monitoring committees played a monitoring cum mentoring role that was appreciated by the industry. SBIRI remains the most participatory programme of the department with scientists from the respective programme divisions on the monitoring committees.

The Technical Screening Committee was keen to undertake an evaluation of the completed/ completing projects to get a sense of the achievements and also to identify the next steps to take innovation forward in this decade of innovation. The findings are captured in the pages of this document and hence no attempt is made here to describe them. It would suffice to say that the successful implementation of the SBIRI and the learning experience from SBIRI encouraged the department to launch new initiatives like the Biotechnology Industry Partnership Programme (BIPP), Biotechnology Ignition Grant, (BIG), Biotechnology Industry Research Assistance Programme (BIRAP) and Biotechnology Industry Research Assistance Council (BIRAC). In a sense, the SBIRI has been the mother of all these programmes.

While we continue our march towards an innovation based society, modest steps like SBIRI give us a sense of satisfaction and help us to do things better. ●

Dr. George John, Senior Adviser & SBIRI Incharge, Department of Biotechnology, New Delhi

SBIRI

Milestones behind, Miles ahead

Suchita Ninawe

The Department of Biotechnology launched the Small Business Innovation Research Initiative (SBIRI) in September 2005 to promote innovation and facilitating translation of knowledge into useful products & processes for commercialization by the dynamic and vibrant biotech organization of India.

SBIRI : Core objectives

The core objectives of SBIRI are:

(i) encourage innovation in the private sector,

(ii) facilitate development of knowledge enterprises in the country,

(iii) enhance opportunities for techno-preneurs to start technology based enterprises

(iv) create an ecosystem for translation of innovations into commercially tenable products / processes by private sector,

(vi) promote public-private-partnership in technology development, and

SBIRI covers all areas of biotechnology including agriculture and allied areas; health - care; industrial processes & products; environmental biotechnology; bio-medical devices and bio-instrumentation; bioinformatics. The proposals can be submitted

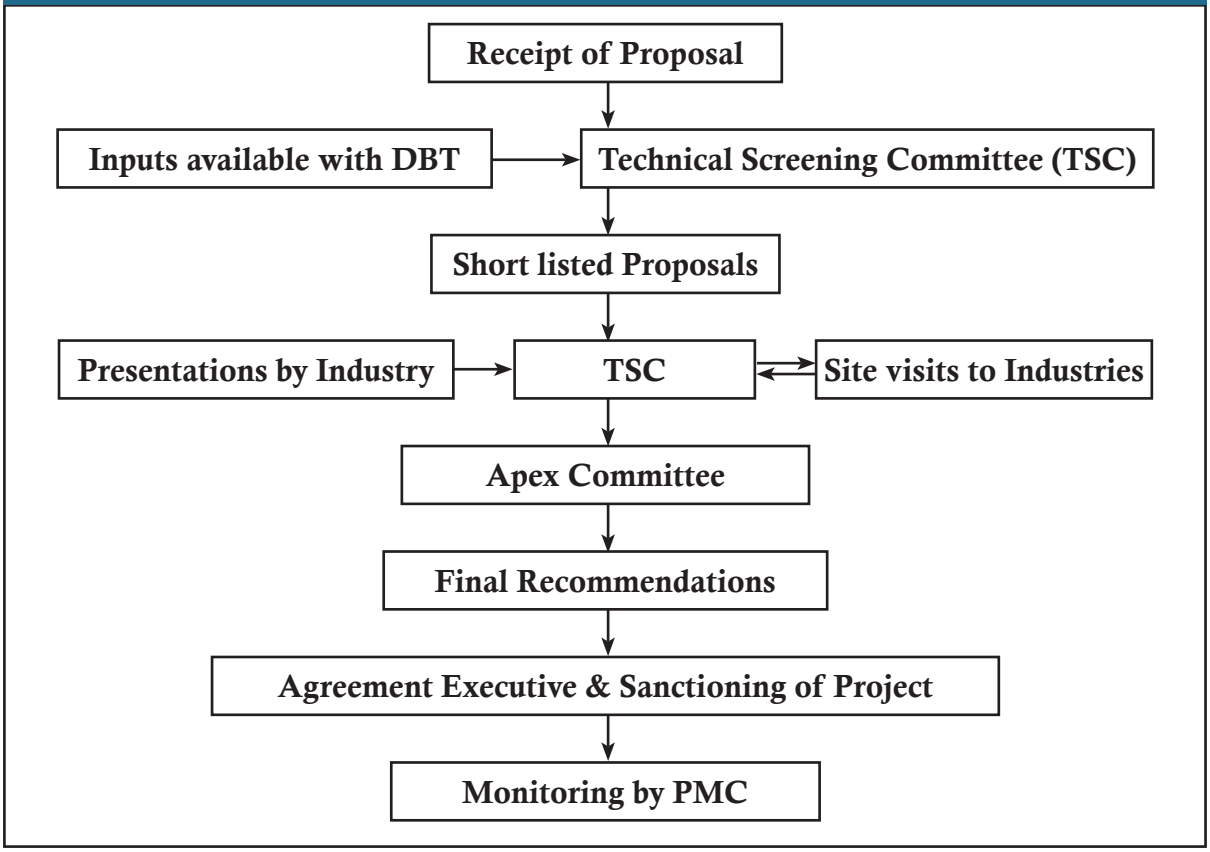
Eligibility Criteria : Industrial Organisations

- Should be registered in India and must fulfill the criteria of Small Business Unit (i.e. an enterprise with not more than 500 employees in R&D).
- Majority (>50%) shares should be held by Indian citizens including NRIs.
- Should have an in-house R&D unit recognized by Department of Scientific and Industrial Research (DSIR).OR should have ownership of IPR, developed or acquired, which is proposed to be exploited under the project.

Dr. Suchita Ninawe, Scientist 'F' & SBIRI Programme Officer, Department of Biotechnology, New Delhi

SBIRI : Facts and Figures	
Total number of Calls	20
First Call announced	September, 2005.
Last Call announced	September 2012 (open till 15th October, 2012).
Average number of proposals in each batch	50
Total number of proposals received	1010 (20 more anticipated in the present call).
Total number of organisations approached	595 (from 26 states).
Projects recommended by Apex Committee	202.
Projects sanctioned	121 (some cases were withdrawn/closed for different reasons, others are in pipeline for sanction)
Projects completed	57 (2 projects could not be implemented and were closed).

SBIRI : Evaluation Process



by private sector industrial organization singly, or in consortia along with, if required, public sector partner(s). A network programme of common interest to the sector/area concerned can be proposed by a group of industries and/ or public partners. The lead applicant should be an industrial organization. Here "Industrial Organisation" is defined as any profit making entity/ commercial enterprise including proprietary concerns, closely held firms, etc. "Public Sector Partner" can be any state funded R&D or academic institution, university, non-profit registered R&D entities, etc. A proposal with no involvement of an industrial organization, as defined above, does not qualify for support under SBIRI.

In a short time since its inception, SBIRI has been successful in bringing different stakeholders from industry, academia and the government on a common platform to work for the growth of the biotech sector. The scheme is operated through the Apex Committee of SBIRI (ACS) and the Technical Screening Committee (TSC) specially constituted for the purpose.

The challenge was to enable the private industry to take the path of innovation, to generate new ideas, take more risks and support late-stage-development wherever the proof of principle has been generated. Timely access to adequate funds is one of the major bottlenecks in the growth and development of the biotech industry in India. Technology innovation in biotechnology is a highly risk game and requires significant investment and careful nurturing. This is especially true for start-ups which are unlikely to succeed in converting new innovations into viable products and processes unless supported with care. SBIRI provides early stage funding to resolve this constraint and also strengthens the academia-industry interaction which is critical for accelerated product and process development. By mobilizing Government funding SBIRI, has also spurred increased investments by the private sector as well. In fact private sector has contributed more than the government to the projects initiated under the SBIRI unbrella.

The scheme is coordinated by the SBIRI Management Agency (SMA). Presently the Biotech Consortium India Ltd. (BCIL), a company registered under the Indian Companies Act, 1956 acts as the SMA. ●

SBIRI : FUNDING STRUCTURE

Phase I : High risk, innovative, early stage, proof of concept, lab/ pilot level research

Project Cost	Support in the form of	
	Grants-in-aid	Soft Loan (interest free)
Upto Rs. 25 lakhs	80% of the project cost	—
Rs. 25 lakhs to Rs. 100 lakhs	50% of the project cost (minimum Rs. 20 lakhs and maximum Rs. 50 lakhs)	—
Beyond Rs. 100 lakhs	Rs. 50 lakhs	Upto 50% of the amount by which the total project cost exceeds Rs. 100 lakhs (maximum Rs. 50 lakhs)

Idea to Lab/ Pilot level Development

Evaluation Criteria
- Significance
- Approach
- Innovation
- Expertise
- Facilities

Phase II : Late development and commercialization of innovative research leads

Loan amount	Interest Rate (simple)
Upto Rs. 100 lakhs	1%
Beyond Rs. 100 lakhs and upto Rs. 10 crores	2%

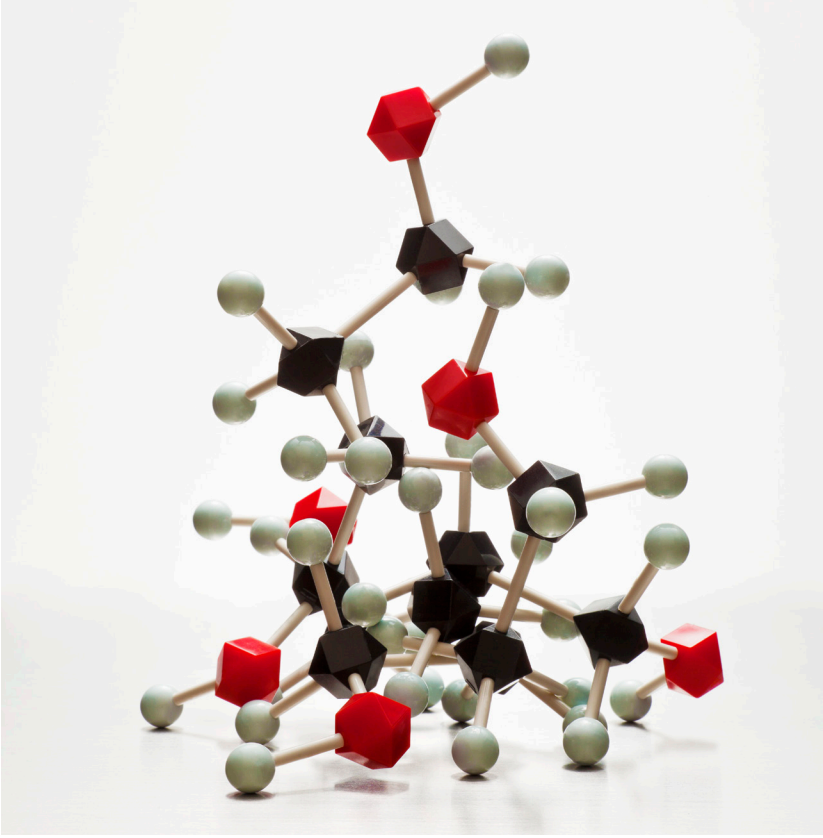
The public institution partner, if any, in the project is eligible for Grants-in-aid

Lab to End User

Evaluation Criteria

- Same as in Phase I
- Preliminary leads
- Feasibility

Since SBIRI is a PPP Initiative, each sanctioned project has to have contributions from DBT and proponent industrial organization(s). Of the 121 projects sanctioned till date, DBT's commitment has been Rs 192.84 crores (Rs. 27.28 crores as Grants-in-aid and Rs 165.56 crores as soft loans). Proponent organisations have committed an investment of Rs 211.54 crores. DBT has already released Rs 147.65 crores till date with proponent organisations also contributing their share as well. DBT has allocated Rs. 150 crores for SBIRI in the Five Year Plan 2012-17.



PROJECT profiles >

Abiotic Stress Tolerant Transgenic Crops

Development of Transgenic Drought Tolerant Genotypes of Rice, Corn & Cotton and Transgenic Salinity Tolerant Rice Hybrids

M/s Bioseed Research India Pvt Ltd, Hyderabad

Development of crops tolerant to abiotic stresses is an important area of research in the public and private domain. The success obtained in the proof-of-concept through SBIRI supported projects M/s Bioseed Research India Pvt Ltd, Hyderabad for some of the genes identified as major factors in abiotic stress tolerance is a positive indicator of progress in the right direction. The projects were focused on studies on drought tolerant and salinity tolerant genotypes in collaboration with International Center for Genetic Engineering and Biotechnology (ICGEB), New Delhi. The company is well established in agri-business and is involved in biotech R&D.

Drought tolerant genotypes: Under the first project, the molecular biology work related to cloning of *dreb*, *lea* and *sod* genes and stress inducible promoters, including preparation of plant transformation vectors based on requirement of the crop was carried out by ICGEB. Also, the transformation of rice was carried out at ICGEB to generate events carrying *dreb*, *lea* and *sod* genes. The company studied these three known abiotic stress tolerance genes in important crops viz. rice, corn and cotton. The experimental work in lab, glass house and contained field established the positive role of *dreb* and *lea genes* in imparting drought tolerance in rice and corn, though the studies on corn were not conclusive. The company anticipates that further studies on the stability of traits under field conditions and evaluation of transgenic lines for their agronomic performance will be useful in development of durable drought stress tolerant rice.

Salinity tolerant genotype: Under the second project, the company worked on the development of rice lines carrying genes for salinity tolerance. The transgenic events of

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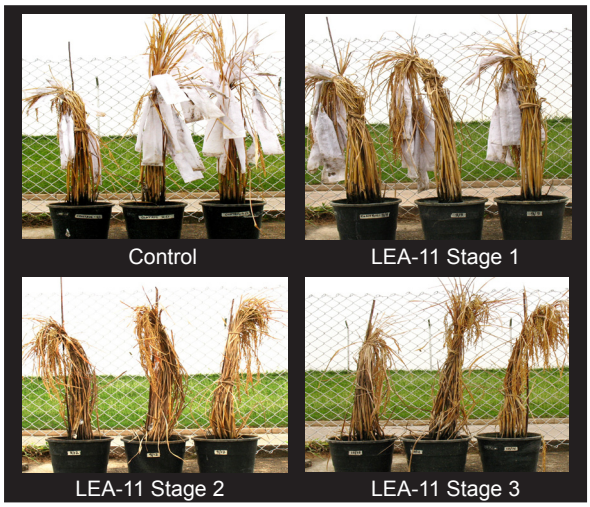
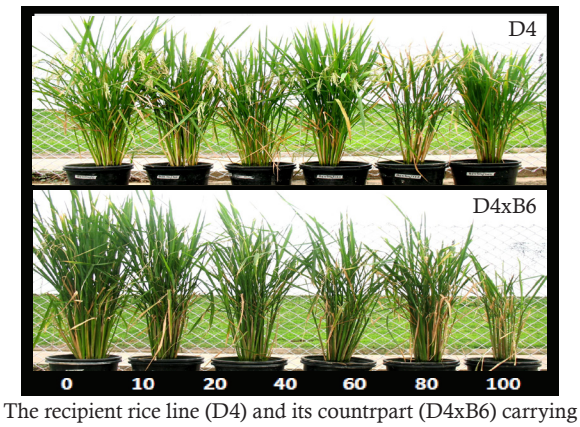


Effect of lea gene in improving drought tolerance of transgenic rice at different growth stages.



The recipient rice line (D4) and its countrpart (D4xB6) carrying *glyI+glyII* genes showed enhanced tolerance to salinity stress

Drought Tolerant Transgenic Maize

Stacking of Candidate Genes Addressing Different Moisture Stress Resistance Strategies in Maize

M/s Nuziveedu Seeds Pvt Ltd, Pochampally

In the agri-sector, today the challenging task next to withstanding biotic stress is to develop plants which withstand drought/moisture stress. Any transgenic product tolerant to abiotic stress will have a good market potential. Support was extended under SBIRI to M/s *Nuziveedu Seeds* Pvt Ltd, *Pochampally* to develop drought resistant transgenic maize plants. It is one of the leading companies in the Indian agri-biotech sector. The project was taken up in collaboration with International Center for Genetic Engineering and Biotechnology (ICGEB), New Delhi.

The project was designed to introduce all the key genes involved in the ascorbate-glutathione pathway into crop plants by *in vitro* pyramiding driven by stress inducible tissue-specific promoters for effective deactivation of reactive oxygen intermediate molecules from multiple redox reactions to protect the plant cells from oxidative damage, thereby, making them abiotic stress resistant. ICGEB developed a construct having the five genes viz. *apx, sod, mdhr, dhar, gr* along with *basta*, the bar gene as the selectable marker. This construct was used for transformation work by the company. Different inbred lines available were screened using different *in vitro* practices & hormone (2,4D and Kn) concentrations and high through-put regeneration protocol was developed using the first shoot node and immature embryos that yielded high number of plantlets with large quantities of embryogenic calli. Significant numbers of putatives were isolated and confirmed with gene, promoter and marker specific primers and were hardened and grown in poly-house. They were tested with *basta* at field level and methyl viologen in

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Different stages of *in vitro* culture and transformation of *Zea mays* through *Agrobacterium* mediated transformation: Nodal explants **(A-D)** and Immature Embryos **(E-H)** showing embryogenic callus, somatic embryos and regenerated plantlet; **I -** regenerated plants on the selection medium; **J&K -** Primary and completely hardened plants; **L –** Gel picture showing the expected size of amplicon with the gene specific primers in putative transgenics; **(M-Q) –** Field level Basta screening of transgenics; Leaves painted with Basta were completely dried in control **(M&N)**; in putatives **(O-Q)** no drying was observed; **R -** Seedling level Basta Screening in maize; **(S-U) -** Leaf disc experiment with Methyl Viologen with control (S&T) and transgenics **(U).**

Viral Resistant Transgenic Cassava

Transgenic Cassava Production with Genes Conferring Resistance to Indian Cassava Mosaic Virus Disease

M/s Rasi Seeds Pvt Ltd, Attur

Cassava is an important food crop which suffers yield loss of 25-80% due to Cassava Mosaic Disease (CMD). In India CMD is caused by two strains of Geminivirus namely Indian Cassava Mosaic Virus (ICMV) and Sri-Lankan Cassava Mosaic Virus (SLCMV). In response, viral resistant cassava planting materials is in much sought after by the farming community.

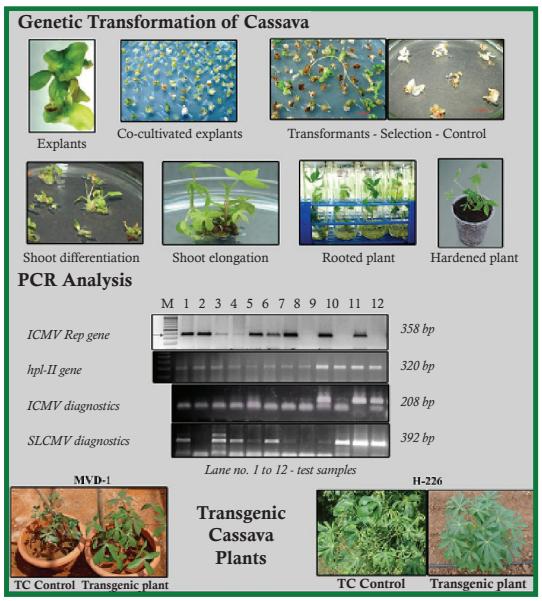
With support from SBIRI, M/s Rasi Seeds Pvt Ltd, Attur aimed to incorporate viral resistant gene(s) for ICMV and SLCMV into economically important cassava cultivars, using pathogen-derived resistance through RNAi and antisense genes approach. It is a well established agri-business company.

Under the project, a tissue culture protocol was developed for two leading and economically important cassava cultivars namely H-226 and MVD-1. Similarly an efficient and highly reproducible Agrobacterium-mediated transformation protocol was also developed. The gene constructs using RNAi technology for ICMV and SLCMV replicase genes were developed to target both viruses individually. In addition, replicase gene of SLCMV in antisense orientation was also used. The constructs were developed by Tamil Nadu Agriculture University, Coimbatore and Madurai Kamaraj University, Madurai respectively. These gene constructs were used for genetic transformation of cassava cultivars through Agrobacterium mediated transformation to develop virus resistant transgenic cassava plants.

A total of 257 putative transgenic plants were developed for H-226 and MVD-1 using three gene constructs. Incorporation of virus resistance genes was confirmed through molecular assays.

Further, the transgenic plants were tested for resistance through virus challenge studies. A total of 91 virus-resistant transgenic plants were identified after virus challenging through whitefly-mediated virus transmission studies in poly-house. These transgenic plants are maintained to carry out further confined field trails to confirm the stability of virus resistance and to analyze tuber yield and other agronomic characters.

SBIRI-PMC experts Dr E A Siddiq, Hyderabad; Dr M Udayakumar, University of Agriculture Sciences, Bangalore; Dr V G Malathi, Indian Agriculture Research Institute, New Delhi; Dr George Thottappilly, Sahrdaya College of Engineering & Technology, Thrissur and Dr K S Charak, DBT, New Delhi directed the project towards its successful completion. SBIRI-TSC also guided the company to achieve the targeted objective in the project. ●



Disease Resistant Transgenic Vegetable Crops

Genetically Modified Vegetable Crops for Insect and Disease Resistance

M/s Bejo Sheetal Seeds Pvt Ltd, Jalna

After the success of *Bt*-cotton in India, it is expected that yields can be increased by addressing the problems of insect pests and disease damages through transgenic crop cultivation. The SBIRI project was supported at M/s Bejo Sheetal Seeds Pvt Ltd, Jalna to confer insect and disease resistance in brinjal, tomato and okra. The company has a well-established agri-business and is engaged in developing and marketing quality vegetable seeds in India and abroad using its excellence in vegetable breeding.

Transgenic brinjal : The company licensed *Bt*-brinjal technology from IARI, New Delhi and procured Pusa Purple Long variety of brinjal expressing *Bt cry1Fa1* gene (Event-142). *Cry1Fa1* is a 1851 bp long gene modified to contain high GC content for plant codon usage. Using IARI's technology the company achieved significant progress in the development of transgenic brinjal hybrid varieties with different genetic background. *Bt* expression analysis and molecular characterization indicated high level of resistance against fruit *(Helicoverpa)* & shoot *(Euzophera)* borer in developed hybrids and is promising. Two *Bt* brinjal hybrids carrying *cry1Fa1* gene were used for multi-location trial evaluation and showed maximum resistance against the target insect. Yield increase was above 40% in *Bt* brinjal than local check i.e. var. *Manjirigota* (Jalna, Maharashtra), *Kanakdurga* (Guntur, Andhra Pradesh) and *Swekkar 521* (Varanasi, Uttar Pradesh). BRL-1 trials were repeated and found satisfactory for resistance with high yield performance. Studies were completed as per the biosafety guidelines. Multi-location trials of BRL-2 will be undertaken.

