Make in India for BIO - TECH the way forward

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Make in India for
Bio - Tech
the way forward
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Foreword

India was one of the early countries that recognised the potential of biotechnology and its power to bring innovative products to solve the problems of humanity. DBT was set up in 1986 to harness this potential. In mid 2000s DBT initiated focused industry programmes that nudged the industry, in PPP mode, to invest in