Transgenic tomato: Transgenic tomato was developed using *cry1Ac* gene in variety Pusa Ruby. Gene integration and expression was

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Bt fruits Non-Bt fruits

Non transgenic ToLCV susceptible plant

Transgenic ToLCV tolerant plant

Tomato fruit Non Bt

Tomato fruit Bt

Biopesticides – *Helimar & Spodomar*

Enhancing Effectiveness of Nucleopolyhedro Viruses in Commercially Produced HaNPV and SINPV

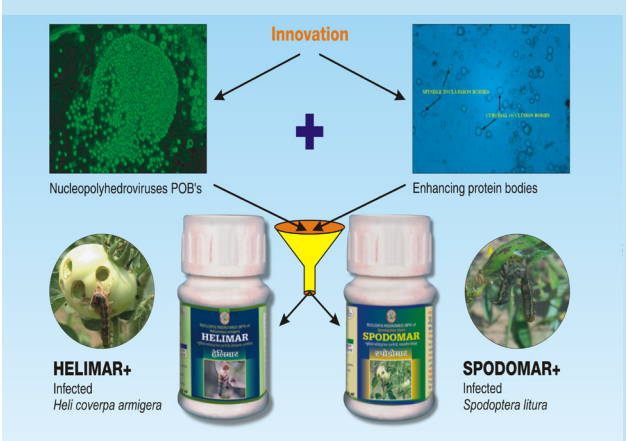
M/s Multiplex Bio-Tech Pvt Ltd, Bangalore

Baculoviruses are regarded as safe and selective bioinsecticides, restricted to invertebrates. They have been used worldwide against many insect pests. In India, it is mainly used against *Helicoverpa armigera*, a cotton boll worm and *Spodoptera litura*, a tobacco leaf eating caterpillar. However, narrow host range, slow killing speed, timing of application, variability in field efficacy are factors that have limited the use of the insect virus. SBIRI supported a project at M/s Multiplex Bio-Tech Pvt Ltd, Bangalore to develop strategies that counteract some of the limitations of baculoviruses and develop promising commecializable biopesticides. The company has its Core business of in micronutrient products, seeds, bio-activators and bio-pesticides.

The company worked on different approaches that included the use of optical brightener to protect insect virus from UV light, addition of insect derived enhancing protein to increase the speed of kill and addition of phago-stimulants to attract larva to make them consume more virus particles and thereby, increasing the chance of viral infection. The improved formulations were tested for enhanced viral activity, increased speed of kill and reduced larval feeding activity. These formulations named as *Helimar* and *Spodomar* are packaged in ready-to-use form to attract farmers' interest.

The production process for *Helimar* was scaled up for its use over an area of 48,000 hectares. The production of *Spodomar* was optimized to the level sufficient for 12,000 hectares. The company will now carry out multi-location trials to study field efficacy of these new formulations.

The project was mentored by SBIRI-PMC experts Dr K P Gopinathan, Indian Institute of Science, Bangalore; Dr M Udayakumar, University of Agricultural Sciences, Bangalore and Dr Seema Wahab, DBT, New Delhi. SBIRI-TSC also played a key role in development of these improved biopesticide formulations. ●



IMPROVISATION

- Eco friendly
- Does not allow resistance development
- Increased shelf life
- Better efficacy with lower POB's
- UV protected

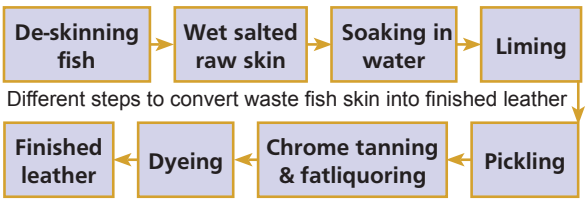
Products From Fish Waste

Pet Animal Food, Fish Leather and Other Marine Biotechnology Products From Fish Waste

M/s Millennium Exports, Chennai

Enormous quantities of marine fish waste is discarded by fishermen at landing sites in India. Any technology that enables the use of marine waste for value added products can have good economic potential. With support from SBIRI, M/s Millennium Exports, Chennai in collaboration with Aquaculture Foundation of India, Chennai focused on development of leather from discarded fish skin and converting fish waste into dog chew. The company is involved in manufacture, export and distribution of a wide range of marine and pet products.

Fish leather. The fish species selected for making fish leather was Stingray (genus *Himantura).* Tanning of skin was done in a commercial tannery in Ambur. Various tanning processes were tested for yielding soft, pliable, dyed and finished fish leather. Finished leather was developed from fish skin using chrome free tanning method and the leather was used for making wallets, key fobs and shoes. The project has also highlighted the potential of using fish leather in high end furniture products. Fish leather developed under the project was three times stronger than buffalo leather in addition to having unique scratch and fire resistant properties. Leather from Stingray skin was developed for the first time by an Indian company under this project. It is a product for the high end market.



Different steps to convert waste fish skin into finished leather

Fish Leather exhibited at International Leather Fair held in Chennai in January 2009

Dog chew: The company has developed three dog chews and a dog food supplement from ray fish wastes, fins and cartilages. The dog chews produced were field tested with the help of veterinary practitioners. In India, the market of pet animal products is expanding and pet food & treats occupy a major portion of this market size. As per the company, they are the first one in the world to develop dog treat from fish waste.

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Dog chew

Nitrifying Bioreactors

Design Modification and Commercialization of Nitrifying Bioreactors

M/s Oriental Aquamarine Biotech India Pvt Ltd, Coimbatore

India is a major player in the field of aquaculture with about 300 shrimp hatcheries in operation across the country. However, a large number of hatcheries have closed down due to multiple problems including poor water quality, disease and poor survival rates. Nitrifying Bioreactors are self-sustaining systems that remove ammonia, nitrites and nitrates produced in aquaculture tanks. This help maintain reef quality oligotrophic water conditions leading to better quality and higher production of organic seeds & fish.

SBIRI project supported at M/s Oriental Aquamarine Biotech India Pvt Ltd, Coimbatore was focused to develop a system for water quality and disease management in aquaculture industry. The company acquired patented technology as prototype for development of nitrifying bioreactors with information generated on their efficacy from Cochin University of Science and Technology, Kochi (which was supported earlier by DBT for R&D).

Using SBIRI funds, commercial models of nitrifying bioreactors were developed for establishment of recirculating aquaculture systems and information on their kinetics was generated. This included a Stringed Bed Suspended Bioreactor (SBSBR) with a capacity to handle 500 liters of water, and Packed Bed Bioreactor (PBBR) to handle 60,000 liters of water. The SBSBR can be used for *in situ* nitrification in larval production systems; quarantine of the brood stock and in live animal transportation. The PBBR can be used for establishment of re-circulating aquaculture systems for maturation & brood stock

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Stringed Bed Suspended Bioreactor

Abiotic Stress Tolerant Transgenic Crops

Contd. from pg. 10

rice carrying *glyI+glyII* genes were developed and expression of the transgenes was studied by ICGEB. Also, new marker free transgenic events were developed with the same genes at ICGEB. The company carried out evaluation of transgenic lines containing *glyI+glyII* genes in simulated saline conditions in glass house that proved the positive effect of the genes in imparting salinity tolerance. The transgenic events were introgressed into five proprietary parental lines by crossing and backcrossing accompanied by marker assisted background selection. The recipient lines included three susceptible and two tolerant lines. The converted lines along with their non-transgenic counterpart were evaluated for three generations in glass house. In the salinity susceptible lines, the impact of presence of *glyI+glyII* genes was significant and resulted in markedly superior performance in simulated saline conditions.

The projects were steered under the continuous guidance of Dr A R Reddy, Yogi Vemana University, Kadapa; Dr S S Kadam, Marathwada Agricultural University, Parbahni and Dr V P Gupta, DBT, New Delhi as members of SBIRI-PMC. Regular mentoring was also done through SBIRI-TSC.

The company is now developing marker free transgenic events of rice with the drought and salinity tolerance genes (*dreb1a, lea* and *glyI+glyII*) as stack to study the complementary role of these genes in imparting abiotic stress tolerance. ●

Drought Tolerant Transgenic Maize

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lab using leaf disks. Prominent difference was observed between transgenic and control plants. Transgenic plants showed resistance against *basta*. Further confirmation of putatives is being carried out by lipid peroxidation and enzyme assays for APX, SOD, MDHR, DHAR, GR and methods are being standardized.

SBIRI-PMC experts Dr A R Reddy, Yogi Vemana University, Kadapa; Dr M Udayakumar, University of Agricultural Sciences, Bangalore and Dr K S Charak, DBT, New Delhi mentored the project technically and gave valuable suggestions to the company that resulted in obtaining prominent research leads. SBIRI-TSC reviewed the project regularly.

The company has planned to take forward the research leads from this SBIRI project for field evaluation. Further introduction of other leftover key genes of this pathway will be attempted. ●

Products From Fish Waste

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SBIRI-PMC experts Dr R B Narayanan, Anna University, Chennai; Late Dr P K Sehgal, Central Leather Research Institute, Chennai and Dr George John, DBT, New Delhi were involved in the monitoring and mentoring of the project. The reviews conducted by SBIRI-TSC were immensely beneficial to the company in product development.

The products are now being test marketed in India and abroad. This project has demonstrated that there is a large scope in India to convert marine wastes into viable import substitutes and export oriented commercial products. ●

Disease Resistant Transgenic Vegetable Crops

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confirmed in T1 progeny with segregation analysis by molecular test. Promising insect resistant (*Helicoverpa armigera*) progenies were identified and subjected to further evaluation.In another study, transgenic tomato was developed using T-*rep* gene for ToLCV resistance in the susceptible variety of their own. Molecular analysis and whitefly (*Bemisia tabaci*) mediated challenge inoculation of virus was done to evaluate the resistance levels against ToLCV disease. Another project has been supported under SBIRI at the company to take forward the research leads obtained from this project.

Transgenic okra: Transgenic okra development was initiated using *cry1Ac* gene for developing insect resistance (*Earis vitella*). Genetic transformation was successful in their own okra variety. The company has continued in-house studies to develop promising transgenic events of okra.

The project was mentored by Dr M. Udayakumar, University of Agricultural Sciences, Bangalore; Dr K Venkateswar Rao, Osmania University, Hyderabad; Dr M S Kurvinashetti, University of Agricultural Sciences, Dharwad and Dr K S Charak, DBT, New Delhi as SBIRI-PMC members durin gits on-site meetings. SBIRI-TSC also directed the progress of the project. ●

Nitrifying Bioreactors

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maintenance; larval production; nitrification of the incoming water; spent water treatment and reuse. The company demonstrated the efficacy of the nitrifying bioreactors in commercial hatcheries through use of the PBBR in a shrimp maturation system under recirculating mode and through field validation of the SBSBR in *Penaeus monodon* larval rearing systems. These nitrifying bioreactors can be used in any fresh/marine/brackish water seed production systems including those of prawn, shrimp, finfishes, mollusks etc, and also in ornamental fish culture systems.

The project was mentored by SBIRI-PMC experts Dr C Ramasamy, Tamil Nadu Agricultural University, Coimbatore; Dr S Felix, Tamil Nadu Veterinary and Animal Sciences University, Chennai and Shri S L Govindwar, DBT, New Delhi periodically through on-site reviews. SBIRI-TSC also guided the company through regular progress reviews. Under a subsequent SBIRI supported project, the company will validate these bioreactors through on-line monitoring systems and make live data accessible to farmers.

The products were launched at the India International Aqua Show, Kochi in February, 2010. Based on indigenous technology, the company has been able to bring the products to the market at costs much lower than comparable international brands. These bioreactors are functioning well. This SBIRI supported project has enabled the company to gain much needed visibility and success in the commercial space which has in turn prompted it to establish facilities to manufacture these bioreactors. ●

S. No.	Organisation(s)	Short Title	PMC Experts
1	Aditya Biotech Lab and Research Pvt. Ltd., Raipur	DNA markers in micro-propagated banana plants	Dr T R Sharma, IARI, New Delhi, Dr Paramjit Khurana, UDSC, New Delhi and Dr Suchita Ninawe, DBT, New Delhi
2	Amar Immunodiagnostics Pvt. Ltd., Hyderabad	GMOs testing kits for agriculture	Dr Satish Gupta, NII, New Delhi, Dr A R Reddy, YVU, Kadapa and Dr S R Rao, DBT, New Delhi
3	Aristogene Biosciences Pvt. Ltd., Bangalore in collaboration with Bangalore University, Bangalore	PCR kits for shrimp viruses	Dr V V Suryanarayana, IVRI, Bangalore, Dr S V Alavndi, CIBA, Chennai and Dr Shahajuddin Ahmed, DBT, New Delhi
4	Auroprobe Laboratories, New Delhi in collaboration with Maharshi Dayanand Gosamwardhan, Kendra, Ghaziabad	Detection of A1 and A2 β casein variants in cows	Dr H K Prasad, AIIMS, New Delhi, Dr Ravi Dhar, NII, New Delhi and Dr A K Rawat, DBT, New Delhi
5	Bejo Sheetal Seeds Pvt. Ltd., Jalna in collaboration with Indian Agricultural Research Institute, New Delhi	Development of dual resistance in tomato	Dr Bharat B Chatoo, MSU, Baroda, Dr Sunil Mukherjee, ICGEB, New Delhi and Dr R R Sinha, DBT, New Delhi
6	Devleela Biotechs, Raipur in collaboration with Indian Agricultural Research Institute, New Delhi	Virus free garlic	Dr K Lawande, ICAR, Pune, Dr J B Mythili, IIHR, Bangalore and Dr Suchita Ninawe, DBT, New Delhi
7	Global Transgenes Limited, Aurangabad	Transgenic cotton, rice and brinjal for enhanced tolerance against lepidopteran	Dr J P Khurana, UDSC, New Delhi, Dr Vanga Siva Reddy, ICGEB, New Delhi and Dr K S Charak, DBT, New Delhi
8	Hi Tech BioSciences India Ltd., Pune in collaboration with National Chemical Laboratory, Pune	Biopesticides for control of *Helicoverpa armigera*	Dr O M Bambawale, NCIPM, Delhi, Dr A K Panda, NII, New Delhi and Shri Arvind Duggal, DBT, New Delhi
9	Hydrolina Biotech Private Limited, Chennai	Lycopene from tomato	Dr R Sarada, CFTRI, Mysore, Dr P K Seth, Biotech Park, Lucknow and Dr Rajesh Kapur, DBT, New Delhi

10	Indo American Hybrid Seeds (India) Pvt. Ltd., Bangalore	Salt tolerant hybrids in rice	Dr T R Sharma, IARI, New Delhi, Dr Vanga Siva Reddy, ICGEB, New Delhi and Dr O N Tiwari, DBT, New Delhi
11	Indovax Pvt. Ltd., Gurgaon	Marek's Disease vaccine of Poultry	Dr V V Suryanarayana, IVRI, Bangalore, Dr A S Yadav, CARI, UP and Dr A K Rawat, DBT, New Delhi
12	Juan Biotechnology Private Limited, Bhubaneswar	Management of sheath blight of rice	Dr T R Sharma, IARI, New Delhi, Dr H B Singh, BHU, Varanasi and Dr Vaishali Punjabi, DBT, New Delhi
13	Krishidhan Research Foundation Pvt. Ltd., Jalna in collaboration with Jawaharlal Nehru University, New Delhi	Transgenic bhendi resistant to yellow vein mosaic virus	Dr Sunil Mukherjee, ICGEB, Delhi, Dr B B Chattoo, MSU, Baroda and Dr S R Rao, DBT, New Delhi
14	Labland Biotech Private Limited, Mysore	Micropropagation of *Jatropha curcas* L.	Dr Ajay Kumar Parida, MSSRF, Chennai, Dr K Gurumurthi, IFGTB, Coimbatore and Dr Meenakshi Munshi, DBT, New Delhi
15	Maharashtra Hybrid Seeds Company Limited, Jalna in collaboration with Indian Institute of Science, Bangalore	Transgenic cotton for resistance to leaf curl disease	Dr O P Govila, IARI, New Delhi, Dr U G Kulkarni, MAU, Parbhani and Dr K S Charak, DBT, New Delhi
16	Nandan Biomatrix Limited, Hyderabad	Micropropagation of *Jatropha curcas* L	Dr G J Samathanam, DST, Delhi, Dr T R Sharma, IARI, Delhi and Dr Sangita Kasture, DBT, New Delhi
17	Ocimum Biosolutions Ltd., Hyderabad in collaboration with International Centre for Genetic Engineering and Biotechnology, New Delhi	Development and validation of miRNA expression platform	Dr B B Chattoo, MSU, Baroda, Dr Utpal Bhadra, CCMB, Hyderabad and Dr R R Sinha, DBT, New Delhi
18	Poseidon Biotech, Chennai	Control of White Spot Syndrome Virus of shrimp	Dr R B Narayanan, Anna University, Chennai, Dr S V Alavandi, CIFA, Chennai and Dr George John, DBT, New Delhi

19	Reliance Life Sciences Pvt. Ltd., Navi Mumbai	Micropropagation of date palm	Dr G J Samathanam, DST, New Delhi, Dr Sanjaj Nene, NCL, Pune and Dr George John, DBT, New Delhi
20	Sri Biotech Laboratories India Private Limited, Hyderabad in collaboration with University of Hyderabad, Hyderabad.	Microbial agents for weed management in rice	Dr R D Prasad, Directorate of Oil seeds, Hyderabad, Dr S Balasubramanian, NIPHM,Hyderabad, Dr Seema Wahab, DBT, New Delhi and Dr R R Sinha, DBT, New Delhi
21	Sun Agrigenetics Pvt. Ltd., Vadodara	Micropropagation technology for date palm	Dr G J Samathanam, DST, New Delhi, Dr B B Chattoo, MSU, Baroda and Dr S R Rao, DBT, New Delhi
22	Sun Agrigenetics Pvt. Ltd., Vadodara	Micro propagation technology for Red Sandalwood	Dr Vibha Dhawan, TERI, New Delhi, Dr A K Sharma, NBRI, Luknow, Dr S R Thengene, NCL, Pune and Dr K S Charak, DBT, New Delhi
23	T. Stanes & Company Limited., Coimbatore in collaboration with PSG College of Art and Science, Coimbatore	Passive immunotherapy for gastrointestinal infections in poultry	Dr Subeer Majumdar, NII, New Delhi, Dr P N Rangarajan, IISC, Bangalore and Dr Vamsi Krishna Addanki, DBT, New Delhi

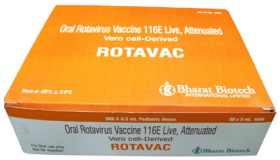
Rotavirus Vaccine – *Rotavac*

Development and Standardization of Manufacturing and Testing of Neonatal Rotavirus Vaccine

M/s Bharat Biotech International Ltd, Hyderabad

An estimated 130,000 infants die annually in India from severe rotavirus gastroenteritis. A vaccine for preventing this tragic and avoidable loss of life is hence critical and deserving great priority in India's vaccine development program. In recognition of this urgency, SBIRI support was provided to M/s Bharat Biotech International Ltd, Hyderabad in the initial stage of development of a live oral rotavirus vaccine. The company has invested in the development and manufacture of vaccines and bio-therapeutics. The company used rotavirus strain 116E isolated from an asymptomatic neonate at AIIMS, New Delhi.

The company developed a robust manufacturing process for production of a clinical grade -20°C stabilized formulation of the Live Oral Rotavirus Vaccine 116E (ORV 116E) with 2-year shelf life and beyond. The company further developed a formulation stable at 2°C and 8°C. Stabilized formulation of ORV 116E at 20°C was used in a Phase III efficacy trial on infants. The trial is now in the follow up phase. The vaccine with the trade name of ROTAVAC® awaits the trial results before moving towards commercial production.



The live attenuated rotaviruses exhibit better stability characteristics and are useful in prevention of rotavirus infections and/or rotavirus gastroenteritis in children. Two doses of the vero cell–adapted vaccine were evaluated. 187 infants received a vaccine dose of 10^4 focus-forming units (ffu) and 182 received a dose of 10^5 ffu in a 1:1 randomization with placebo recipients. Infants received the vaccine at 8, 12, and 16 weeks, separately from routine vaccines. There were no vaccine-related serious adverse events. A four-fold increase in rotavirus immunoglobulin antibody titer was observed in 66.7% and 64.5% of infants after the first administration and in 62.1% and 89.7% of infants after 3 administrations of doses of 10^4 ffu and 10^5 ffu, respectively. The differences between these groups and placebo recipients were statistically significant.

The SBIRI project was mentored by Dr C Durga Rao, Indian Institute of Science, Bangalore; Dr Sudhanshu Vrati, National Institute Immunology, New Delhi and Dr T S Rao, DBT, New Delhi through on-site monitoring and reviews. Initial support from SBIRI helped the company to access funds from other sources including international agencies. The dose-escalation safety and immunogenicity studies were undertaken with funding from international agencies also. This is a first ever instance of an indigenously developed vaccine for rotavirus diarrhea. The company has indicated that the vaccine will be sold to governments of different countries, including UN procurement agencies, at a price of around USD 1. ●

Recombinant Follicle Stimulating Hormone – *Foligraf*

Clinical Development and Commercial Manufacturing of Recombinant Follicle Stimulating Hormone

M/s Bharat Serums and Vaccines Ltd, Mumbai

Follicle stimulating hormone (FSH) is used extensively to treat fertility disorders in women. Recombinant FSH has an inherent advantage over the urinary product in terms of safety, no threat of transmission of viruses like HIV, HCV, HBsAg and batch-to-batch consistency with a well-controlled manufacturing process. Also, there are now restrictions to the use of media containing product of animal origin to grow cell-lines. With support under SBIRI, a project was undertaken by M/s Bharat Serums and Vaccines Ltd, Mumbai to scale up the production of rFSH derived from CHO cell-line and to clinically prove the safety and efficacy of the indigenously developed rFSH *vis-à-vis* the commercially available product. The company is one of the fast growing bio-pharmaceutical companies in India with mixed product portfolio including plasma derivatives, monoclonals, hormones, equine antitoxins and serums, antifungals, anaesthetics, cardiovascular and diagnostic products.

Under the project, fermentation parameters were optimized for large scale production of r-hFSH after standardization at the pilot scale. Downstream process parameters for the manufacture of r-hFSH were optimized. Two viral removal steps were incorporated in the manufacturing process. The company successfully launched the product in the Indian market in September 2008 under the brand name *Foligraf*™, after obtaining manufacturing and marketing authorization from the Drug Controller General of India. *Foligraf*™ is a subcutaneous injectable preparation of a recombinant follicle stimulating hormone for use in infertility treatment regimen. At present, the company manufactures the product at its plant in Ambernath (near Mumbai) which was constructed specially for manufacture of r-hFSH as part of this project. The capacity of this plant is sufficient not only to cater to the domestic requirements but with some capacity for servicing a part of the export market as well.

The success of the project was possible through

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Recombinant Drugs – *Tuly & Defuse*

Development of Recombinant Uricase for Treatment of Tumor Lysis Syndrome and Recombinant Fuzeon for Treatment of AIDS

M/s Virchow Biotech Pvt Ltd, Hyderabad

Using SBIRI support, M/s Virchow Biotech Pvt Ltd, Hyderabad embarked on the path to develop indigenous recombinant drugs under two of its projects. The company is engaged in development and manufacture of a wide range of biologicals and high value bio-generic products.

Recombinant uricase: During chemotherapy of leukemia, lymphoma or any solid tumor, a marked increase in the excretion of uric acid is observed, known as tumor lysis syndrome and if not controlled, can lead to acute renal failure. In the first project, the company successfully produced 'Rasburicase', a recombinant uricase to control hyperuricemia in cancer patients undergoing chemotherapy. The company developed a clone in *E. coli* and optimized an innovative and economical production process for the recombinant uricase. The trade name for the stable formulation is *TULY*. After required regulatory approvals, the company successfully conducted phase III multi-centric clinical trials of the product involving 100 subjects with safety and efficacy results in line with the available published reports.

The company has informed that it has successfully out licensed the technology for *TULY* to M/s Abbott India Pvt Ltd and expect a turnover of Rs. 5-10 crore per year from this arrangement. The company has further developed pegylated uricase for gout disease and is planning clinical trials in 2013.

The project was guided by SRIRI-PMC experts Dr B Sesikaran, National Institute Immunology, Hyderabad, Dr Ranjan Sen, Centre for DNA Fingerprinting and Diagnostics, Hyderabad and Dr Bindu Dey, DBT, New Delhi through on-site reviews.

Recombinant fuzeon: Fuzeon is a U.S. FDA approved drug which is very effective in treating HIV infection by preventing the virus

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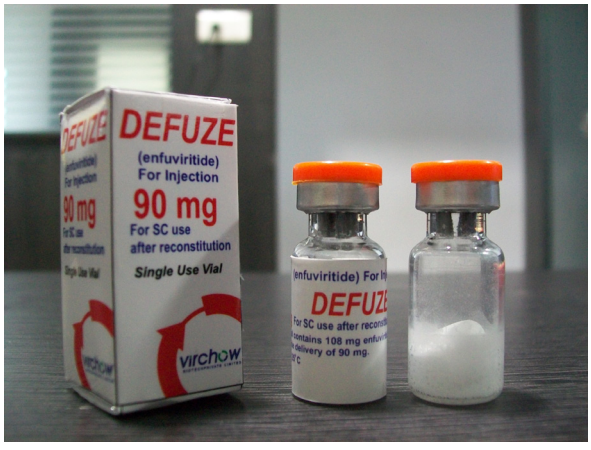

Osteoclast Inhibitory Peptide

Nanotechnology Based Delivery of Peptide Inhibitors for the Treatment of Osteoporosis

M/s Imgenex India Pvt Ltd, Bhubaneswar

When the rate of bone resorption exceeds that of bone formation, destruction of bone tissue occurs resulting in a fragile skeleton. The clinical consequences viz. osteoporosis and fragility fractures are common problems. Treatments that normalize the balance of bone turnover by inhibiting bone resorption preserve bone mass and reduce the risk of fracture. The receptor activator of nuclear factor-κB ligand (RANKL) is a pivotal regulator of osteoclast activity and provides a new therapeutic target. Receptor activator of nuclear factor-κB (RANK) is expressed by osteoclasts and their precursors. By binding to its receptor RANK on osteoclastic precursors, RANKL controls the differentiation, proliferation, and survival of osteoclasts.

A project supported under SBIRI at M/s Imgenex India Pvt Ltd, Bhubaneswar aimed to identify peptide inhibitors of RANKL mediated osteoclastogenesis. As of now the only commercially available product addressing this pathway is a monoclonal antibody against RANKL. There are no peptide inhibitors available commercially. The company also tried to use a nanoparticle delivery system for the peptides. They are involved in development of antibodies for research in immunology, cancer, neurological disorders, inflammatory diseases, infectious diseases, stem cell, etc. and have a long-term aim to produce therapeutic antibodies as a cure against such deadly diseases. The company and Institute of Life Sciences, Bhubaneswar developed successful collaboration in this project.

In the present project, the company designed and synthesized several peptides for the effective blocking of the ligand-receptor (RANKL-RANK) interaction. These peptides were able to significantly inhibit the osteoclast formation in RANKL treated RAW cell-line *in vitro* and were also found to inhibit the breast cancer induced osteolytic lesion in nude mice. The selected peptides were pegylated and characterized for an improved delivery system. The chitosan based nano-particles were found to be toxic for the cells, whereas, the pegylated form of peptides were found to be non-toxic and also were able to inhibit osteoclast formation *in vitro.* The company, therefore, proceeded with pegylation of their peptides and is now attempting to establish stability, safety and efficacy of this product.

The company was guided by SBIRI-PMC comprising of Dr A K Panda, National Institute of Immunology, New Delhi; Dr Debi P Sarkar, University of Delhi South Campus, New Delhi; Dr B S Das, Bhubaneswar and Shri Arvind Duggal, DBT, New Delhi through regular reviews. Expert inputs through SBIRI-TSC also contributed significantly in implementation of the project. ●

Monoclonal Antibodies for Health Care

Production of Monoclonal Antibodies for RBC Phenotyping and Treatment of Snakebites

M/s Mediclone Biotech Pvt Ltd, Chennai

SBIRI support was extended to M/s Mediclone Biotech Pvt Ltd, Chennai for two projects focusing on development of monoclonal antibodies for RBC phenotyping and snake venom neutralization. The company has considerable expertise in the area of immune biology and has developed various monoclonal antibody-based kits.

RBC Phenotyping MAbs: Red blood cell typing is one of the prerequisites in medical diagnostics pertaining to blood transfusion, surgery and management of pregnancy complications. In this project, the company developed the technology to produce monoclonal antibody based medical diagnostic reagents for RBC-immunophenotyping as per the IP/BP/WHO standards. Clinical evaluations of formulated products were done and stability, sensitivity and affinity of the products were matched with Indian, European and American Pharmacopia standards. WHO GMP norms were followed and ISO quality certificate was obtained. The company has achieved the set objectives and has been able to develop RBC-microphenotyping reagents/kits. The product is of both IgM and IgG type monoclonals. The entire range of monoclonal antibodies for blood phenotyping is bulk produced and packaged for retail, OEM and bulk customers. Monoclonals of Anti A, B, AB, A1, H RhD(IgM), RhD(IgG), RhD(IgG+IgM), also Coomb's Sera, 22% BSA and LISS Buffer are being made available as a complete package for blood immune-phenotyping. The monoclonal antibodies of bloodgrouping are marketed with brand names *Mediclone A (anti-A), Mediclone B (anti-B), Mediclone AB (anti-AB)* and *Mediclone D (anti-RhD)*

The company claims to be the first to produce a complete range of blood phenotyping products in the Asian continent and hence an important player in the estimated Rs. 100 crores import substitution market. To keep pace with opportunities, the company is setting up a sales and marketing department and plans to market the product through government tenders and bulk purchasers. It foresees competition from multinational companies, mostly from Europe but is confident to become the market leader and reach the top position in the market through the fully indigenized and cost effective manufacturing process.

Anti snake venom MAbs: Patients of snakebites are currently treated only through the antibody neutralization method, by infusing anti- venom

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Malaria Diagnostic Kit– *Malariscan*

HRP-II/ p-LDH Based Diagnostic Kits for the Differential Detection of Malarial Parasites

M/s Bhat Bio-tech India Pvt Ltd, Bangalore

Malaria is typically diagnosed by a microscopic examination of blood and antigen-based rapid diagnostic tests. The conventional microscopic detection of malarial parasite is time consuming and limited access to effective diagnosis in endemic regions results in significant mortality and morbidity. SBIRI support was made available to M/s Bhat Bio-tech India Pvt Ltd, Bangalore to develop non-microscopic rapid diagnostic test (RDT) based on the detection of antigen(s) released from the parasitized erythrocytes as a competent market product. The company is an ISO, GMP and CE certified company pioneering in the manufacture of various diagnostic kits.

The company in collaboration with National Institute of Malaria Research, New Delhi has improved the RDT test using histidine-rich protein 2 (HRP2) to detect *Plasmodium falciparum* specifically and lactate dehydrogenase (LDH) - from the parasite glycolytic pathway to detect *Plasmodium* species (PAM specific) in humans. Sensitivity and cost are main bottlenecks in available RDT tests. The company has successfully cloned and expressed HRP-II and p-LDH and has also produced monoclonal and polyclonal antibodies for the same, with the specific aim to reduce the cost of the kit. The maximum time duration of the test is 20 minutes using a whole blood sample.

Specific	:	No cross-reaction
Sensitivity	:	98% for Pf & 98% for P.v
Specificity	:	99.5%
Available in Pack Size	:	25 & 50 Tests

The project was mentored by SBIRI-PMC experts Dr Saumitra Das, Indian Institute of Science, Bangalore ; Dr Uday Kumar Ranga, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore; Dr Navin Khanna, International Centre for Genetic Engineering and Biotechnology, New Delhi and Dr T S Rao & Shri S Sinha of DBT, New Delhi through on-site reviews. SBIRI–TSC did periodical progress reviews to steer the project in the desired direction.

The company has gone forward to work on improving sensitivity and specificity of the kit. The malaria diagnostic kit is now being marketed under trade name *MALARISCAN*™ (Antigen Card Test). It is a rapid, qualitative, two-step immunoassay based on the immune-chromatographic principle for the detection of malaria P.f/ P.v antibodies in human serum or plasma.

Biomarkers for Cancer

Development of Immunoassays for Prostate and Breast Cancers Through Molecular Characterization of Markers

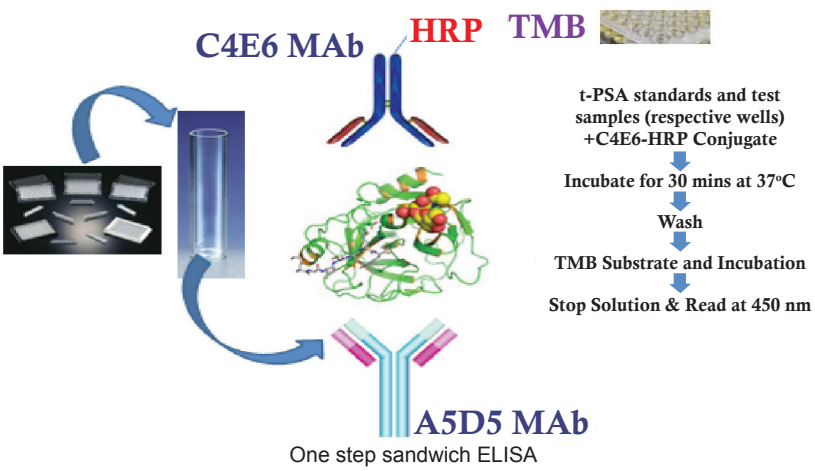
M/s Yashraj Biotechnology Ltd, Navi Mumbai

Breast and prostate cancers are among the most common types of cancers in India. Development of specific immunoassays can significantly help in a timely diagnosis and improved prognosis. SBIRI project funded to M/s Yashraj Biotechnology Ltd, Navi Mumbai aimed at developing high-specificity immunoassays for these cancers through molecular characterization of existing biomarkers and development of novel markers. The company is a pioneer in the manufacture of diagnostic antigens from human biomedical fluids as well as in raising monoclonal and polyclonal antibodies.

Using SBIRI support, the company developed indigenous antibodies and ELISA assays for total and free-PSA. The anti-PSA antibody A5D5 identifies all forms of PSA. Similarly monoclonal antibodies against non-complex forming PSA isoforms having great opportunity in free-PSA assay have been successfully developed. The company is also progressing well on breast cancer biomarker assay development. Prototypes of sandwich ELISA assays for total and free PSA, and CA 15-3 have been developed.

In addition, work related to cloning and expression of novel markers MUC-1/Y, ST3 and ST6 has been completed and development of monoclonal antibodies is in progress. Sandwich ELISA would be developed to study the specificity and sensitivity of these markers using clinical samples collected in collaboration with Tata Memorial Center, Mumbai. At present, the company is planning to market the antibodies raised against total-PSA, non-complex forming PSA, MUC-1/Y, ST-3 & ST-6 as independent products and also good quality PSA-ACT complex as an antigen product to manufacturers of in-vitro diagnostics in India and abroad.

Dr Subrata Sinha, All India Institute of Medical Sciences, New Delhi (now at National Brain Research Centre); Dr Rita Mulherkar, Advanced Centre for Treatment, Research and Education in Cancer, Mumbai and Dr Bindu Dey, DBT, New Delhi mentored the project as members of SBIRI-PMC, through on-site reviews. SBIRI-TSC reviewed the work periodically and directed the company with midterm corrections. ●



One step sandwich ELISA

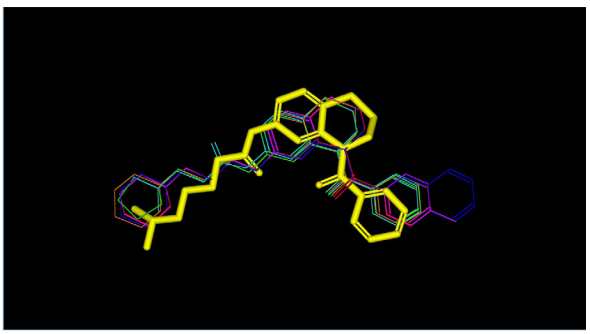
Histamine Receptor Antagonists

Design and Development of H3 and other GPC Receptor Ligands for Various Therapeutic Applications

M/s Oxygen Healthcare Research Pvt. Ltd, Ahmedabad

Ligands for H3 receptors, if brain penetrant, could have a role in the treatment of Alzheimer's and other cognitive disorders; and also sleep disorders and states related with obesity. The sequential aims of this SBIRI project undertaken by M/s Oxygen Healthcare Research Pvt. Ltd, Ahmedabad were designing novel ligands for H3 receptors, identifying those with high brain penetration qualities, and then undertaking pre-clinical studies on cognitive functions. It is a start-up drug discovery services company.

As a part of its efforts, the company identified five compounds which had high pKi values (8.2 - 9.4). These compounds were further tested for the antagonist selection using in-house developed Eu-GTP functional assay. The compounds were found to be either antagonists or inverse agonists, which are useful for the treatment of cognitive disorders like Alzheimer's. The compounds were screened at 10 micromolar concentrations which is 1000 folds higher than the pKi of the compounds at the H3R to ensure a high safety margin and were found to be selective to H3R against the major CNS GPCRs. The compounds were also tested *in vitro* for the drug-likeness using microxomal stability, CYP inhibition profile (metabolic toxicity), hERG binding assay (cardiac toxicity), physico-chemical properties and BAMPA assay (permeability). The company is undertaking additional studies for PK and tissue distribution. Their physico-chemical properties do suggest a high brain penetration. Two compounds were tested in animals, and found to be orally bioavailable, though the exact status of their efficacy in the animal models will need further studies.



Pharmacophore searching for H3R antagonist

As a spin-off outcome of the project, in-house assays for the binding of H3R ligands was developed. The company has established the facilities for general *in vitro* screening for evaluation of drug-likeness of the novel chemical entities.

The project implemetation was mentored by Dr Shiv Kumar Sharma, National Brain Research Centre, Gurgaon; Dr M V Padma, All India Institute of Medical Sciences, New Delhi and Dr Suman Govil, DBT, New Delhi as SBIRI-PMC experts. SBIRI-TSC mentored the project through regular progress reviews. As a start-up, the company has gained good visibility because of its association with SBIRI.

There are numerous other indications, for which the H3R inverse agonists and the antagonists are being proposed either as selective ligands or as multiple ligands and since there is no molecule as yet which has crossed the Phase-IIb clinical trials, the company is hopeful of further development of this molecule as treatment for the disease.

Insilico Drug Designing for Tuberculosis

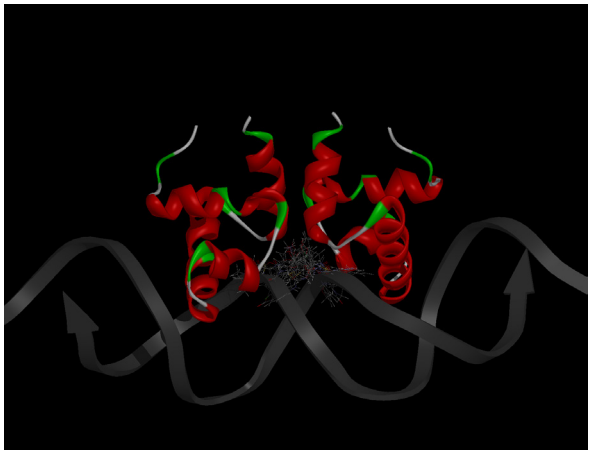
Computational Design and Development of Inhibitors for Treatment of Tuberculosis

M/s Lead Invent Technology Pvt Ltd, New Delhi

All current therapies for treating tuberculosis work by eliminating actively replicating TB bacteria. The latent TB form escapes these therapies and persists even after treatment. SBIRI project undertaken by M/s Lead Invent Technology Pvt Ltd, New Delhi aimed at understanding and designing small molecules that would target the latent *Mycobacteria*. The study, in collaboration with All India Institute of Medical Sciences (AIIMS), New Delhi was centered on the transcription factor, DevR which is the primary mediator of adaptation to hypoxia in *Mycobacterium tuberculosis* and is directly implicated in Latent TB**.** The major end point significance of such compounds would be in combination therapy with the existing anti TB drugs to shorten the treatment time. The company is a start-up with required expertise in the field of computational drug designing.

The main aim of the study was to identify molecules that bind to DevR, a known drug target for latent tuberculosis. This concept was taken up from AIIMS, New Delhi where extensive work has been done on characterizing DevR system in latent TB. DevR acts by binding to bacterial DNA. AIIMS provided the necessary inputs for this work including results from their previous screen to the simulation team. The simulation team at the company systematically studied DevR-DNA system hydrogen bond contacts and worked out key interactions that stabilize the DevR-DNA complex. These interactions were further studied through mutation studies at AIIMS to validate the simulated data and to establish experimental basis for further work. The company created a pharmacophore model around the DNA binding site of DevR and proposed binding mode of few selected small organic molecules that could potentially interfere with DevR-DNA binding. It also suggested changes to the compounds which were tested in EMSA assay to pin point the active moieties in the tested compounds. The joint efforts of the company and AIIMS have led to capture of key binding motif that can be exploited to optimize the hit to lead. Ten lead molecules have been identified for further studies.

SBIRI-PMC experts Dr Alok Bhattacharya, Jawaharlal Nehru University, New Delhi; Dr Dinakar M Salunke, National Institute of Immunology, New Delhi and Dr Madhan Mohan, DBT, New Delhi mentored the project. The company also received guidance from SBIRI-TSC. ●



The interference created by different molecules between DNA molecule(Grey) and DevR Protein (Red)

Drug Eluting Stents

Manufacture and Clinical Evaluation of Non-Polymeric Drug Eluting Stent

M/s Relisys Medical Devices Ltd, Hyderabad

Restenosis continues to be a major challenge in treating coronary artery disease through percutaneuous approaches. Though drug eluting stents have been considered superior to bare metal stents in reducing restenosis that occur due to neo-intimal hyperplasia, it continues to be a clinically relevant problem in some patients. Late stent thrombosis has emerged as a new threat to the use of drug eluting stents. The major problem of late thrombosis has been attributed to the polymer used for the drug release.

In this SBIRI supported project, M/s Relisys Medical Devices Ltd, Hyderabad tried a nano-carbon porous matrix for the drug release with precise control. The company has a large scale integrated facility capable of providing end-to-end solutions for designing, developing and manufacturing critical care devices like stents, catheters and stent systems in cardiac and non-cardiac segments.

Initial studies carried out by the company showed that nanoporous carbon- coating offered no advantage over the polymer based DES in relation to safety and in terms of angiographic late restenosis. As a result of this, further development of this stent for commercial purposes was not taken up. The company worked to develop bare metal stent manufacturing process using in-house proprietary process in laser processing, post laser processing, heat treatment and surface modification technologies enabling development of cobalt chromium coronary stents with enhanced mechanical and surface properties. These enhanced properties led to better clinical outcomes. The setting up of a fully integrated plant for manufacturing of coronary stents has been one of the major milestones of the project. The manufacturing plant set up by the company has been able to manufacture 22,300 Cobalt BMS stents and 600 SS stents so far, yielding a sales revenue of about Rs. 9.5 crores.

The company has also been able to develop in-house technologies for shape memory applications like self-expanding stents, vascular grafts, ASD closure devices etc. It is the first Indian company to develop process technologies for manufacturing various types of balloon catheters. The development and commencement of the sale of 17,500 balloon catheters for the stents

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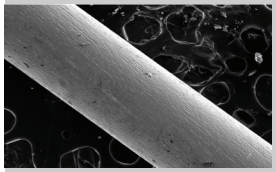
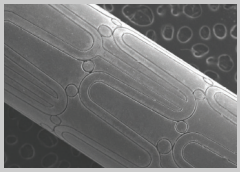
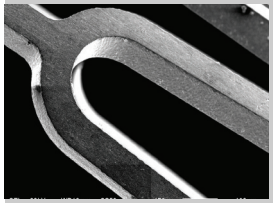
SEM Images - At different stages of stent processing, coating and implantation



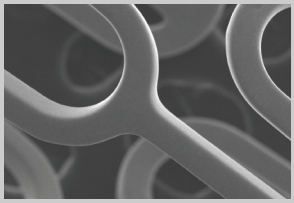
1. CoCr - Hypo tube



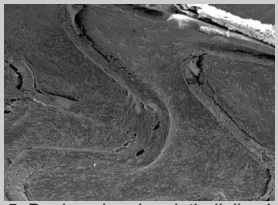
2. Laser cut



3. Annealed and Pickled Stent



4. Finished stent



5. Deployed and endothelialised stent in rabbits (After 15 days)

Xenografts and Homografts

Tissue Engineering of Homologous Natural Biomaterial for Clinical Use

M/s Frontier Lifeline Pvt Ltd, Chennai

Acellular xenografts and homografts are commonly used in clinical cardiovascular surgery. SBIRI project supported at M/s Frontier Lifeline Pvt Ltd, Chennai was aimed at developing the acellular tissue products which can be used without any complications of immune rejection, infection, calcification and thrombosis. The company is known for providing state-of-the-art facilities in cardiac diagnosis, treatment, research and education.

To achieve project goals, the company harvested tissues from inspected abattoirs and processed them under sterile conditions. Decellularization of the tissue was carried out with detergent and acellularity of the tissues was confirmed with histopathological evaluation, scanning microscopic studies and with DNA extraction analysis. The decellularized tissues were further cross-linked with aldehydes to strengthen these grafts so that *in vivo* autologous cell seeding was possible. Mechanical strength of these grafts was validated with Tensile test, Burst test, DSC and FTIR studies. Moreover, toxicity and biocompatibility of these tissue products were extensively studied. The animal experiments confirmed the *in vivo* cell immigration into the acellular scaffolds so that these grafts to become autografts. The stability of these engineered tissues was tested with various preservation techniques. Alcohol was confirmed as the best preservative with antibacterial/fungal properties, which can preserve these grafts for six months duration without any decline in biomechanical properties. The project resulted in the development of novel tissue engineered xenograft conduits and patch in the form of bovine pericardium, porcine pulmonary artery, and bovine jugular vein which can be used in cardiac surgical procedures.

Subsequent to the successful *in vitro* test and *in vivo* animal experiments, these indigenously processed xenografts from bovine and porcine source were implanted in more than 900 patients with various cardiovascular ailments, who had no other option for their survival. Moreover, the tissue engineered human amniotic membrane collected from various hospitals was found

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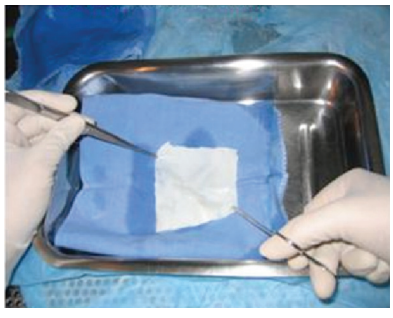
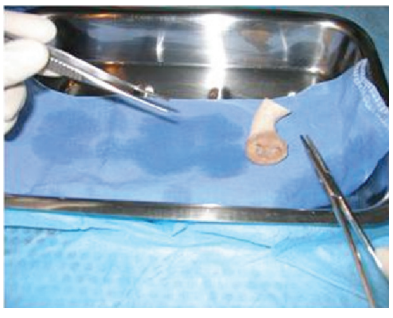
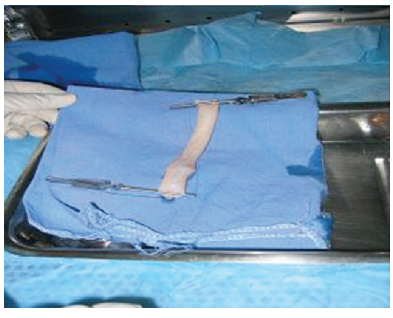


Bovine Pericardium



Procine Pulmonary Artery



Bovine Jugular Vein

Serifilm as Bioactive Wound Dressing

Development and Commercialization of Silk Protein Blend Film for Burn Wound Management

M/s Healthline Pvt Ltd, Bangalore

About one million burn wound cases are reported every year in India and a majority of them lead to disfigurement, emotional trauma and in some cases, death due to lack of affordable care. The idea of developing an effective occlusive dressing for burn wound management in the form of a bilaminate silk protein blend film using silk fibroin as the raw material was attempted through this SBIRI project supported at M/s Healthline Pvt Ltd, Bangalore. The company has domain expertise in the area of sericulture based products.

The company has developed a clinical grade silk protein based film 'Serifilm' BF27 (PV). The proof of concept was established through a series of lab testing for mechanical strength, porosity, water permeability, suction, cell growth etc, *in vitro* bio-compatibility and bio-degradation testing as well as *in vivo* assessment for toxicity, irritation, sensitization and performance in various animal models using standard OECD guidelines. *In vitro* studies showed that the film supported the growth of fibroblast and keratinocytes. The company has now standardized the production parameters and specifications for bilaminate silk protein blend film. The bilaminate film has hydrophilic, hydrophobic ends, allowing movement of air and absorption of exudates. It has specific peptides for stimulating the growth of fibroblasts and keratinocytes and is free of bio-load and has no animal component. Different sizes suitable to cover the wound including body wrap are available. *In vivo* studies were done in rat and rabbit models as well as in 35 human patients. The company is planning to produce 1000 films/ month under GMP conditions for evaluation through Phase III multi-centric clinical trials.

The project was mentored through its progress by SBIRI-PMC experts Dr K P Gopinathan, Indian Institute of Science, Bangalore, Dr Mary Babu, Central Leather Research Institute, Chennai and Dr Mohd Aslam & Alka Sharma of DBT, New Delhi. SBIRI-TSC reviewed the progress regularly during its meetings.

The company foresees a significant market potential, addressing the needs of a large number of burn patients in almost all major public hospitals. Also, they are planning to test the product on diabetic wounds and cancer lesions. The bilaminate film has efficacy comparable to collagen films and will be priced competitively.

Day 0 with Serifilm

Day 8 with Serifilm

Day 12 with Serifilm

Efficacy demonstrated in Phase II trials

Recombinant Follicle Stimulating Hormone – Foligraf

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the expert guidance of Dr Satish K Gupta, National Institute Immunology, New Delhi; Dr P B Seshagiri, Indian Institute of Science, Bangalore; Dr C P Puri, National Institute for Research in Reproductive Health, Mumbai and Dr T S Rao, DBT, New Delhi through on-site monitoring meetings as members of SBIRI-PMC and through regular reviews by SBIRI-TSC.

The present Indian market for recombinant FSH is around Rs.100 crores and is growing at the rate of about 15% per annum. Presently, formulations of rFSH available in India are imported. This is the first Indian company to develop, manufacture and sell a recombinant FSH product. Notably, the technology developed obviates the use of animal derived sera products in the culture medium, thus making the product safe. The company has emerged as one of the leading companies in the Indian market with a very capable marketing team. This is evident by the fact (as reported by them) that *Foligraf*™ already has cornered about 30% a market share in the Indian recombinant FSH market in just 15 months since its launch. ●

Recombinant Drugs – *Tuly* & *Defuse*

Contd. from pg. 24

from fusing with the cell. It decreases HIV-1 viral load and increases CD4+ cell count and thereby improves the quality of life of AIDS patient. Produced using extensive chemical synthesis, Fuzeon is currently available only in US. There is a huge need for this product both in India and rest of the world, especially for HIV-1 infected patients not responding to HAART. In India alone, about 6.5 million HIV patients can benefit from this drug. Considering the societal requirements as well as unmet market demand for the drug, SBIRI supported a second project at the company for indigenous development of a recombinant fuzeon, 'Enfuvirtide'

The company adopted multimeric cloning approach to express fuzeon in *E. coli* that yielded about 20% expression. The production process was optimized for upstream and downstream operations using 500 liter fermentation batch with a yield of about 2500 doses per batch. Stability studies of the formulated recombinant fuzeon for 3 process validation batches at the real time temperature conditions were completed following the protocol based on the ICH guidelines. The company also optimized the pegylation process for recombinant fuzeon in order to develop a long acting molecule. Pre-clinical safety and toxicological studies have been done. Clinical trials are expected to start shortly to compare the PK/PD profiles of indigenous recombinant fuzeon with that of the one produced internationally. A recombinant version of enfuviritide will be marketed with the trade name *DEFUSE*.

Dr A K Panda, National Institute of Immunology, New Delhi; Dr G P Agarwal, Indian Institute of Technology, Delhi and Shri S Sinha, DBT, New Delhi as SBIRI-PMC members guided the company.

The company has stated that it is the first to develop indigenous recombinant uricase and fuzeon. Both the projects were mentored through regular reviews by SBIRI-TSC. ●

Monoclonal Antibodies for Health Care

Contd. from pg. 26

antibodies. There is chronic short-supply of anti-venom serum because of inconsistent production methods that are followed. Monoclonal cocktail production of anti- venom serum of consistent quality, and in required quantities, can eliminate dependence on biological systems for production of anti-venom serum. With SBIRI support, the company worked on development of therapeutic MAbs for major poisonous snakes of India.

To begin with, lethal fractions were identified, keeping in view the complexity of snake venom proteins. Monoclonal antibodies against four major poisonous snakes of Indian origin i.e. Cobra, Russell's viper, Echies and Krait were developed and cross neutralizing antibodies were selected as members of monoclonal cocktail that could completely neutralize entire range of snake venom toxins. Two different cocktails of snake venom antibody (6 hybridoma products, each) were successfully generated and tested for efficacy. Animal studies showed its efficacy in preventing deaths. LD50 studies were done. Isotypes of antibodies were identified. Through the support of SBIRI, the company developed an improved process to indigenously produce monoclonal based therapeutics for treating snakebites.

Dr Navin Khanna, International Centre for Genetic Engineering and Biotechnology, New Delhi; Dr Girish Sahni, Institute of Microbial Technology, Chandigarh and Dr A K Rawat, DBT, New Delhi were SBIRI-PMC experts hand-holding the efforts of the company during implementation of both these projects. SBIRI-TSC also guided the timely progress through its reviews. ●

Xenografts and Homografts

Contd. from pg. 32

to be an excellent dressing material for skin wounds and burns. The company informed that for some of the patients, these xenografts were functioning with excellent biocompatibility for over the years under review. These indigenously processed grafts have performed better than commercially available imported products in the terms of acellularity and calcification which gives them great market potential. These processed grafts are completely acellular, without any threat for xenozoonosis. They do not elicit immunorejection or graft-versus-host disease and are safe and biocompatible for human implantation.

SBIRI-PMC experts Dr Paul Kumaran, Tuberculosis Research Centre, Madurai ; Dr Girish Sahni, Institute of Microbial Technology, Chandigarh and Dr Alka Sharma, DBT, New Delhi reviewed the project through on-site visits. SBIRI-TSC also advised the company regularly through progress reviews during the meetings.

The company is continuing the work on improvising these grafts with nanotechnology to create uniform surface with greater mechanical strength and biocompatibility which can make them better than other commercially available processed tissues. It is in the process of obtaining regulatory permissions to carry out multicentric trials and to market these tissue engineered products. The company has proposed to sell its tissue engineered products at reasonable costs; Bovine Pericardium @ Rs 5,000/piece, Porcine Pulmonary Artery @ Rs 10,000/ graft and Human Amniotic Membrane, human saphenous vein @ Rs 800 – Rs 2,500 depending on the size. ●

S. No.	Organisation(s)	Short Title	PMC Experts
1	Abexome Biosciences Pvt Ltd., Bangalore	Monoclonal antibodies against human embryonic stem cells	Dr Sharmila Bapat, NCCS, Pune, Dr V V Suryanarayana, IVRI, Bangalore and Dr Alka Sharma, DBT, New Delhi
2	ABL Biotechnologies Limited, Chennai	Drug delivery systems	Dr A K Panda, NII, Delhi, Dr Debi Sarkar, UDSC, New Delhi and Dr K K Tripathi, DBT, New Delhi
3	Actis Biologics Private India Limited, Mumbai	Sustained delivery of MSP36	Dr Vineeta Bal, NII, New Delhi, Dr Rajeev Sarin, ACTREC, Mumbai and Dr Bindu Dey, DBT, New Delhi
4	Advanced Neuro-Science Allies Pvt. Ltd, Bangalore in collaboration with Vittal Mallya Scientific Research Foundation, Bangalore	Studies of human mesenchymal stem cells in autoimmune diseases	Dr P B Seshagiri, IISC, Bangalore, Dr Rita Mulheker, ACTREC, Mumbai and Dr Kalaivani Ganesan, DBT, New Delhi
5	Ara Healthcare Private Limited, Gurgaon	Recombinant therapeutic proteins	Dr Subrata Sinha, NBRC, Gurgaon, Dr Nikhil Tandon, AIIMS, New Delhi and Dr Bindu Dey, DBT, New Delhi
6	Arbro Pharmaceuticals Ltd., New Delhi in collaboration with LSR Institute of TB and Respiratory Diseases, New Delhi, AIIMS, New Delhi	Methods for diagnosis of tuberculosis	Dr A K Panda, NII, Delhi, Dr Ashok Shah, VPCI, Delhi and Dr Suchita Ninawe, DBT, New Delhi
7	Arjuna Natural Extracts Ltd., Aluva, Kerala	Chemical profiling and evaluation of antidiabetic plant extract	Dr A K Panda, NII, New Delhi, Dr P N Rangarajan, IISC, Bangalore and Dr Mohd Aslam, DBT, New Delhi
8	Avesthagen Limited, Bangalore	Scale-up and evaluation of Etanercept	Dr A K Panda, NII, New Delhi, Dr K V Rao, ICGEB, New Delhi, Dr K B Ramachandran, IIT, Chennai, Shri Arvind Duggal, DBT, New Delhi
9	Avesthagen Ltd., Bangalore	Hepatocyte-like cells for hepatotoxicity screening of xenobiotics	Dr Ashok Mukhopathyay, NII, New Delhi, Dr Deepa Bhartiya, NIRRH, Mumbai and Dr Alka Sharma, DBT, New Delhi
10	Bharat Serum and Vaccines Limited, Mumbai	Pulmonary surfactant	Dr Vinod Kumar Paul, AIIMS, New Delhi, Dr Rinti Baneerjee, IIT, Mumbai and Dr Alka Sharma, DBT, New Delhi

S. No.	Organisation(s)	Short Title	PMC Experts
11	Bisen Biotech & Biopharma Private Limited, Gwalior in collaboration with Jiwaji University, Gwalior	TB screen test	Dr Kanury V S Rao, ICGEB, New Delhi, Dr Jaya S Tyagi, AIIMS, New Delhi and Shri S Sinha, DBT, New Delhi
12	Cadila Pharmaceuticals Ltd., Ahmedabad	*Mycobacterium w* as an adjuvant for anti – rabies vaccine	Dr A K Panda, NII, New Delhi, Dr V M Katoch, ICMR, New Delhi and Dr Bindu Dey, DBT, New Delhi
13	Century Pharmaceuticals Ltd., Vadodara	Allergy and asthma treatment	Dr Dipankar Nandi, IISc, Bangalore, Dr G Das, ICGEB, New Delhi and Dr Alka Sharma, DBT, New Delhi
14	Curadev Pharma Private Limited, Noida	Modulators of the apoptotic pathway	Dr Samit Chattopadhyay, NCCS, Pune, Dr S Chandrasekhar, IICT, Hyderabad and Dr Garima Gupta, DBT, New Delhi
15	Healthline Private Limited, Bangalore	Clinical evaluations, of silk protein blend film for wound management	Dr A K Tahlan, CRI, Kasauli, Dr Shinjini Bhatnagar, THSTI, Gurgaon, Dr M S Shashi Kumar, DBT, New Delhi and Dr Alka Sharma, DBT, New Delhi
16	IcubedG Ideas Private Limited, New Delhi	Male injectable contraceptive	Dr A K Panda, NII, New Delhi, Dr K Satyanarayana, ICMR, New Delhi and Dr Manish Rana, DBT, New Delhi
17	Imgenex India Pvt. Ltd., Bhubaneswar	Generation of induced pluripotent stem cells from adult somatic cells	Dr P Das, CIFA, Bhubaneswar, Dr Rita Mulkherker, ACTREC, Mumbai and Dr Alka Sharma, DBT, New Delhi
18	Incozen Therapeutics Pvt. Ltd., Hyderabad	Dihydroorotate dehydrogenase inhibitors in inflammatory bowel diseases	Dr Vineet Ahuja, AIIMS, New Delhi, Dr S Chandrasekaran, IICT, Hyderabad and Dr T S Rao, DBT, New Delhi
19	Indian Immunologicals Limited, Hyderabad in collaboration with Indian Institute of Science, Bangalore	Rapid diagnostic test for malaria	Dr K M Pakniker, ARI, Pune, Dr Pawan Malhotra, ICGEB, Delhi and Dr T S Rao, DBT, New Delhi
20	Invictus Oncology Pvt. Ltd., New Delhi	Antibody-Platinum conjugates for Therapy of EGFR-overexpressing tumors	Dr Vinod Raina, AIIMS, New Delhi, Dr. A K Panda, NII, New Delhi and Dr Kalaivani Ganesan, DBT, New Delhi

S. No.	Organisation(s)	Short Title	PMC Experts
21	Jupiter Bioscience Limited in collaboration with The Maharaja Sayajirao University of Baroda, Baroda	Effective treatment of lung cancer	Dr Kumar Prabhash, Tata Memorial Hospital, Mumabi, Dr A K Panda, NII, New Delhi and Shri Arvind Duggal, DBT, New Delhi
22	Laila Impex, Vijayawada	Development of curcumin for treating cataract	Dr Chitra Kannabiran, LV Prasad Eye Institute, Hyderabad and Dr T S Rao, DBT, New Delhi
23	LeadInvent Technologies Pvt. Ltd., New Delhi in collaboration with Indian Institute of Technology, Chennai	Design of Hit Molecules for cancer targets	Dr D Mohanti, NII, New Delhi, Dr Anil Suri, NII, New Delhi, Dr Indira Ghosh, JNU, New Delhi and Dr Bindu Dey, DBT, New Delhi
24	Lifecare Innovation Private Limited, Gurgaon	Toxicity free Amphotericin B for treatment of Kalaazar	Dr Nikhil Tandon, AIIMS, New Delhi, Dr A K Panda, NII, New Delhi and Dr Bindu Dey, DBT, New Delhi
25	Microbax (India) Ltd., Hyderabad in collaboration with Talwar Research Foundation (TRF), New Delhi	Probiotic tablets for relieving vaginosis/vaginitis	Dr Shinjini Bhatnagar, AIIMS, New Delhi, Dr Neerja Bhatla, AIIMS, New Delhi, Dr V Lakshmi, NIMS, Hyderabad and Dr T S Rao, DBT, New Delhi
26	Orchid Chemicals & Pharmaceuticals Ltd., Chennai in collaboration with AU-KBC Research Center, Chennai	Cell-tissue co-culture model for aiding liver specific studies	Dr Rita Mulherkar, ACTREC, Mumbai, Dr Subeer S Majumdar, NII, New Delhi and Dr Kalaivani Ganesan, DBT, New Delhi
27	Pochiraju Industries Limited, Ranga Reddy District, Andhra Pradesh	Hexavalent lipo-oligosaccharide vaccine for *Neisseria meningitidis*	Dr V V Suryanarayana, IVRI, Bangalore, Dr Joyoti Malik Logani, DBT, New Delhi
28	Reliance Life Sciences Pvt. Ltd., Navi Mumbai	Safety and efficacy studies of tissue engineered R-STE-001 cartilage defect of femoral condyle	Dr Rajesh Malhotra, AIIMS, New Delhi, Dr Mohan R Wani, NCCS, Pune and Shri S Sinha, DBT, New Delhi
29	SaiAdvantium Pharma Limited, Hyderabad	PI3K/mTOR dual inhibitors in treatment of cancer	Dr Vinod Raina, AIIMS, New Delhi, Dr Kumaravel Soma Sundaram, IISc, Bangalore and Shri S Sinha, DBT, New Delhi
30	Sandor Proteomics Private Limited, Hyderabad	Biomarkers of rejection and immuno-suppression in transplantation	Dr Vivekanand Jha, PGIMER, Chandigarh, Dr S K Agarwal, AIIMS, New Delhi, Dr Lalit Garg, NII, New Delhi and Dr T S Rao, DBT, New Delhi
31	Shantani Proteome Analytics Pvt. Ltd., Pune	New drug targets for type 2 diabetics treatment	Dr Chittaranjan S Yajnik, KEM Hospital, Pune, Dr Saroj Ghaskadbi, University of Pune, Pune and Dr A K Rawat, DBT, New Delhi

S. No.	Organisation(s)	Short Title	PMC Experts
32	Sri Raghavendra Biotechnologies Pvt. Ltd., Bangalore	Characterization of umbilical cord Wharton's jelly – derived mesenchymal stem cells	Dr P B Seshagiri, IISC, Bangalore, Dr Maneesha Inamdar, JNCASR, Bangalore and Dr Alka Sharma, DBT, New Delhi
33	Stempeutics Research Pvt Ltd., Bangalore	Characterization of human Wharton's Jelly-derived mesenchymal stem cells	Dr Jyostna Dhawan, INSTEM, Bangalore, Dr Ashok Mukhopathaya, NII, New Delhi and Dr A K Rawat, DBT, New Delhi
34	Sugen Life Sciences Pvt. Ltd., Tirupati	Wound healing efficacy of novel formulation	Dr Y K Gupta, AIIMS, New Delhi and Dr Jyoti Logani, DBT, New Delhi
35	Surya Pharmaceuticals, Varanasi	Polyherbal formulation for bronchial asthma	Dr A K Singh, CIMAP, Lucknow, Dr D S Arya, AIIMS, New Delhi and Dr Manoj Modi, DBT, New Delhi
36	USV Limited, Mumbai	Vaccine for Typhoid	Dr B L Jailkhani, AIIMS, New Delhi, Dr Robin Mukhopadhyay, ACTREC, Mumbai, Dr Sanjukta SenGupta, NII, Delhi, Dr Ramesh Kumar, AIIMS, New Delhi, Late Dr Vinod Bhakuni, CDRI, Lucknow, Dr Lalit C Garg, NII, New Delhi and Shri S Sinha, DBT, New Delhi
37	Vivo Bio Tech Limited, Hyderabad	Production of recombinant exenatide	Dr A K Panda, NII, New Delhi, Dr Nikhil Tandon, AIIMS, New Delhi and Shri Arvind Duggal, DBT, New Delhi
38	Zenotech Laboratories Limited, Hyderabad	Monoclonal antibodies against human epidermal growth factor receptor	Dr B Sesikaran, NII, Hyderabad, Dr Ranjan Sen, CDFD, Hyderabad, Dr J Gowrishankar CDFD, Hyderabad and Dr Shailja V Gupta, DBT, New Delhi

Drug Eluting Stents

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is a significant. Another interesting feature is development of cobalt-chromium alloy stent (COREL+C) with strut thickness of 60µ. These developments are likely to provide the basis for future advanced technology platforms.

The project was mentored through its progress by SBIRI-PMC experts Dr K Satyanarayana, Indian Council of Medical Research, New Delhi; Dr Nikhil Tandon, All India Institute of Medical Sciences, New Delhi; Dr G S Bhuvaneshwar, Sree Chitra Tirunal Institute for Medical Sciences & Technology, Trivandrum and Shri Arvind Duggal, DBT, New Delhi. SBIRI-TSC also took periodical reviews and mentored the progress. ●

Dextranase for Sugar Industry – *Dextrasol*

Indigenous Production of Dextranase Using SSF Technique

M/s Varuna Biocell Pvt Ltd, Varanasi

In sugar production, dextrans are undesirable compounds synthesized by contaminating microbes using sucrose that increase viscosity of flow thereby reducing industrial recovery and causing significant loss of sugar. Dextrans also cause processing problems like increased juice viscosity, poor clarification and crystal elongation which are also causes of economic loss. There is a demand for indigenous low cost dextranase for use in cane sugar production to derive qualitative and commercial advantage. With SBIRI funds, a project was undertaken by M/s Varuna Biocell Pvt Ltd, Varanasi to develop a process for production of dextranse from *Penicillium aculeatum* using solid state fermentation. The company is engaged in manufacture of industrial enzymes, bio-bleaching system, bio-surfactants, alcohol, herbal drugs & food supplements.

As a part of the project, the company has modulated a strain to produce viable yields of dextranase. Another objective of the project was to standardize downstream processing for cost effective extraction and formulation of dextranase for industrial application. The company consistently produced 10 batches of enzymes at 30 liter scale. The enzyme was characterized to suit industrial application. Further optimization of the formulation resulted in a stable ready-to-use formulation *Dextrasol* which is suitable for industrial application. *Dextrasol* was successfully applied at plant level deriving cost and qualitative advantages. The company has also developed dextranase in powder form with higher activity and higher shelf life.

Results of Dextrasol application trial in Sugar Plant at Shahunagar

A dose of 3500 µ/ gm @5ppm of mixed sugar cane juice was used

1. Dextran hydrolysis was appx. 45%.
2. Starch hydrolysis was appx. 85% at clear juice and 50-60% at massecuites/molasses level.
3. Mixed juice to clear juice purity rise was 1.01 unit as compared to control 0.60 unit.
4. Drop in final molasses purity was 1.97 unit.
5. Recovery rise was 0.04%.
6. Exhaustion at C/massecuites level was improved.
7. Viscosity and stickiness of C/massecuites and final molasses was very less during enzyme application.
8. Colour of sugar was improved.

The project was mentored through its progress by Dr Sanjay Nene, National Chemical Laboratory, Pune; Late Dr Vinod Bhakuni, Central Drug Research Institute, Lucknow and Dr Suchita Ninawe, DBT, New Delhi. The project was reviewed regularly by SBIRI-TSC.

The company has projected Dextranase with enzymatic activity more than 4000 u/gm at a price of Rs. 900 per kg at commercial level as compared to imported dextranase from large multinational companies which costs more than Rs. 2000 per kg at importer/distributor level. ●

Phytase For Aquaculture & Poultry – *Palkofeed*

Development of a Cost Effective Process for Phytase Production and its Application Studies

M/s Maps Enzymes Ltd, Ahmedabad

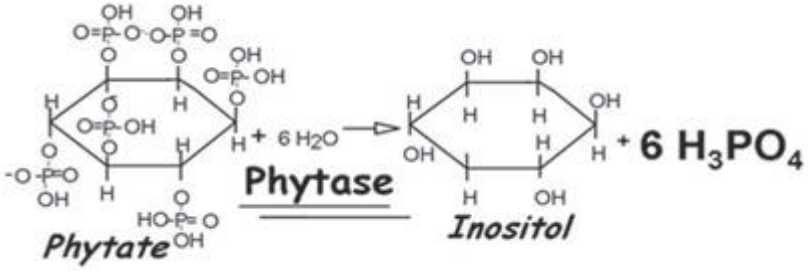
Phytases are phosphatase enzymes that catalyze the hydrolysis of phytic acid (myo-inositol hexakisphosphate), an indigestible, organic form of phosphorus found in grains & oil seeds and releases a usable form of inorganic phosphorus. Research in the field of animal nutrition has supported the idea of supplementing feed with phytase so as to release phytate-bound nutrients like calcium, phosphorus, other minerals, carbohydrates and proteins, resulting in reduction or elimination of inorganic phosphate supplementation to animal feed. Studies have shown a reduction of up to 30% in the phosphorus levels found in pig manure when phytase is added to animal feed. These results have greatly increased the demands for phytase.

With support under SBIRI, M/s Maps Enzymes Ltd, Ahmedabad have developed a cost-effective technology for production of phytase. It is a pioneering biotechnology company producing enzymes with focus on non-GMO based technologies.

Primary objective of the project was to obtain hyper-producing strain of *Aspergillus ficuum* through mutagenesis. Solid state fermentation process at pilot scale was optimized to get 157 IU/gm of phytase using the selected mutant of *A. ficuum*. This resulted in development of the product *Palkofeed PHY 5000*. Beneficial effects of the enzyme formulations as a feed supplementation in aquaculture and poultry have been demonstrated.

Palkofeed PHY 5000 supplementation at 500 FTU per kg diet with 35% crude protein led to improvement of growth, dry matter and crude protein digestibility in *P. pangasius* fingerlings. Supplementation of 500 FTU of phytase per kg corn-soyabean diet can reduce NPP level to 0.12% in the layer diet without affecting laying performance and resulting in a significant reduction of phosphorus excretion.

The project was guided by Dr G P Agarwal, Indian Institute of Technology, New Delhi; Dr Amit Ghosh, *National Institute of Cholera and Enteric Diseases*, Kolkata and Dr A K Rawat, DBT, New Delhi through on-site reviews as SBIRI-PMC members, in addition to expert mentoring from SBIRI-TSC. ●



Value Added Products – *Pelrich*

Novel Methods of Isolation of Biochemicals from Crustacean Exoskeleton

M/s Pelican Biotech & Chemical Labs, Kuthiathode

The market for chitin and its derivatives is growing at a rate of 5% annually. The market size is estimated at around 1000 MT/month in India and around 10000 MT a month globally. Astaxanthin, a powerful anti-oxidant is one of the front runners in the nutraceutical industry. Keeping this in view, SBIRI support was provided to a start-up company M/s Pelican Biotech & Chemical Labs, Kuthiathode to develop a process for obtaining value added products using shrimp industry waste. The company that was started as a small lab to process prawn waste, is now growing as a biotech company and operating in the areas of biopolymers, nutraceuticals and agricultural inputs.

The project was aimed at development of high quality chitin and astaxanthin from prawn wastes. A novel protocol that included two demineralization processes with an intermediate deproteinization process was developed and this was found to be efficient for yielding best quality chitin, chitosan and astaxanthin. The company has developed chitin and chitosan as packaged products that are now being marketed. Further work on standardization of granulation process for astaxanthin production is going on.

In a different component of the project, fish processing effluent carrying organic matter and other proteinaceous material was successfully used to develop compost with high nitrogen content using coir pith. The work resulted in the development of a new technology for manufacture of organic fertilizer. These products, being marketed as '*Pelrich plus*' and '*Pelrich planting media*', have attracted good market response as a substitute for garden soil.

The project was mentored by SBIRI–PMC experts Dr Ajit Haridas, National Institute for Interdisciplinary Science and Technology, Trivandrum; Dr C T Achuthankutty, National Institute of Oceanography, Goa and Dr Rajesh Kapur & Dr Arun Ninawe of DBT, New Delhi through on-site reviews and also through regular reviews by SBIRI-TSC.

The company continued its efforts on the treatment of effluent and has succeeded in developing a zero pollution method of treating shrimp industry waste. SBIRI support has been extended to a new project by the company to demonstrate the process in states of Kerala and Tamil Nadu. ●

Antihyper-Lipidemic Formulations– *LipiChek*

Development of Lipid Lowering Phytoformulations

M/s T. Stanes & Co. Ltd, Coimbatore

Once considered a problem associated with populations of developed countries, obesity and obesity-related complications such as metabolic syndrome are rapidly spreading around the globe. Obesity has been shown to contribute to high serum cholesterol, low HDL cholesterol and hyperglycemia, all of which increase the chances of cardiovascular disease. With support from SBIRI, M/s T Stanes & Co Ltd, Coimbatore took up development of a phyto-formulation to inhibit Acetyl CoA Carboxylase (a key enzyme in fatty-acid biosynthesis) and to investigate mechanisms to make the formulation exert its hypolipidemic/ hypotriglyceridemic effect in humans. The company is engaged in manufacturing and marketing of ayurvedic medicines, green tea, phytochemicals, biofertilizers & biopesticides, plant extracts, antioxidants, etc.

Based on the proof-of-concept that was developed, ten different formulations with potent constituents were evaluated for their effectiveness through *in vitro* studies and expression in hepatic cell lines, followed by animal model studies. The formulations that showed lower levels of formation of malonyl CoA formation (a key metabolite in the regulation of fatty acid synthesis through *in vitro* analysis) were taken up for *in vivo* studies. Using both *in vitro* and *in vivo* models, it was observed that the formulation prevented atheroma, induced plaque regression, decreased serum and lipid fractions & improved the antioxidant levels and excretion of cholesterol.

The evaluation of the *Acetyl CoA Carboxylase* inhibitory activities provided a non-invasive tool for screening a large number of plant constituents and assessing their anti-hyper-lipidemic properties. It was noted that the product Phyto-formulation–I that was developed for targeting the enzyme *Acetyl CoA carboxylase*, significantly lowered the level of triglycerides compared to cholesterol and hence could serve as an adjuvant to the existing

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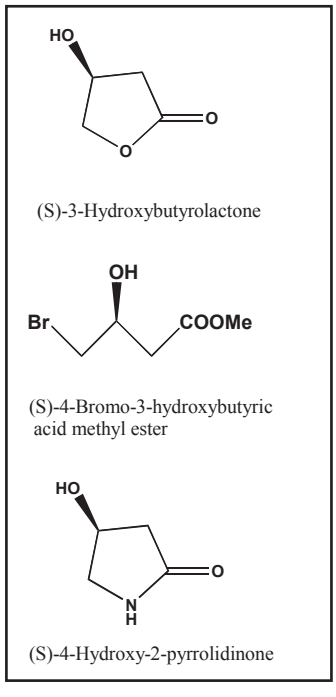
Drug Intermediates From Biomass

Processes for Manufacture of (S)-3-Hydroxybutyrolactone From Biomass and (S)-4-Hydroxy-2-pyrrolidinone Therefrom

M/s Bharavi Laboratories (P) Ltd, Bangalore

Production of (S)-3-hydroxybutyro-lactone is of industrial importance because it has certain unique features. This included a 4-carbon unit with a chiral centre and three chemical functionalities that could make it a versatile starting point for a variety of high-valued products, particularly the cholesterol reducing drugs, statins (for example, Atorvastatin) with a sales of USD 20-25 billion annually. The configuration of the chiral centre (S)-3-hydroxybutyro-lactone is the same as in the statins.

Utilization of the vast biomass generated in the country has largely been towards manure or energy. Going away from this approach, the project supported under SBIRI at M/s Bharavi Laboratories (P) Ltd, Bangalore envisioned the development of new processes for manufacture of high value-added products from biomass. The company is involved in a research-based technology & product development and caters to the needs of the pharmaceutical industry.



(S)-3-Hydroxybytrolactone and Products

In the project, use of maltodextrin as raw material helped in standardization of the alkaline hydrogen peroxide oxidation and prior treatment of maltodextrin with the enzyme pullulanase, that selectively cleaved 1.6-linked glucose units in maltodextrin and improved the yield of the desired (S)-3-hydroxybutyrolactone appreciably. Most commercial products of (S)-3-hydroxybutyrolactone are reddish brown viscous liquids while the product made under this project had a light straw color. This was achieved by removing of large volumes of water using azeotropic distillation with toluene which minimized the exposure of the product to high temperature and also prevented the product from coming in contact with air. The product obtained in the present process is of such a high quality that it could be used for most purposes without high-vacuum distillation. Conversion of (S)-3-hydroxybutyrolactone to (S)-4-hydroxy-2-pyrrolidinone, a key intermediate for the manufacture of several pharmaceutical products could be achieved by making the versatile intermediate, (S)-4-bromo-3-hydroxybutyric acid methyl ester and treating with ammonia, thus avoiding the use of large volumes of the dangerous sodium azide and hydrogenation.

The company has estimated the cost of the product to be approximately USD 500/kg.

SBIRI-PMC experts Dr S Chandrasekaran, Indian Institute Science, Bangalore ; Dr Anju Chadha, Indian Institue of Technology, Chennai and Shri Arvind Duggal & Shri S L Govindwar of DBT, New Delhi guided the project. SBIRI-TSC mentored the project through progress reviews.

Synthetic Curcumin

Large Scale Production of Curcumin-Piperoyl Conjugates

M/s India Pesticides Ltd, Lucknow

Turmeric has been used historically as a spice in Indian cuisine. It is also a prominent component of ayurvedic system of medicine. Curcumin, an active component of turmeric is the agent responsible for most of the biological activity of turmeric. Curcumin has been demonstrated to exert anti-inflammatory, antibiotic and anti-cancerous influence in various disease models and cell-lines.

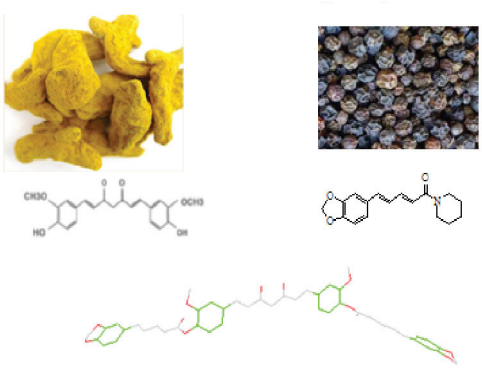
SBIRI project supported to M/s India Pesticides Ltd, Lucknow was aimed to prepare different conjugates involving piperine and curcumin. With its focused R&D effort in the recent past, the company has improved the process conditions for existing products resulting in their better quality. It has also developed process conditions for other agrochemicals with large usage levels.

Dietary curcumin exhibits poor bioavailability. Numerous approaches for increasing curcumin bioavailability have been explored including the use of adjuvants like piperine, which interfere with glucuronidation. Piperonyl derivatives are known to improve bio-efficacy of curcumin absorption *in vivo* making it an important area of research. There is an immense potential in India for preparation of these conjugates and their use in therapeutical formulations or liposomal drug delivery systems. In its efforts under the project, the company developed a pure synthetic curcumin on a large scale (3kg/batch, 20 kg was prepared of 99% purity) and also used it to synthesize different conjugates. The method of extraction of piperine from black pepper was standardized and piperine was converted into piperoyl chloride and conjugated to sodium salt of curcumin to obtain dipiperoylcurcumin. It has also synthesized different curcuminoids such as demethoxycurcumin, bis-demethoxy and tetramethoxycurcumin. All the final synthesized products were analyzed using NMR and other stereoscopy techniques.

Dr P K Seth, Biotech Park, Lucknow; Dr Rakesh Maurya, Central Drug Research Institute, Lucknow and Dr Mohd Aslam, DBT, New Delhi guided the company as part of SBIRI-PMC. SBIRI-TSC also did regular progress reviews.

The company is working further on the SBIRI project leads. The bioactivity of the synthesized compounds is being tested in cell-lines and animal model to enhance the applicability of these conjugates. ●

Optimization for Large Scale Synthesis of Curcumin Di-O-Piperoyl Ester



Expression Systems for Heterologous Proteins

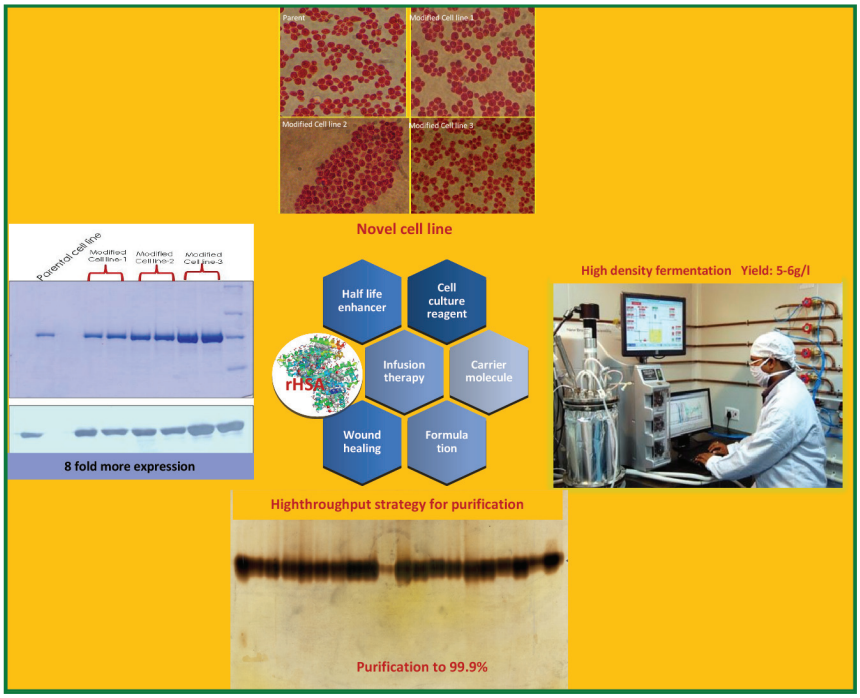
Development of Platform for Production of Complex Peptides and Proteins

M/s Navya Biologicals Pvt Ltd, Bangalore

Circumventing the bottlenecks in recombinant protein expression especially those involving multiple disulphide bridges, cystine knots or bridges between non-consecutive cysteine residues has been, for long, of significant interest to researchers. Human serum albumin (HSA), which has 17 disulphide bridges, is difficult to produce optimally in unmodified yeast. Similarly, prethrombin-2, the precursor to thrombin, has a complex secondary structure that has been difficult to produce in microbial systems.

In this SBIRI project, M/s Navya Biologicals Pvt Ltd, Bangalore worked on the hypothesis that over-expression of three key chaperones, involved in three different but critical points, in the secretory pathway, would lead to substantial enhancement in the secretion of two heterologous proteins, especially those containing multiple di-sulphide bridges. The company has expertise in the area of recombinant protein expression and has embarked on the production of therapeutic proteins.

The company optimized the expression system for producing HSA and prethrombin-2 in *Pichia pastoris* and succeeded in expressing the same while co-expressing three chaperones. The expression level of recombinant HSA was improved upon optimization. The efforts to optimize expression level of prethrombin-2 are underway. The project provided an efficient expression vector for production of recombinant HSA. With process optimization using a fermenter, this strain can be a potential source for commercial production of recombinant HSA. Another project has been sanctioned to the company to further optimize production and purification of recombinant HSA and recombinant human thrombin in yeast.



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Silkworm Expression System

Expression of Peptidyl Amidase and Aprotinin in Baculoviral Systems and Development of Silkworm as a Bioreactor

M/s EnZene Biosciences Pvt Ltd, Bangalore

Silkworm expression system is an inexpensive alternative for the expression of proteins through insect cell culture systems and can be used to produce commercially important proteins. There are several proteins such as globulin and albumins which are expressed at high concentrations in silkworm.

With support through SBIRI, M/s EnZene Biosciences Pvt Ltd, Bangalore has been able to develop a promising platform to produce therapeutically important antibodies. It is a start-up company that offers a host of products (fine reagents, PCR solutions, research & industrial enzymes, diagnostic reagents, teaching aids) and contract research services to the biotechnology and pharmaceutical industry.

The focus of the project was to establish inexpensive silkworm bioreactors to express genes cloned in BmNPV based baculoviral vectors. The advantage in this approach is that instead of cell cultures, insect larvae are used for large scale production of proteins. The company successfully established a silkworm expression system and validated it using peptidyl amidase and aprotinin proteins. With the SBIRI funds, cell culture and silkworm rearing & infection facilities were established by the company. They developed *bac-to-bac* BmNPV cloning system for the expression of genes in silkworm and also characterized the Bm16 cell-line. These cell-lines were adapted to a serum free medium to generate the recombinant BmNPV. Bm16 cell-lines were characterized for wild type BmNPV infection and transfection efficiency using GFP plasmids. The success of this project has also helped the company to establish AcNPV expression platform that has already been successful in landing and executing several contractual projects. It is now in a position to establish partnership arrangements with a big company for collaborative research.

This project was guided by Dr J Nagaraju, *Centre for DNA Fingerprinting and Diagnostics*, Hyderabad; Dr K M Ponnuvelu, Central Silk Board, Bangalore and Dr Mohd Aslam, DBT, New Delhi as SBIRI-PMC members. SBIRI-TSC also undertook reviews for bringing the work to a logical conclusion.

The company is now optimizing the system to scale up of Peptidyl-glycine Alpha-amidating Monooxygenase gene production and achieve its commercialization.

Silkworm rearing and infection facility

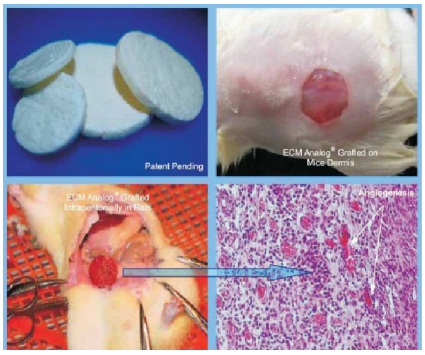
3D Cell Culture Wares

Novel Tissue Engineering and Three Dimensional Cell Culture Technology

M/s ExCel Matrix Biological Devices (P) Ltd, Hyderabad

Current limitations in the area of regenerative medicine/tissue engineering and stem cell applications can be largely attributed to lack of cell interactive biomaterials for *in vitro* culture of desired cell types. With support through SBIRI, M/s ExCel Matrix Biological Devices (P) Ltd, Hyderabad in collaboration with National Institute of Immunology, New Delhi undertook a project aimed at developing novel tools for cell culture. This includes three dimensional cell culture ware as an alternative to current methods based on glass or flat plastic surfaces. To begin with, the company optimized the process of development of three dimensional cell interactive biomaterial and analyzed its physico-chemical properties. Biological properties like cell matrix interactivity and cell functionality were studied. This led to development of two specific applications namely, 3D cell culture (Dot-Cult® & Confo-Cult®) commercial prototypes and tissue engineering (PMc®) proof-of-concept prototypes. EMBDL has also developed a customizable extracellular matrix to serve as a porous scaffold for specific type cell culture *in vitro* and *in vivo.*

Sol-Cell-Gel® developed by the company is a cell therapy modality in form of a injectable formulation of extracellular matrix with desired cells that gel in situ localizing cells at the site of injury unlike injecting cell suspension that spreads cells all over. It can potentially create tissues on demand on site by tissue specific ECM mixture with cells isolated by enzymatic treatment from the donor site/ site of injury within a short time. A proof-of-principle has been demonstrated under the SBIRI project. Apart from these, three-dimensional constructs



ECM Analog® : For specific type cell culture

of skin cells (epithelium and fibroblast) and cartilage were also developed and chondrocytes demonstrated as tissue engineering prototypes using ECM Analog® technology.

The technical mentoring by SBIRI-PMC experts Dr Arbinda Choudhuri, Indian Institute

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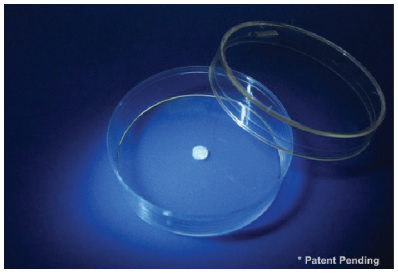
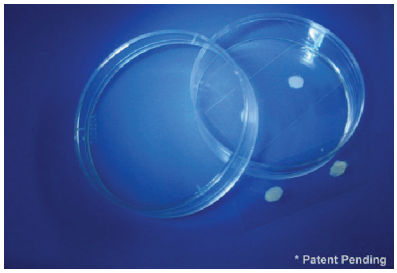


Dot-Cult® : A convenient device for routine 3D cell culture



Confo-Cult®: A device for confocal microscopy of 3D cell cultures

PMc®: Porous Microcarrier for large-scale cell culture, cell therapy and tissue engineering solutions

Antihyper-Lipidemic Formulations–*LipiChek*

Contd. from pg. 43

antihyper-lipidemic drugs, or even as a stand alone therapy, depending on the enormity of the condition. Adjunctive and combination therapy are becoming increasingly widespread as a means to achieve a comprehensive control of deranged lipid levels. In addition, the alleviation of HDL levels and risk factors like myofibrillar degeneration, plaque formation and atherosclerotic lesions in the treated group are significant findings of this project.

SBIRI-PMC experts Dr S P Thyagarajan, Chennai; Dr D C Katoch, Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), New Delhi and Dr George John, DBT, New Delhi mentored the project through on-site reviews. SBIRI-TSC guided the company throughout the implementation of the project .

The present market for allopathic segment is heavily skewed with a few companies accounting for 80% of the sales. However, the range of products in the lipid management class is relatively limited at present. This includes *HMG-CoA reductase* inhibitors (statins), fibrates, bile acid sequestrants, nicotinic acid-based products and cholesterol absorption inhibitors. The results of this collaborative project imply that the Phyto-formulation I tested for its anti-hyperlipidemic activity has the potential for treatment of hyperlipidemia, exerting its actions through the mechanism of inhibiting *Acetyl CoA Carboxylase* activity and by intestinal absorption. It is a safe alternative to the existing drugs which have undesirable side effects.

The company is on its way to commence production and test marketing of *Lipi-Chek* tablets for hypercholesteroloemia and hypertriglyceridemia and *LipiChek* herbal tea for management of dyslipidemia, after obtaining requisite product licenses. ●

Expression Systems for Heterologous Proteins

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The company foresees an opportunity for rh-Albumin in the formulation, cell culture and therapeutic market. Global market for therapeutic HSA today is estimated to be Rs 7000 crore and growing steadily at 5% per annum. Recombinant HSA, though more expensive at the moment, is safer and has already been approved for use with vaccines. As per the company's management team, rh-Albumin in the market is developed at productivity levels of upto 5-6 g/l at fermentation level. The company hopes to exceed these yields in order to be in a position to favorably compete in the market. Also, it is aiming to generate value by the platform through IPs, exports to regulated markets and develop other molecules using this platform.

The success of the project was guided by SBIRI-PMC experts Dr Rup Lal, University of Delhi, Delhi; Dr P N Rangarajan, Indian Institute of Science, Bangalore and Dr K K Tripathi, DBT, New Delhi through on-site reviews and also by SBIRI-TSC.

Interestingly, this project also marks the success of a woman scientist in the field of entrepreneurship. SBIRI support has enabled the company to significantly expand its operations as well as enhance its expertise in generating products with strong commercial potential. ●

S.No.	Organisation(s)	Short Title	PMC Experts
1	Anthem Biosciences Pvt. Ltd., Bangalore	Extracellular production of industrial enzymes	Dr Sanjay S Nene, NCL, Pune, Dr A K Panda, NII, New Delhi and Dr Suchita Ninawe, DBT, New Delhi
2	Aumgene Biosciences Pvt. Ltd., Surat	Cloning and expression of recombinant Lipase enzyme	Dr Bharat B Chattoo, MSU, Baroda, Dr Subhash Chand, IIT, New Delhi and Dr Suchita Ninawe, DBT, New Delhi
3	Bioorganics and Applied Materials Pvt Ltd., Bangalore	Deuterium labeling of molecules for drug discovery	Dr Chandrasekharan, IISc, Bangalore, Dr Aruna Korde, BARC, Maumbai and Shri Arvind Duggal, DBT, New Delhi
4	Codon Biotech Pvt Limited, Noida	Bioconversion of glycerol, into 1,3 propandiol,	Dr T Satyanarayana, UDSC, New Delhi, Dr G P Agarwal, IIT, New Delhi and Dr Kakali Dey Dasgupta, DBT, New Delhi
5	GVS Biotech Pvt. Ltd., Bangalore,	0-calorie natural sweetener from stevia	Dr G J Samathanam, DST, New Delhi, Dr Sanjay Nene, NCL, Pune and Dr K S Charak, DBT, New Delhi
6	Hi Tech BioSciences India Ltd., Pune in collaboration with Indian Institute of Technology, Mumbai	Nitrilase catalyzed bio-transformation processes	Dr Sanjay Nene, NCL, Pune, Dr A K Panda, NII, New Delhi and Shri Arvind Duggal, DBT, New Delhi
7	I Cube Nanotec India Pvt. Limited, Noida in collaboration with Institute of Microbial Technology, Chandigarh	Conversion of lactose and glucose based feedstocks to Butanol	Dr G P Agarwal, IIT, Delhi, Dr A K Panda, NII, New Delhi and Dr Rajalakshmi Muralidharan, DBT, New Delhi
8	Jay BioZyme Technologies, Pune in collaboration with University of Delhi South Campus, New Delhi	Pectinase for retting of plant fibers	Dr R V Gadre, NCL, Pune, Dr Y S Shouche, NCCS, Pune and Dr Kakali Dey Dasgupta, DBT, New Delhi
9	Myko Tech Private Limited, Goa in collaboration with Asthagiri Herbal Research Foundation, Chennai	Biopolymerization of active principles from medicinal plants using laccasse	Dr R C Kuhad, UDSC, New Delhi, Dr Aparna Dixit, JNU, New Delhi and Dr Suchita Ninawe, DBT, New Delhi
10	Navya Biologicals Pvt Ltd., Dharwad	Recombinant human serum albumin and thrombin in yeast	Dr P N Rangarajan, IISC, Bangalore, Dr V V Suryanarayana, IVRI, Bangalore and Dr T S Rao, DBT, New Delhi

S.No.	Organisation(s)	Short Title	PMC Experts
11	Pelican Biotech & Chemical Labs (P) Ltd, Alappuzha, Kerala	Zero discharge processing of shrimp wastes	Dr Sanjay Nene, NCL, Pune, Dr A K Panda, NII, New Delhi and Dr Arun Ninawe, DBT, New Delhi
12	Privi Organics Private Limited, Navi Mumbai	Enzyme catalyzed manufacture of esters	Dr Padma V Devarajan, ICT, Mumbai, Dr N S Punekar, IIT, Mumbai and Dr Suman Govil, DBT, New Delhi
13	Proalgen Biotech Limited, Chennai	Biodiesel from algae	Dr G P Agarwal, IIT, Delhi, Dr K B Ramachandran, IIT, Chennai and Dr George John, DBT, New Delhi
14	Sri Surya Anjaneya Industries, Vishakhapatnam	Microbial process for beta carotene production	Dr Ahmed Kamal, IICT, Hyderabad, Dr L B Shukla, RRL, Bhubaneswar and Shri Arvind Duggal, DBT, New Delhi
15	Sugen Life Sciences Pvt. Ltd., Tirupati	Special feed/ diet for experimental animals	Dr P B Seshagiri, IISC, Bangalore, Dr Ramesh C Juyal, NII, New Delhi and Dr Suchita Ninawe, DBT, New Delhi
16	Transgene Biotek Ltd., Hyderabad	Optimization of orlistat production	Dr Sanjay S Nene, NCL, Pune, Dr Vikram Sahai, IIT, Delhi and Dr Suchita Ninawe, DBT, New Delhi
17	Varuna Biocell Pvt. Ltd., Varanasi	Large production of Dextranase	Dr R C Kuhad, UDSC, New Delhi, Dr Sanjay Nene, NCL, Pune and Dr Suchita Ninawe, DBT, New Delhi

3D Cell Culture Wares

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of Chemical Technology, Hyderabad ; Dr A K Panda, National Institute of Immunology, New Delhi and Shri Arvind Duggal & Dr Alka Sharma of DBT, New Delhi was beneficial in moving the project forward. Regular reviews by SBIRI-TSC was a major guiding force for the company.

As indicated by the company, their commercial focus is towards development of hemostatic and wound healing applications involving nano-porous collagen/chitosan etc. created by using high internal phase emulsion process. It also has plans to make in situ injectable gel for novel tissue engineering therapy. The company hopes to partner/license out the 3D cell culture ware technology/product to appropriate parties and foresees scaling up of the application of its technology ECM Analog® from research use to therapeutic products development in coming years. ●

Targeting System For CT Guided Procedures

Commercialization of PIGA – Tool Positioner for Use in Image Guided Interventional Procedures

M/s Perfint Healthcare Pvt Ltd, Chennai

Every suspected case of cancer needs to be investigated and diagnosis confirmed using a biopsy procedure. Chances of survival are closely linked to the stage at which disease is detected. If diagnosed and treated early, the survival rates can be as high as 85% even after 15 years of diagnosis. However, early stage investigation and treatment faces the challenge of dealing with small size of early stage lesion.

A project was supported under SBIRI to M/s Perfint Healthcare Pvt Ltd, Chennai to work further based on pilot feedback on their patented product PIGA, a platform of medical tool positioners for use in image guided interventional procedures. The company is a world leader in planning and targeting solutions for image guided interventional procedures with an emphasis on oncology and pain care.

Validation results have indicated that the PIGA enables the radiologist to accurately access the tumor/lesion even if it is 5 mm in size. There are several other new possibilities that require accurate positioning of a tool inside the human body without extensive surgery, where PIGA can be effectively used. With almost 12 million cancer cases being reported annually all over the world, making available an affordable early stage intervention tool would help save a large number of lives. With this mission, the project

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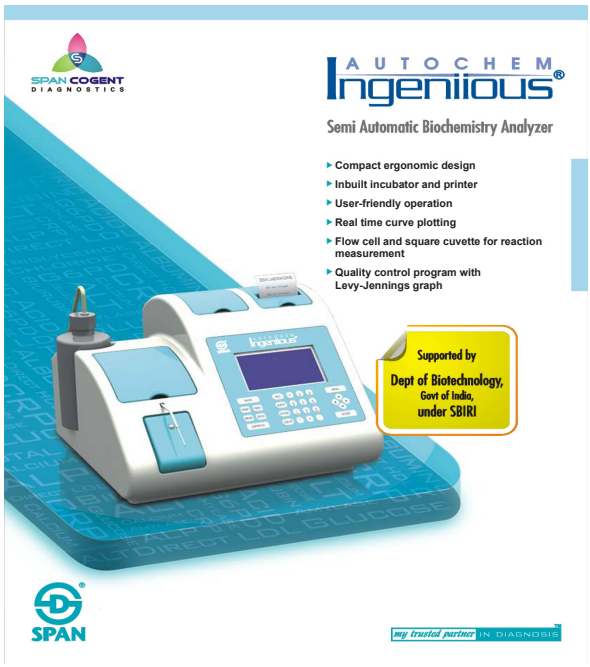
Clinical Chemistry Analyzer – *Autochem Ingenious*

Manufacturing and Commercialization of a Low Cost and Reliable Clinical Chemistry Analyzer

M/s Span Diagnostics Ltd, Surat

Expansion of medical diagnostic services is essential for any country to meet its growing healthcare needs. Clinical analysers are critical for laboratories that offer diagnostic services. Development of an affordable improved version of clinical analyzer was taken up by M/s Span Diagnostics Ltd, Surat, which is a pioneering Indian company in the field of lab diagnostics. The project was co-ordinated by a woman entrepreneur with a team of professionals having competence in Electronic Design, Mechanical Design, Software Development and Testing.

At the very start, a prototype of the clinical chemistry analyzer was developed, which was followed up by testing and redesigning the analyzer to improve performance and reliability and reduce costs. The newly designed analyzer was named as *Autochem Ingeniious*®.



A pilot batch of 15 analyzers was produced, with each analyzer consisting of about 1200 components, of which some 300 components were unique. Three analyzers were allotted for concurrent embedded software development and testing. The remaining twelve analyzers were used for evaluation to compare performance with commercially available Indian and imported benchmark analyzers and spectrophotometer. The analyzers were under evaluation through field trials for a period of more than one year. There was no failure or any adverse report about reliability. The results obtained on *Autochem Ingeniious*® with blood samples were compared with benchmark analyzers. Accuracy and precision were found to be at par or better than benchmark analyzers. Customer feedback from field trials was obtained and further design improvements were made in the product.

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Pilot Batch Evaluation

Diagnosis of Acute Kidney Injury

Development of MEMS Based Sensor for Neutrophil Gelatinase Associated Lipocalin

M/s Bigtec labs, Bangalore

Neutrophil Gelatinase Associated Lipocalin (NGAL) is an early biomarker for kidney dysfunction and appears within two hours of acute kidney injury (AKI). It is released during chronic kidney injury (CKI) also. This makes the detection of NGAL very important from a clinical perspective. The project supported under SBIRI at M/s *Bigtec Labs, Bangalore* aimed at developing a fluorescence polarization based immune assay (FPIA) for NGAL as well as a hand-held FPIA instrument. The company has capabilities in design, fabrication and testing of micro electromechanical systems (MEMS) and hand-held electronics, genomics, proteomics, biology and chemistry.

Currently the kits used to monitor NGAL levels are imported. The requirement of this assay in Bangalore itself is for about 2000 tests/week corresponding to 300-500 surgeries/week. Currently available tests take about 20-30 min to give results. Given the fact that a typical kidney surgery is of three hour duration and NGAL levels have to be monitored a minimum of 3 times, the usage of NGAL assay is impacted due to the time required for each assay.

Under the studies supported by SBIRI, a working prototype of FPIA was developed with a detection limit of 1 ug/ml with polyclonal antibodies. The instrument's efficiency was compared with Thermo Appliskan Multimode Reader and its performance optimized with 2, 4-D pesticide which is a calibrated standard. The FPIA results can become available in less than 2 minutes as compared to ELISA, or any other clinical method, which requires 20-30 minutes. The FPIA instrument was transformed from the desktop-set-up to stand-alone-set-up. The company has also developed NGAL monoclonal antibodies and is now in the process of achieving the clinically acceptable detection limit of 100 ng/ml with monoclonal antibodies. The company plans to transform the set-up into a chip based system through miniaturization and automation of the whole NGAL assay before taking it to the market.

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Working Prototype of FP Instrument

Multi Deck Shaker

Research, Design, Engineer and Manufacture Multi Deck Shaker

M/s Scigenics Biotech Pvt Ltd, Chennai

Large scale production of cells is a primary requirement in many microbiological processes that seek to develop an industrial product through biotech route. Machining systems with specifications that can facilitate microbial cultivation are often required to address specific needs in R&D and production processes.

The project supported under SBIRI at M/s Scigenics Biotech Pvt Ltd, Chennai aimed at development of a multi deck shaker with an extended smooth orbital motion at different RPMs to facilitate uniform and large growth of cells while minimizing cell shear. The company is an ISO 9001:2008 certified company and has, till date, installed over 2700 units of their ORBITEK® brand of shakers in India and abroad.

As a first indigenous attempt to design and manufacture a multi deck shaker having variable amplitude with speed, temperature and gas purging, the project was implemented by a team of engineers with expertise in mechanical engineering, instrumentation and bioprocess technology. To achieve project objectives, the company worked on several important engineering aspects of design and manufacturing aimed at minimizing the product tare, eliminate vibration, improving structural stability and weight to strength ratio. A twin locational dynamic counter balancing system with enhanced moment of inertia (for smooth running at all amplitudes irrespective of platform loading level) was developed. The air flow and distribution system was also optimized for maintenance of uniform temperature inside the chamber for the entire range.

Multi-deck Shaker in operation

Before launching the product in the market, a fully functional prototype that followed CE norms for electrical insulation and safety was displayed at an exhibition held on in December, 2011 at CCMB, Pune.

The project was mentored by Dr Vikram Sahai, Indian Institute of Technology, New Delhi; Dr K B Ramachandran, Indian Institute of Technology, Chennai and Shri Arvind Duggal, DBT, New Delhi as SBIRI-PMC members through on-site reviews. Additionally, the company benefited through technical mentoring by SBIRI-TSC.

The indigenously manufactured *ORBITEK® Multi Deck Shaker* was launched commercially in 2012. SBPL expects to sell more than 20 units by 2014-2015 at an estimated cost of Rs. 15 lakhs per unit. The company enjoys the lead in India for this novel product, though some international companies are also in the market.

Microcarrier Culture With Perfusion Technology

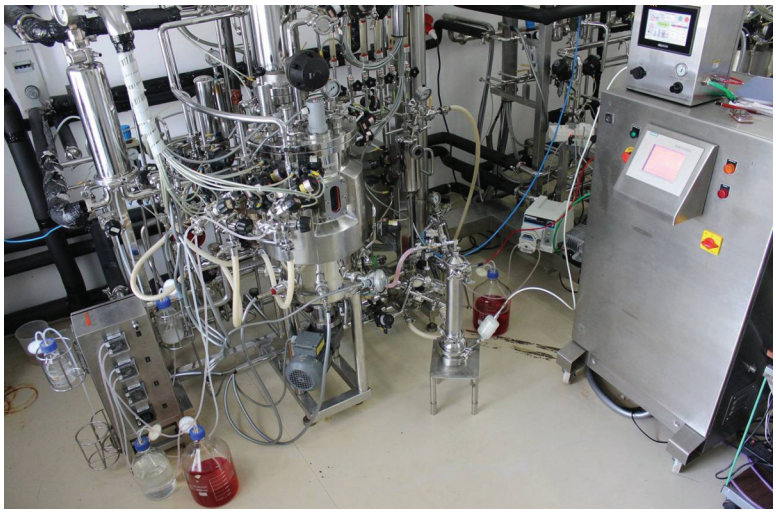
Development of Platform Technology for Culture of Adherent Cells on Microcarriers

M/s Bangalore Biotech Labs Pvt. Ltd., Bangalore

Cell culture techniques are a very important component of biotechnology. They help create the basic material for production of many biopharmaceuticals of therapeutic and/or diagnostic significance. This includes viral vaccines, monoclonal antibodies and polypeptide growth factors. Under the SBIRI umbrella, M/s Bangalore Biotech Labs Pvt Ltd, Bangalore took up the development of a process for culturing adherent cells using micro-carriers and as a follow-up thereafter design and build automated bioreactors for culturing adherent cells in suspension. It is an ISO 9001:2008 certified bioprocess engineering organization involved in manufacture of bioprocess equipment, consultancy services, manpower training and bioprocess research.

The principle behind the project was that use of micro-carriers enables large-scale culture of anchorage-dependent animal cells that is efficient, practical and economical. Growing cells on micro-carriers provides a variety of benefits leading to improved yields, reduction in serum/ media costs, less risk of contamination, and truncated number of handling steps. Micro-carrier cell culture technology provides an optimized environment for anchorage-dependent animal cell culture. However, high costs and lack of expertise in process engineering has limited the access to this technology in the developing world. .

To develop a platform technology for the growth of adherent cells on micro-carrier beads, a beginning was made with 75 X10^6 cells from 100 ml spinner flask (working volume of 50 ml) and scaled up to 271×10^9 cells in 125 bioreactor (working volume of 60 L) in 3 scale up stages. Next step was to establish optimum seeding concentrations, stirring speed, feeding time, trypsinisation and harvesting for 5 L culture. Depletion of nutrients and accumulation of metabolites were identified as limiting factors for continuous maintenance of the cells. To overcome these, perfusion culture technique was adopted with a micro-carrier system. The automation needs identified during the 5 L, 40 L and 125 L bioreactor trials drove the process automation efforts. Based on these efforts, the company is ready to commercialize the bioreactor with ATF perfusion system. While there are other micro-carrier based bioreactors available in the market, addition



Perfusion trials in 40 L Bioreactor with ATF System

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Automated Dispensing System – *Rapidec*

Development of Automated Bio-instruments viz. Dispensing System and Cell Counter

M/s Customised Technologies Pvt Ltd, Bangalore

Automated dispensing systems and cell counters have a significant role in biomedical research and industry. SBIRI support to M/s Customised Technologies Pvt Ltd, Bangalore allowed it to launch its efforts in the field of biotechnology with a definite focus. Set by a group of young entrepreneurs, it is a vertically integrated, R&D intensive company engaged in design, development and manufacture of a wide range of products in the areas of precision mechanics, electronics, embedded systems, optics, application software, automation and robotics.

With SBIRI support, the company demonstrated innovation to develop *Rapidec*, a low cost, high precision automated dispensing system. Installed and tested at Central Electrochemical Research Institute, Karaikkudi, *Rapidec* is now ready for market launch. The company has also developed an automated cell counting system combined with dispensing for auto-sample preparation. It is under evaluation at present to determine further improvisation needs.

Given the scope for its use in hospitals and diagnostics labs across the country, the market for product being developed is large. Priced at about Rs. 7 Lacs per unit, *Rapidec* is competitively priced compared to products from international players. SBIRI linkage has helped the company initiate new R&D projects and also to grow in terms of people employed, turnover etc. It is now among the leading players in India in the niche Precision Offline Vision Measuring Systems space.

SBIRI-PMC experts Dr Anuranjan Anand, Jawaharlal Nehru Center for Advanced Studies and Research, Bangalore; Dr Utpal Tatu, Indian Institute of Science, Bangalore and Shri Arvind Duggal & Dr Alka Sharma of DBT, New Delhi provided valuable technical guidance in improving and accelerating the development process. This project is also an example of success of SBIRI-TSC in tapping young entrepreneurial talent and encouraging them to enter the biotech sector. ●

Automated Dispensing System *Rapidec* - Ready to Market

Targeting System For CT Guided Procedures

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was designed to commercialize a patented concept of PIGA. The company incorporated pre-production design and engineering changes in the existing product to make it viable to meet global requirements and standards. This resulted in the development of two variants viz. *ROBIO EX* with additional features to meet the requirements and *ROBIO EZ*, an economic variant for diagnostic centers.

ROBIO EX provides clinicians with the ability to plan and validate a wide range of interventional procedures. It is a CT guided robotic positioning system that assists with fast and accurate tumor targeting and tool placement for abdominal and thoracic interventions, including biopsy, FNAC, pain management, drainage and tumor ablation. It offers several useful features that help clinicians to target the tumor and plan for accurate tool placement for diagnosis or therapy. It can be used for targeting and tool placement in deep seated lesions requiring orbital or crano-caudal angulation, or a combination of both. *ROBIO EX* reduces the number of needle punctures, check scans, procedure time, patient pain and radiation exposure. *ROBIO EZ* is a low cost variant with reduction of packing size and foot print but with overall architecture similar to PIGA for predictable performance and risk.

Dr G Sridhar, Christian Medical College, Vellore; Dr Raju Sharma, All India Institute of Medical Sciences, New Delhi and Dr T S Rao, DBT, New Delhi mentored the project as the members of SBIRI-PMC through on-site reviews. Also SBIRI-TSC monitored the progress regularly during implementation.

The products *ROBIO EX* and *ROBIO EZ* have been commercialized following the standard guidelines in accordance with licensing/ certification processes for respective countries. The company anticipates recovering its investment through sale of 650 units in India and abroad over the next three years. ●

Clinical Chemistry Analyzer – *Autochem Ingenious*

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The company benefited from the project monitoring and mentoring by SBIRI-PMC experts Dr B D Malhotra, National Physical Laboratory, Delhi; Dr Rakesh Aggarwal, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow and Dr R R Sinha, DBT, New Delhi who continuously guided the project in achieving the milestones. SBIRI-TSC provided expert advice to the company from time to time.

In India, there is a market for about 1800 units of semi-automatic clinical chemistry analyzers of the category of *Autochem Ingeniious*® per year. Outside India, the market is for about 8000 semi-automatic analyzers per year. There are only a few manufacturers of semi-automated chemistry analyzers in India. *Autochem Ingeniious*® would be a unique analyzer which is economical and fully packed with all the advanced features. Globally there are about 50 other companies manufacturing such analyzers.

Autochem Ingeniious® is expected to be marketed at less than Rs. 1 lakh per piece as indicated by the company. This provides a comparative price advantage with regard to imported machines. Further cost reduction will be achieved with increased volumes and long term indigenization of some modules. The company is considering bringing out additional products based on the successful outcome of this project. ●

S. No.	Organisation(s)	Short Title	PMC Experts
1	Adler Mediequip Pvt. Ltd., Pune	Development of locked bone plating system	Dr Shantikumar V Nair, AIMS, Kochi, Dr Rajesh Malhotra, AIIMS and Dr Garima Gupta, DBT, New Delhi
2	Erkadi Systems, Bangalore	Low cost blower/ BLDC Motor ICU Ventilator	Mr D S Nagesh, SCTIMST, Trivandrum, Dr C M Manjunath, Sri Jayadeva Instt of Cardiology, Bangalore, Dr L M Bhardwaj, CSIR, Chandigarh and Dr Manish Rana, DBT, New Delhi
3	Genomix Molecular Diagnostics Pvt. Ltd., Hyderabad in collaboration with Birla Institute of Technology & Science, Pilani, National Institute of Malaria Research, New Delhi, National Institute of Malaria Research Field Station, Jabalpur, Osmania University, Hyderabad	Hand-held diagnostic point of care instrumentation to detect malaria	Dr Pawan Malhotra, ICGEB, New Delhi, Dr Harpal Singh, IIT, Delhi and Dr T S Rao, DBT, New Delhi
4	MediVed Innovations Pvt. Ltd., Bangalore	Implantable drug eluting cardiac pacing leads	Dr Shantikumar V Nair, AIMS, Kochi, Dr K Sarat Chandra, NIMS, Hyderabad, Dr K M Paknikar, ARI, Pune, Dr L M Bhardwaj, CSIO, Chandigarh, Dr C V Muraleedharan, SCTIMST, Thiruvananthapuram and Dr O N Tiwari, DBT, New Delhi

Diagnosis of Acute Kidney Injury

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The assay as described above could prove to be a game-changer by replacing currently used diagnostic tools for detection of NGAL. It could replace creatinine monitoring as NGAL has a higher clinical relevance to kidney malfunction.

The project was mentored by SBIRI-PMC experts Dr S K Agarwal, All India Institute of Medical Sciences, New Delhi; Dr Vivekanand Jha, Post Graduate Institute of Medical Education and Research, Chandigarh and Shri Arvind Duggal, DBT, New Delhi through on-site reviews. Additionally, SBIRI-TSC guided the company regularly through its reviews during the implementation of the project. ●

Microcarrier Culture With Perfusion Technology

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of perfusion system to the bioreactor gives the company a unique niche in the market.

The company received technical guidance of SBIRI-PMC members Dr Sanjay Nene, National Chemical Laboratory, Pune; Dr Jayant Modak, Indian Institute of Science, Bangalore and Dr Niloo Srivastava, DBT, New Delhi. SBIRI-TSC also mentored the project through regular progress reviews. ●

APPENdices >

SBIRI Committees

Apex Committee of SBIRI (ACS)

ACS is an inter-ministrial committee that makes recommendations on policy issues and projects to be supported under the scheme. It has 15 government ministries/departments/ associations represented on this. ACS was first constituted in October 2005 and has been reconstituted four times since then. The tenure of the present ACS is upto 31 August 2013. The committee met 18 times till now.

As Secretary, DBT, Dr M K Bhan is the Chairman of ACS with Prof. G Padmanaban as the Co-Chairman. Dr. N. K. Ganguly, Adviser, Translational Health Science and Technology Institute, (Ex-DG, ICMR), New Delhi and Dr V. S. Chauhan, Director ICGEB, New Delhi have contributed as Experts. Shri S. B. Krishnan, Former Secretary, Technology Development Board has participated as Finance Expert.

Ministries/departments/associations Represented on ACS

Ministry of Health & Family Welfare, New Delhi	Ministry of Micro, Small & Medium Enterprises, New Delhi
Department of Agriculture and Co-operation, New Delhi	Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), New Delhi
Department of Chemicals & Petrochemicals, New Delhi	Department of Commerce, New Delhi
Department of Pharmaceutical, New Delhi	Department of Science & Technology, New Delhi
Planning Commission, New Delhi	Technology Development Board, New Delhi
Council of Scientific and Industrial Research, New Delhi	Indian Council of Medical Research, New Delhi
Federation of Indian Chambers of Commerce and Industry, New Delhi	Confederation of Indian Industry, New Delhi
	All India Biotech Association, New Delhi

Technical Screening Committee (TSC)

Chaired by Prof G. Padmanaban, Indian Institute of Science, Bangalore, TSC comprises of eminent scientists from different fields of biotechnology. TSC was first constituted in October 2005 and has been reconstituted four times since then. It met 45 times so far. Present tenure will be over 24th Oct 2012. Scientists who have served on TSC from time to time are listed below.

Members

Dr. G.P. Agarwal Indian Institute of Technology, New Delhi	**Dr. S.V. Alavandi** Central Institute of Brackishwater Aquaculture, Chennai
Dr. Jayesh Bellare Indian Institute of Technology, Mumbai	**Late Dr. Vinod Bhakuni** Central Drug Research Institute, Lucknow
Dr. P. A. Loka Bharathi National Institute of Oceanography, Goa	**Dr. Rakesh Bhatnagar** Jawahar Lal Nehru University, New Delhi

Dr. Shinjini Bhatnagar Translational Health Science and Technology Institute, Gurgaon	**Dr. G.S. Bhuvaneshwar** Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram
Dr. Tapan Chakraborty National Environmental Engineering Research Institute, Nagpur	**Dr. S. Chandrasekhar** Indian Institute of Chemical Technology, Hyderabad
Dr. Anil Chatterjee National Institute of Oceanography, Goa	**Dr. Bharat B. Chattoo** Maharaja Sayajirao University of Baroda, Baroda
Dr. Ravi Dhar National Institute of Immunology, New Delhi	**Dr. Lalit Garg** National Institute of Immunology, New Delhi
Dr. C.M. Gupta Central Drug Research Institute, Lucknow	**Dr. D. Karunagaran** Indian Institute of Technology, Chennai
Dr. V.M. Katoch Central JALMA Institute for Leprosy and Other Mycobacterial Diseases, Agra (Now DG, ICMR)	**Dr. Navin Khanna** International Centre for Genetic Engineering and Biotechnology, New Delhi
Dr. Jitendra P. Khurana University of Delhi South Campus, New Delhi	**Dr. Subeer S. Majumdar** National Institute of Immunology, New Delhi
Dr. HemantaK. Majumder Indian Institute of Chemical Biology, Kolkata	**Dr. Rita Mulherkar** Advanced Centre for Treatment, Research & Education in Cancer, Navi Mumbai
Dr. Sanjay Nene National Chemical Laboratory, Pune	**Dr. K. M. Paknikar** Agharkar Research Institute, Pune
Dr. A. K. Panda National Institute of Immunology, New Delhi	**Dr. Bhushan Patwardhan** Institute of Ayurveda and Integrative, Bangalore (Now at Symbiosis International University, Pune)
Dr. Deepak Pental University of Delhi South Campus, New Delhi	**Dr. Hemant Purohit** National Environmental Engineering Research Institute, Nagpur
Dr. K.B. Ramachandran Indian Institute of Technology, Chennai.	**Dr. P. N. Rangarajan** Indian Institute of Sciences, Bangalore
Dr. Ch. Mohan Rao Centre for Cellular and Molecular Biology, Hyderabad	**Dr. Rama Rao** National Institute of Pharmaceutical Educational and Research, Mohali
Dr. A.R. Reddy Yogi Vemana University, Cuddapah	**Dr. Vanga Siva Reddy** International Centre for Genetic Engineering and Biotechnology, New Delhi
Dr. Girish Sahni Institute of Microbial Technology, Chandigarh	**Dr. G.J. Samathanam** Department of Science and Technology, New Delhi
Dr. K. Satyanarayana Indian Council of Medical Research, New Delhi	**Dr. T.R. Sharma** Indian Agricultural Research Institute, New Delhi
Shri Dinesh Sharma Technology Development Board, New Delhi	**Dr. Yogesh S. Shouche** National Centre for Cell Science, Pune

Dr. Kavita Singh International Centre for Genetic Engineering and Biotechnology, New Delhi	**Dr. S.K. Sopory** International Centre for Genetic Engineering and Biotechnology, New Delhi.
Dr. V.V. S. Suryanarayana Indian Veterinary Research Institute, Bangalore	**Dr. Nikhil Tandon** All India Institute of Medical Sciences, New Delhi
Dr. Akhilesh Tyagi University of Delhi South Campus, New Delhi	**Dr. M. Udayakumar** University of Agricultural Sciences, Bangalore

Special Invitees

Dr. L. M. Bhardwaj Central Scientific Instrument Organisation, Chandigarh	**Dr. Alok Bhattacharya** Jawahar Lal Nehru University, New Delhi
Dr. Vinod Raina All India Institute of Medical Sciences, New Delhi	**Dr. Polani B. Seshagiri** Indian Institute of Sciences, Bangalore
Dr. Sudhanshu Vrati National Institute of Immunology, New Delhi	

DBT Scientists who participated in ACS/TSC

Dr George John, Sr. Adviser	**Dr BM Gandhi**, Former Adviser
Dr VP Gupta, Adviser	**Dr Alka Sharma**, Scientist 'F'
Dr K K Tripathi, Adviser	**Dr Meenakshi Munshi**, Scientist 'F
Dr KS Charak, Adviser	**Dr AKRawat**, Scientist 'E'
Shri Arvind Duggal, Adviser	**Dr Kalaivani Ganesan**, Scientist 'C'
Dr Bindu Dey, Adviser	**Dr MS Shashi Kumar**, Scientist 'B'
Shri K. P. Pandian, Former JS & FA**, Smt Anuradha Mitra**, JS & FA and **Shri Sanjay Goel**, Director participated as Finance Experts from the department.	
Dr Suchita Ninawe, Scientist 'F' acted as Member Secretary of ACS and TSC.	

Site-visit Expert Teams

On-site visits of Expert Teams to the companies to undertake in-depth evaluation of the shortlisted proposals and to do financial due-diligence is an important step in the evaluation process of SBIRI. The SBIRI Division has conducted such 313 site-visits so far. For each project, a separate team comprising of 2-3 area experts, a representative of DBT-SBIRI and BCIL-Finance. (Earlier in some of the cases, YES Bank had participated in financial due diligence of the projects.)

Project Monitoring Committees (PMCs)

Each project supported under SBIRI is monitored by a separate PMC. So far 119 such PMCs have been constituted comprising of 2-3 area experts, a representative of DBT and BCIL-Finance. These committees mentor the projects through their half yearly on-site visits to the companies.

M/s Bejo Sheetal Seeds Pvt Ltd, Jalna	
Publication	B. Mazumdar, P. Naphde, A. Mali, N. Kunchge, S. Agrawal. 2012. 'Effect of *Bt cry1Fa1* gene on target insect, non target insect and economic benefit of Brinjal'. Presented at South East Asia Vegetable Symposium, held at Chaing Mai, Thialand in January 2012. (*Received Best Poster Award*)

M/s Bharat Biotech International Ltd, Hyderabad	
Publication	N Bhandari, P Sharma, S Taneja, T Kumar, T Rongsen-Chandola, M B Appaiahgari, A Mishra, S Singh, S Vrati and Rotavirus Vaccine Development Group, 2009, 'A Dose-Escalation Safety and Immunogenicity Study of Live Attenuated Oral Rotavirus Vaccine 116E in Infants: A Randomized, Double-Blind, Placebo-Controlled Trial', *J Infect Dis,* 200 (3): 421-429.
Patent filed	Patent Application No. : PCT/IN2010/000041 (PCT) Date of Filing: 25.01.2010 Title: "A composition useful as Rotavirus Vaccine and Method therefor."

M/s Bharat Serums and Vaccines Ltd, Mumbai	
Recognitions	Obtained a place amongst the Top 10 companies in the Women's Health Portfolio in 2012 as per AWACS AIOCD. Received 'Frost & Sullivan India Healthcare Excellence Awards 2012' as Fastest-Growing Indian Biotechnology Company of the Year.

M/s ExCel Matrix Biological Devices (P) Ltd, Hyderabad	
Publications	R C Dutta, A K Dutta, 2010, 'Comprehension of ECM-Cell dynamics: A prerequisite for tissue regeneration', *Biotechnol Adv*, 28: 764-769. R C Dutta, Aroop K Dutta, 2009, 'Cell-interactive 3D-scaffold: Advances and Applications', *Biotechnol Adv,* 27(4):334-339. R C Dutta, A K Dutta, 2012, 'ECM analog technology: a simple tool for exploring Cell-ECM dynamics', *Front Biosci*, 4:1043-1048.
Patents filed	Patent Application No.: S20120094372 (US) Date of Filing/ Publication: Published on 19th April 2012 Title: "Ex Vivo Cell Culture: Enabling Process and Devices" Patent Application No.: 1468/DEL/2007 (India) and US20090017092 Date of Filing/ Publication Indian patent filed in July 2007 US patent published on 15th Jan 2009 Title: "Novel Class of Cell-Interactive Material and Process of Preparation of Artificial Tissues of Human and Animal Origin"
Recognitions	Awarded of 'DST-Lockheed Martin India Innovation Growth Program 2009' for its ECM Analog Technology. Received 'Indo-UK expansion Award, 2012' of University of Nottingham and IIT Kanpur jointly for ECM Analog technology.

M/s Frontier Lifeline Pvt Ltd, Chennai		
Publications	S Guhathakurta, S Verghese, V Balasubramanian R Agarwal, B S Murthy, S Veerappan, P Padmaja, K M Cherian, 2006, 'Technique to process xenogenic tissues for cardiovascular implantation – preliminary report', *Curr Sci*, 91(8): 1068-1073. S Guhathakurta, V Balasubramanian, B V R Tata, B Anathakrishnan, S Veerappan, R Balasundari, K M Cherian, 2008, 'Thrombogenicity studies of three different variants of processed bovine pericardium', *Inno Tech Bio Medicine,* 29:223-230. R Balasundari, R Gupta, S Veerappan, S Arumugam, K M Cherian, S Guhathakurta, 2007, 'Complete microb free processed porcine grafts for clinical use', *Indian J Thora Cardiovas Surg*, 23:240-245. C Radha, R Balasundari, S Veerappan, K M Cherian, N Vijaya, S Guhathakurta, 2007, 'Cytotoxicity and Sensitization Studies of Processed Porcine Xenografts', *Indian J of Thora Cardiovas Surg*, 23:245-248. A S Ramayyan, S Guhathakurta, K M Cherian, A T Pezzella, 2009, 'Indigenous decellularised Jugular Venous Valved Conduit in TruncusArteriosusrepair', *Euro J Cardiotho Surg*, 35:196. R Balasundari, M Santosh, G Satish, K M Cherian, S Guhathakurta, 2012, 'Cross-linked Acellular Saphenous Vein for Small-Diameter Vascular Graft', *Asian Cardiovas Thora Annals, (In Press).*	
Patents filed	Patent Application No.:	76CHE07(5.51) (India)
	Date of Filing/Publication	7th September 2007
	Title:	"A Method of Processing of Xenografts"
	Patent Application No.:	2221CHE/07 (G.136) (India)
	Date of Filing/Publication	9th April 2009
	Title:	"A treated Amniotic membrane and a method of treating amniotic membrane"
	Patent Application No.:	2222/CHE/07 (G.137) (India)
	Date of Filing/Publication	9th April 2009
	Title:	"A small diameter vascular graft from processed cadaver saphenous vein"
	Patent Application No.:	US 2012/0029655 A1 (US)
	Date of Filing/Publication	14th October 2010
	Title:	"An implantable xenograft prepared from non-human tissue portion"

M/s Healthline Pvt Ltd, Bangalore		
Patent granted	Patent No.:	245840 (India)
	Date of Grant	03-02-2011
	Title	"A silk-protein based bilaminate film for wound healing and method of preparing the same"

M/s Imgenex India Pvt Ltd, Bhubaneswar	
Publications	J Akhtar, V Mallaredy, J Dandapat, P Maiti, S K Sahoo, S Singh, 2012, 'PEGylation of an osteoclast inhibitory peptide: Suitable candidate for the treatment of osteoporosis', *Inter J Pharmaceutics.*, 434(1-2):429-36.
Recognition	Received the title "BioSpectrum Asia Pacific Emerging Company of the Year 2011" by BioSpectrum Asia, Singapore for its innovative discovery in osteoporosis therapy.

M/s Lead Invent Technology Pvt Ltd, New Delhi	
Recognition	Received the title "BioSpectrum Asia Pacific Emerging Company of the Year 2011" by Biospectrum Asia, Singapore for its innovation research on Tuberculosis.

M/s Millennium Exports, Chennai	
Publications	K Rahman, 2009, 'Oh Fish!', *Buddy Life*, 1:27. K Rahman, 2007, 'Fish leather prospects and problems', *Sea Queen*, 1 (8): 29 – 32.

M/s Oriental Aquamarine Biotech India Pvt Ltd, Coimbatore	
Publication	V J Rejish Kumar, V Joseph, R Vijai, R Philip, I S Bright Singh, 2011, 'Nitrification in a packed bed bioreactor integrated into a marine recirculating maturation system under different substrate concentrations and flow rates', *J Chem Tech Biotech*, 86(6): 790 - 707.

M/s Oxygen Healthcare Research Pvt Ltd, Ahmedabad	
Publications	J K Singha, A Solankia, R C Maniyara, D Banerjeea, V S Shirsathb, 2012, 'Rapid Equilibrium Dialysis (RED): An In-Vitro high-throughput screening technique for plasma protein binding using human and rat plasma', *J Bioequiv Availab*, 4(3): 134 J K Singh, A Solanki, V S Shirsath, 2012, 'Comparative in-vitro Intrinsic Clearance of Imipramine in Multiple Species Liver Microsomes: Human, Rat, Mouse and Dog', *J Drug Metab Toxicol*, 3(4):1. J K Singh, R C Maniyar, V S Shirsathb, 2012, 'Development of time-resolved fluorescence based [Eu]-GTP binding assay for selection of human Histamine 3 receptor antagonists/inverse agonist: a potential target for Alzheimer's treatment', *Annals of Neurosci*, 19(2):71-75.

M/s Pelican Biotech & Chemical Labs, Kuthiathode		
Patents filed	Patent Application No.: Date of Filing/Publication Title: Patent Application No.: Date of Filing/Publication Title:	No. 115 3/ CHE / 2008 (India) 09-05-2008 "A process for extraction of astaxanthin using acetone, which assists in effective dehydration and preservation of fresh prawn shell" NO. 449 / CHE / 2009 (India) 24-02-2009 "Novel pre-composted organic manure/soil less planting media packed in bio-compostable plastic"

	Patent Application No.: Date of Filing/Publication Title:	NO. 1576 / CHE / 2010 (India) 01-06-2010 "Novel method of dehydration of substances by solvent extraction and novel method of solvent recovery by Radio Frequency / microwave assisted heating"
	Patent Application No.: Date of Filing/Publication Title:	No. 3714 / CHE / 2011 (India) 31-10-2011 "Novel aerobic composting of solid and liquid organic matter using lingo-cellulosic materials and lignolytic microbes"
	Patent Application No.: Date of Filing/Publication Title:	No. 3715 / CHE/ 2011 (India) 31-10- 2011 "Novel chitin- based or demineralised dehydrated chitinaceous / crustacean exoskeleton based formulation with biopesticidal microbes for use in soil / roots as insecticides"
	Patent Application No.: Date of Filing/Publication: Title:	No. 1448 / CHE / 2012 (India) 11-04-2012 "LIVE BOUQUET
Recognition	Received 'Best Entrepreneur Award 2010' of Ministry of Small and Medium Enterprises, Government of Kerala, from the district of Alappuzha, Kerala.	

M/s Perfint Healthcare Pvt Ltd, Chennai		
Patents filed	Patent Application No.: Date of Filing/Publication: Title: Patent Application No.: Date of Filing/Publication: 8th June, 2008, 8th June, 2008, 17th April, 2008, 11th August, 2008 Title:	2918/CHE/2011 (India) 25th August, 2011 "Tool Positioning System" 1903/CHE/2006 (India), 1549/CHE/2008 (India), US20080091101 (US), PCT/IN2008/000507 (PCT) "Needle Positioner and Method"
Recognitions	Received 'Frost & Sullivan India Product Innovation Award 2009' for PIGA CT Device. Received 'Excellence Award 2009' of Institute of Economic Studies, New Delhi. Received "Indian Achievers Award for Industrial Excellence 2007" of Indian Economic Development & Research Association (IEDRA), New Delhi.	

M/s Rasi Seeds Pvt Ltd, Attur		
Patent filed	Patent Application No.: Date of Filing/Publication: Title:	No. 1152/CHE/2011 (India) 4th April 2011 "Regeneration and transformation of cassava (*Manihot esculanta Crantz.)*"

M/s Relisys Medical Devices Ltd, Hyderabad	
Publications	A Anil Kumar, P Srinivas, K Spandana, N Rama, J Vidya Sagar, 2012, 'Rapid and Sensitive HPLC Method for the Determination of Sirolimus with Ketoconazole as Internal Standard and Its Further Applications', *Inter J Pharma Sci Drug Res*, *4(1): 70-73* S Prashanth, A Anil Kumar, B Madhu, J Vidya Sagar, 2011, 'LC and LC-MS Study on Stress Decomposition Behavior of Paclitaxel and Establishment of Validated Stability-Indicating Assay Method', *Inter J Pharma Sci Drug Res*, 3(3): 188-196 Gouda Rajender, Badari Narayan, 2010, 'LC-MS/MS Method for determination of Paclitaxel Coated Drug Eluting Stents', *Asian J. Exp. Biol. Sci.,* Vol 1 (2):243-249. G Rajender, N G B Narayan, G Benarjee, E Narayana, 2010, 'A novel paclitaxel coated drug eluting 316L stents', *Inter J Pharma Bio Sci,* 1(4) : 171-181. G Rajender, N G B Narayana, 2010, 'Liquid Chromatography–Tandem Mass Spectrometry Method for Determination of Paclitaxel in Human Plasma', *Pharma Anal Acta,* 1(1):1-4. G Rajender, N G Narayanan, 2010, ' Liquid chromatography-tandem mass spectrometry method for determination of Sirolimus coated drug eluting nano porous carbon stents', *Biomed Chromato,* 24(3):329-34.

M/s Varuna Biocell Pvt Ltd, Varanasi	
Publication	S Misra, S Karan, P S Pandey, 2012, 'Techno-economical feasibility study of fungal Dextranase (Dextrasol) application at plant level in Sugar production'. Presented at Annual Conference of Sugar Asia at Bangkok in May 2012.

M/s Virchow Biotech Pvt Ltd, Hyderabad		
Patent filed	Patent Application No.:	1693/CHE/2010 (India)
	Date of Filing/Publication:	17.06.2010
	Title:	"Diluent for Solubilisation of Lyophilized proteins"

M/s Yashraj Biotechnology Ltd, Navi Mumbai	
Publication	Varsha Srinivasan, Bharat Borude, Ami Vora, Seema Pisal, Musti V. Krishnasastry, Vedang Murthy, Paresh Bhanushali and Sanjeev Kumar Gupta, 2012 'Indigenous Development of one step sandwich ELISA for quantitative estimation of total PSA (t-PSA) in serum and seminal plasma' . Presented at International Conference on Technological Challenges in Developing Affordable In-Vitro Molecular Diagnostics held at Navi Mumbai in March 2012. *(Received Second Prize)*

Road shows

The foundation of success of a scheme such as SBIRI rests, to a very large extent, on the ability of implementing agencies to ensure that maximum possible number of the targeted stakeholders are aware of the scheme and its various details.

For a country of India's size, this is easier said than done and requires a serious and focused outreach and promotional effort. It is also necessary to have interactive meetings with potential applicants to understand their concerns and resolve the same by providing related information in a first hand and direct manner as clarity on programatic aspects has a direct bearing on quality of proposals that are submitted in response.

SBIRI team of DBT made all its efforts to reach out to potential players through a series of five road-shows and two scientific meetings in various cities of India. These interctions helped in strengthening the bond between SBIRI and various constituents in the industrial sector. This has resulted in generating good projects in different sectors of biotechnology.

BANGALORE | 30th January, 2009

Venue: Conference Hall, The Taj Westend Hotel, Race Course Road, Bangalore

PROGRAMME	
Government support for innovation in Indian Biotechnology Industry	**Shri Shrikumar Suryanarayan** Association of Biotechnology Led Enterprises Bangalore
SBIRI- Meant for whom?	**Dr. George John** Department of Biotechnology New Delhi
SBIRI- How it is different from other funding schemes?	**Prof. K. Kumar** Indian Institute of Management Bangalore
SBIRI – Flexible yet efficient system	**Dr. Purnima Sharma** Biotech Consortium India Limited New Delhi
SBIRI – Trends and future direction	**Dr. M. S. Shashi Kumar** Department of Biotechnology New Delhi
Meet with successful SBIRI applicants	
Q & A Discussion Session	

*The meeting was attended by 70 participants from industry and other organizations.

AHMEDABAD | 2nd February, 2009

Venue : Canterbury Hall, The Le Meridien Hotel, Near Nehru Bridge, Ahmedabad

PROGRAMME	
Government support for innovation in Indian Biotechnology Industry	Shri Shrikumar Suryanarayan, Association of Biotechnology Led Enterprises, Bangalore
SBIRI- Meant for whom?	Dr. George John, Department of Biotechnology, New Delhi
SBIRI- How it is different from other funding schemes?	Shri Jeevan Kumar, Biotech Consortium India Limited, New Delhi
GSBTM- Fostering synergy with SBIRI scheme	Shri Akshay Kumar Saxena, GSBTM, Gandhinagar
SBIRI – Flexible yet efficient procedural mechanism	Shri Jeevan Kumar, Biotech Consortium India Limited, New Delhi
SBIRI – Trends and future direction	Dr. M. S. Shashi Kumar, Department of Biotechnology, New Delhi
Meet with successful SBIRI applicants	
Q & A Discussion Session	

*The meeting was attended by 44 participants from industry and other organizations.

Kolkata | 30th May, 2011

Venue: Taj Bengal, 34 B, Belvedere Road, Alipore, Kolkata

PROGRAMME	
Welcome and Introduction to SBIRI	Dr. George John, Department of Biotechnology, New Delhi
Fostering Public - Private - Partnership for Innovation and Technology Development	Dr. D. Yogeswara Rao, Indian Institute of Chemical Technology, Hyderabad
Role of DSIR In Promoting R&D in Indian Industry	Dr S.K. Deshpande, Department of Scientific and Industrial Research, New Delhi
Enabling Technology Commercialization Through Incubation	Ms. Deepanwita Chattopadhyay, IKP Knowledge Park, Hyderabad
SBIRI – Writing effective proposals	Dr. Purnima Sharma, Biotech Consortium India Limited, New Delhi
Biotechnology Patents	Dr. V.K. Unni, Indian Institute of Management, Kolkata
Plant Biotechnology -Challenges and Opportunities	Dr. Bharat B Chattoo, MS University of Baroda, Vadodara
Prospects of bioinformatics industry in India	Shri Pankaj Sharma, Lead Invent Technologies Pvt. Ltd., New Delhi
Interaction with SBIRI applicants	
Discussion	

*The meeting was attended by 42 participants from industry and other organizations.

Mumbai | 2nd December, 2011

Venue: The Ambassador, V. N. Road, Churchgate, Mumbai

PROGRAMME	
Welcome	Dr. George John, Department of Biotechnology, New Delhi
SBIRI - Research Opportunity Reserved For Bioentrepreneurs	Dr. Kalaivani Ganesan, Department of Biotechnology, New Delhi
SBIRI – Writing effective proposals	Dr. Purnima Sharma, Biotech Consortium India Limited, New Delhi
Role of DSIR in promoting bioentrepreneurship along with SBIRI	Shri A V Chainulu, Department of Scientific and Industrial Research, New Delhi
Incubators in the promotion of innovations	Shri Rahul Sinha, Alexandria Biotech Park, Gurgaon
Patenting innovations- Promises & Challenges w.r.t. Biotech sector	Shri N.S.Bharat, Patent Office, Govt. of India, Mumbai
Shaping the Future with SBIRI	Dr. S. K. Raina, Global Transgenes Limited, Aurangabad
Partnering with SBIRI – Views of Agri Industry	Dr. Nandkumar S. Kunchge, Bejo Sheetal Seeds, Jalna
Nurturing bioentrepreneurship through SBIRI	Dr. Vikas S. Shirsath, Oxygen Healthcare Research Pvt. Ltd, Ahmedabad
Academia-Industry Collaboration and SBIRI	Dr. Arvind Lali, Institute of Chemical Technology, Mumbai
Interaction with SBIRI applicants followed by open discussion	

* The meeting was attended by 74 participants from industry and other organizations.



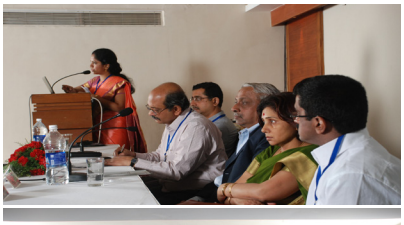



Kochi | 17th February, 2012

Venue: The Avenue Regent, 39/2026, M.G. Road, Kochi

PROGRAMME	
Welcome	Dr. George John, Department of Biotechnology, New Delhi
SBIRI - Research Opportunity Reserved For Bioentrepreneurs	Dr. Kalaivani Ganesan, Department of Biotechnology, New Delhi
SBIRI – Writing effective proposals	Dr. Purnima Sharma, Biotech Consortium India Limited, New Delhi
Role of DSIR in bioentrepreneurship development	Shri A V Chainulu, Department of Scientific and Industrial Research, New Delhi
Relevance and strategies for protecting innovations	Shri Benoy Kadavan, Kerala High Court, Kochi
Incubators in the promotion of innovations	Shri Viju Chacko, KINFRA Biotech Park, Thiruvananthapuram
Emerging Potential of Biomedical Devices in India	Dr. S. Balram, Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram
Nurturing Pioneering Ventures Through Sbiri – Our Experiences	Dr. K. Latha, T. Stanes& Company, Coimbatore
Creating wealth from waste	Dr. C. N. Manoj, Pelican Biotech and Chemical Labs, Alappuzha
Validating herbal drugs	Dr Merina Benny, Arjuna Natural Extracts Ltd., Aluva
Support for niche areas of biotechnology : experience of aquaculture	Shri Mohan Kandaswamy, Oriental Aquamarine Biotech India Private Limited, Coimbatore
Business Incubation Centre	Shri Nitin Singh, Central Institute of Fisheries Technology, Cochin
Biotech Programmes of Kerala Biotechnology Commission	A Presentation by Dr. C. Anil Kumar, Kerala Biotechnology Commission, Thiruvananthapuram

*The meeting was attended by 80 participants from industry and other organizations.



SBIRI INTERACTIVE MEET WITH LIFE SCIENCES SERVICES INDUSTRY CONCLAVE

Bangalore | 3rd April, 2012

Venue: The Atria Hotel, #1, Palace Road, Bangalore

PROGRAMME	
Welcome	Dr. George John, Department of Biotechnology, New Delhi
SBIRI Industry Meet	Prof. G. Padmanaban, Indian Institute of Science, Bangalore
SBIRI - Research opportunity reserved for bioentrepreneurs	Dr. Kalaivani Ganesan, Department of Biotechnology, New Delhi
Product is a Process and Process is a Product	Dr A. K. Panda, National Institute of Immunology, New Delhi
Inclusive growth through affordable healthcare	Dr. A. Jagannadha Rao, Indian Institute of Science, Bangalore
Novel Technological Needs in Agricultural Research for Food Security & Sustainability	Dr. V. Subramanian, Rasi Seeds (P) Ltd, Salem
Sustainable development through agriculture - Opportunities for public-private partnerships	Dr. Vanga Siva Reddy, International Centre for Genetic Engineering & Biotechnology, New Delhi
Nurturing Bioentrepreneurship through SBIRI	Dr. S. Chandrashekaran, Enzene Biosciences Pvt Ltd, Bangalore
SBIRI – Writing effective proposals	Dr. Purnima Sharma, Biotech Consortium India Limited, New Delhi
Opportunity for innovation in Bioinformatics	Dr. Pankaj Sharma, Lead Invent Technologies Pvt. Ltd, New Delhi
Open Discussion	Moderators: Dr. George John and Dr. Suchita Ninawe, DBT, New Delhi

*The meeting was attended by 71 participants from industry and other organizations.

SBIRI SCIENCE MEETING ON "RNAI PRODUCTS IN AGRICULTURE"

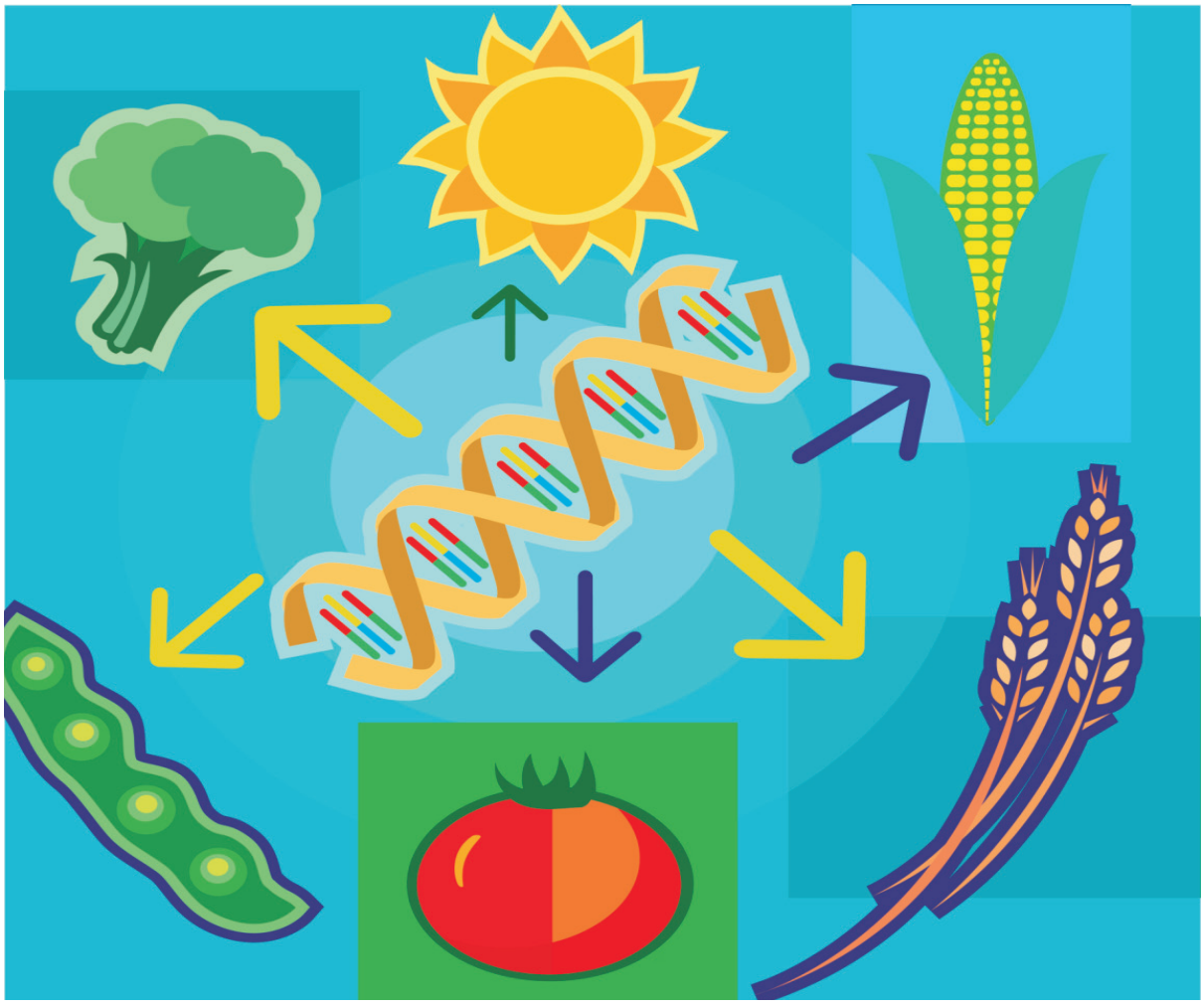
New Delhi | 12th July, 2010

Venue: International Centre for Genetic Engineering and Biotechnology, New Delhi

DBT-SBIRI Team had organized the Interactive Meet of all the stakeholders in the agriculture sector to discuss various approaches, constraints/ scopes for improvements in active research in different areas of agriculture. There was a discussion on crop protection and crop improvement methodologies, including RNAi technology.

The meeting was attended by 27 participants from industry and other organizations.

It helped the department to generate more projects under SBIRI focusing on RNAi technology for improved agriculture.



FEEDBACK

"SBIRI initiative will allow India to gain and sustain the leadership position in the areas of vaccines and other biologics. This encourages innovations and great support from research to commercialization."

S S Easwaran
Bangalore Biotech Labs Pvt Ltd, Bangalore

"SBIRI-PPP is a booster support for private industry to take high risk research programs. Also, technical mentorship to develop road map in the sensitive research areas like genetically modified crops development is one of the major advantages through SBIRI."

B Mazumdar
Bejo Sheetal Seeds Pvt Ltd, Jalna

"SBIRI–PPP initiative encouraged innovation and a time-bound process for the completion of a new vaccine by us. DBT through SBIRI, thereby, set a precedent in the development of a new biologic in India."

G V J A Harshavardhan
Bharat Biotech International Ltd, Hyderabad

"The SBIRI-PPP is an excellent initiative of DBT for companies such as ours, for fostering innovation. In addition to the funding, the companies also benefit immensely from the guidance received from the experts. That facilitate to fast track R&D projects, enabling the company to make available quality products."

Gautam Daftary
Bharat Serums and Vaccines Ltd, Mumbai

"The SBIRI scheme is conceptually excellent and very useful for promoting innovation and technology development. However, the funds provisions may be enhanced to encourage the objectives adequately."

B. Ravindranath
Bharavi Laboratories (P) Ltd, Bangalore

"It is a great idea to have the PPP–SBIRI model of DBT that helps in developing innovations into products. This model helps us to take some risks which otherwise we would not have taken."

Shama Bhat
Bhat Bio-tech India Pvt Ltd, Bangalore

"SBIRI is a great initiative for funding high risk innovative ideas. It is one of the best early stage PPP programs for start-ups in the biotech sector."

Chandrasekhar Nair
Bigtec labs, Bangalore

"SBIRI scheme of DBT is a unique effort to promote active involvement of private sector in high-risk R&D. The scheme allowed us to participate in inter-disciplinary and multi-partner research with focus on transfer of technology from lab-to-land."

Dwarkesh Parihar
Bioseed Research India Pvt Ltd, Hyderabad

"SBIRI is a great program to encourage and support small and medium sized companies to venture into innovative R&D with a real focus on developing value–added products/processes."

R A Narayanan
Customised Technologies Pvt Ltd, Bangalore

FEEDBACK

"For Enzene, SBIRI fund was like the OXYGEN at the time where none of the funding agencies were of any help. SBIRI project also helped in valuation of Enzene to align with Alkem as our strategic partner."

S Chandrashekaran
EnZene Biosciences Pvt Ltd, Bangalore

"SBIRI scheme of DBT is the earliest pioneering example to support innovations. Critical infrastructure for our innovative R&D could be availed under PPP mode. Not being complacent, we hope for equity funding in future."

A K Dutta
ExCel Matrix Biological Devices (P) Ltd, Hyderabad

"SBIRI is an excellent funding programme to develop innovative and creative products by small industries. Moreover this scheme supports the bench top research work to reach global market."

K M Cherian
Frontier Lifeline Pvt Ltd, Chennai

"SBIRI is the most innovative initiative that encourages product development by small technocrat run Cos. It confirms that private industry too, can indeed be trusted with responsible utilization of public funds."

Bharat Tandon
Healthline Pvt Ltd, Bangalore

"DBT's initiative to provide financial and technical help to the Indian Biotech Companies through SBIRI is greatly appreciable. It will definitely have a significant impact in near future and will help India flourish in Biotech sector."

Sujay Singh
Imgenex India Pvt Ltd, Bhubaneswar

"SIBRI is an excellent scheme, a platform for industry and academecia to work together and thus exploit basic sciences for application to humanity and welfare of mankind."

Krishna Misra
India Pesticides Ltd, Lucknow

"It's been a great journey through the SBIRI program. It gave a young company like ours the initial boost to do innovative research and showcase our talent to the world."

Pankaj Sharma
Lead Invent Technology Pvt Ltd, New Delhi

"We appreciate the step of the government to facilitate biotech industry through SBIRI projects. It will create opportunities for new technology based & knowledge-based businesses by science entrepreneurs with innovative ideas."

Piyush Palkhiwala
Maps Enzymes Ltd, Ahmedabad

"SBIRI-PPP initiatives of DBT is really a boon to biotech companies, when venture capital funding methods are not adequate enough for innovations based biotech companies compared to IT companies"

A Mathiyalagan
Mediclone Biotech Pvt Ltd, Chennai

FEEDBACK

"DBT's SBIRI scheme is industry friendly. The experts selected for monitoring not just evaluate the project but also participate in the project in a very cordial manner."

Kaleemur Rahman
Millennium Exports, Chennai

"SBIRI motivates development of better quality products; and we have received better acceptance for our products that are developed through SBIRI funds as compared to earlier years."

Mahesh G Shetty
Multiplex Bio-Tech Pvt Ltd, Bangalore

"SBIRI's efforts on technical mentoring through eminent scientists is very useful to know the status, where to strengthen the efforts and also to understand the difficulties in the project."

P Sateesh Kumar
Nuziveedu Seeds Pvt Ltd, Pochampally

"India needs bold and risk shared PPP initiatives like SBIRI that encourages young scientific and industrial talent to stay back in the country and contribute towards its unique and fast growing demands. Initial few successes through such initiatives will lead to an unleashing of tidal wave of innovations over the longer term."

Rajyashri K R
Navya Biologicals Pvt Ltd, Bangalore

"SBIRI is one of the finest funding programs for technology based start-up companies in India. The program helped in kick-starting the venture in the areas of product development, field level validation, product design and marketing."

Mohan Kandaswamy
Oriental Aquamarine Biotech India Pvt Ltd, Coimbatore

"SBIRI support for conceptual research in the areas which are most demanding as well as most paying in terms of its potential to generate IP for the country is appreciable. We wish this program is continued in this format to support more projects at the concept level."

Vikas Shirsat
Oxygen Healthcare Research Pvt Ltd, Ahmedabad

"We are proud to be the beneficiary of the DBT-SBIRI scheme, which supports techno- commercially sensitive projects and taps the potential of growing biotech firms."

Manoj C N
Pelican Biotech & Chemical Labs, Kuthiathode

"SBIRI has been a great source of support and guidance for growing organizations like ours through its PPP initiative."

S Nanda Kumar
Perfint Healthcare Pvt Ltd, Chennai

FEEDBACK

"It has been wonderful experience to work with SBIRI - DBT: Inputs from Experts and Scientists has been very useful to achieve the target."

V. Subramanian
Rasi Seeds Pvt Ltd, Attur

"SBIRI-PPP initiative of DBT has enabled many companies to develop indigenous state of art facility and novel technology platforms with end to end solutions in different sectors of biotechnology matching the global standards."

N Rama Krishna Rao
Relisys Medical Devices Ltd, Hyderabad

"The singular benefit of SBIRI has been to empower us to think "We can". The SBIRI constantly mentored us to realize our true potential. The fact that SBIRI was trusting us, itself unshackled us from myopic views of an SSI and opened our vision and there was simply no looking back."

Neela
Scigenics Biotech Pvt Ltd, Chennai

"A soft loan from SBIRI along with expert mentoring helped in ensuring timely commercialization of new products developed by us which has given tremendous impetus to our R&D initiatives. SBIRI is proving to be one of the best supportive program."

Sujata Desai
Span Diagnostics Ltd, Surat

"SBIRI envisioned with a realistic approach, towards techno-economic development, and manoeuvered in a systematic, strapped and unswayed method."

K Latha
T. Stanes & Co. Ltd, Coimbatore

"SBIRI scheme is true mentoring of technopreneurs technically, financially and emotionally."

Prabhat Shanker Pandey
Varuna Biocell Pvt Ltd, Varanasi

"Considering the challenges that face the biotech industry in the development of products, I would state that SBIRI initiative is crucial for the teams that toil for years on the projects. I can openly wonder if our project would have ever been completed successfully were it not for SBIRI's timely support."

Murali Tummuru
Virchow Biotech Pvt Ltd, Hyderabad

"SBIRI is a great initiative by DBT as this encourages new entrepreneurs and scientists to convert their ideas into commercial ventures. SBIRI program helps budding companies to establish into an innovative research."

Paresh Bhanushali
Yashraj Biotechnology Ltd, Navi Mumbai

Abbreviations

ACTREC	Advanced Centre for Treatment, Research & Education in Cancer
AFM	Atomic Force Microscopy
AIDS	Acquired Immune Deficiency Syndrome
AIIMS	All India Institute of Medical Sciences
AIMS	Amrita Institute of Medical Science
AKI	Acute Kidney Injury
ARI	Agharkar Research Institute
ASD	Arterial Septal Defect
ATF	Alternating Tangential Flow
BARC	Bhabha Atomic Research Centre
BHU	Banaras Hindu University
BMS	Bare Metal Stents
BP	Blood pressure
BRL	Biosafety Research Level
BSA	Bovine Serum Albumin
Bt	Bacillus Thuringiensis
CARI	Central Avian Research Institute
CCMB	Centre for Cellular and Molecular Biology
CDFD	Centre for DNA Fingerprinting and Diagnostics
CDRI	Central Drug Research Institute
CERI	Central Electrochemical Research Institute
CFTRI	Central Food Technological Research Institute
CHO	Chinese hamster ovary
CIBA	Central Institute of Brackishwater Aquaculture
CIFA	Central Institute of Freshwater Aquaculture
CIMAP	Central Institute of Medicinal and Aromatic Plants
CKI	Chronic Kidney Injury
CLRI	Central Leather Research Institute
CMC	Christian Medical College
CMD	Cassava Mosaic Disease
CNS	Central Nervous System
CPMB	Centre for Plant Molecular Biology
CRI	Central Research Institute
CSB	Central Silk Board
CSIO	Central Scientific Instrument Organisation
CSIR	Council of Scientific & Industrial Research
CT	Computerized Tomography
CUSAT	Cochin University of Science and Technology
DBT	Department of Biotechnology
DCGI	Drug Controller General of India
DES	Drug eluting stents
DNA	Deoxyribonucleic Acid
DSC	Differential Scanning Colorimetry
DST	Department of Science and Technology
DU	Delhi University
ECM	Extracellular Matrix
ELISA	Enzyme-linked Immunosorbent Assay
EMSA	Electrophoretic Mobility Shift Assay
FDA	Food and Drug Administration
FNAC	Fine Needle Aspiration Cytology
FPIA	Fluorescene Polarization Based Immune Acid
FSH	Follicle-stimulating hormone
FTIR	Fourier Transform Infra-Red Spectroscopy
FTU	Phytase activity is expressed as “phytase units” or “FTU” /unit of feed
GFP	Green fluorescent protein
GMO	Genetically modified organism
GMP	Good Manufacturing Practice
GPCRs	G protein coupled receptors
GTP	Guanosine-5’-triphosphate
HAART	Highly Active Antiretroviral Treatment
HAS	Human Serum Albumin
HBsAg	Hepatitis B surface antigen
HCl	Hydrochloric Acid
HCV	Hepatitis C virus
HDL	High density lipoprotein
HIV	Human Immunodeficiency Virus
IAIM	Institute of Ayurveda and Integrative Medicine
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICGEB	International Centre for Genetic Engineering and Biotechnology
ICH	International Conference on Harmonization
ICMR	Indian Council of Medical Research
ICMV	Indian Cassava Mosaic Virus
ICT	Institute of Chemical Technology
IFGTB	Institute of Forest Genetics and Tree Breeding
IgG	Immunoglobulin G
IgM	Immunoglobulin M
IICB	Indian Institute of Chemical Biology
IICT	Indian Institute of Chemical Technology
IIHR	Indian Institute of Horticultural Research
IISc	Indian Institute of Science
IIT	Indian Institute of Technology
ILS	Institute of Life Sciences
IMTECH	Institute of Microbial Technology
INSTEM	Institute for Stem Cell Biology and Regenerative Medicine
ISO	International Organization for Standardization
ISU	Intensive Support Unit
IVRI	Indian Veterinary Research Institute

JALMA	Central JALMA Institute for Leprosy and Other Mycobacterial Diseases
JNCASR	Jawaharlal Nehru Centre for Advanced Scientific Research
JNU	Jawahar Lal Nehru University
LDH	Lactate dehydrogenase
LISS	Low ionic strength solution
LVPEI	LV Prasad Eye Institute
MAb	Monoclonal Antibody
MAU	Marathwada Agricultural University
MEMS	Micro Electromechanical Systems
MKU	Madurai Kamraj University
MSSRF	M S Swaminathan Research Foundation
MSU	Maharaja Sayajirao University of Baroda
NBRC	National Brain Research Centre
NBRI	National Botanical Research Institute
NCCS	National Centre for Cell Science
NCIPM	National Centre for Integrated Pest Management
NCL	National Chemical Laboratory
NEERI	National Environmental Engineering Research Institute
NGAL	Neutrophil Gelatinase Associated Lipocalin
NICED	National Institute of Cholera & Enteric Diseases
NII	National Institute of Immunology
NIIST	National Institute of Interdisciplinary Science & Technology
NIMR	National Institute of Malaria Research
NIMS	Nizam's Institute of Medical Sciences
NIN	National Institute of Nutrition
NIO	National Institute of Oceanography
NIPER	National Institute of Pharmaceutical Educational and Research
NIPHM	National Institute of Plant Health Management
NIRRH	National Institute for Research in Reproductive Health
NMR	Nuclear magnetic resonance
NMRI	National Institute of Malaria Research
NPL	National Physical Laboratory
NPP- non-phytate phosphorus	
npt II	Neomycin Phosphotransferace II
OECD	Organisation for Economic Co-operation and Development
OEM	Original equipment manufacturer
PAM- Pregnancy Associated Malaria	
PCR	Polymerase Chain Reaction
PDI	Protein disulfide isomerase
PGIMER	Post Graduate Institute of Medical Education and Research
PK/PD	Pharmacokinetic/Pharmacodynamic
PMC	Project Monitoring Committee
PSA	Prostate specific antigen
R&D	Research and development
RANKL	Receptor activator of nuclear factor kappa-B ligand
RBC	Red blood cells
RCGM –Review Committee for Genetic Modification	
RDT	Rapid Diagnostic Test
Rep gene	Replicase gene
Rh-Albumin	recombinant human albumin
RNAi- RNA interference	
RRL	Regional Research Laboratory
SAARC- South Asian Association for Regional Cooperation	
SBIRI	Small Business Innovation Research Initiative
SCET	Sahrdaya College of Engineering & Technology
SCTIMST	Sree Chitra Tirunal Institute for Medical Sciences & Technology
SEBI	Securities and Exchange Board of India
SEM	Scanning Electron Microscope
SGPGI	Sanjay Gandhi Post Graduate Institute of Medical Sciences
SLCMV	Sri Lankan Cassava Mosaic Virus
SS	Stainless Steel Stents
SSF	Solid State Fermentation
TANUVAS	Tamil Nadu Veterinary and Animal Sciences University
TB	Tuberculosis
TDB	Technology Development Board
TERI	The Energy and Resources Institute
THSTI	Translational Health Science and Technology Institute
TMC	Tata Memorial Centre
TMH	Tata Memorial Hospital
TNAU	Tamil Nadu Agricultural University
ToLCV	Tomato leaf curl virus
TRC	Tuberculosis Research Centre
TSC	Technical Screening Committee
UAS	University of Agricultural Sciences
UDSC	University of Delhi South Campus
UN	United Nations
UOH	University of Hyderabad
US	United States
VPCI	Vallabhbhai Patel Chest Institute
WHO	World Health Organization
YVU	Yogi Vemana University

Small Business Innovation Research Initiative

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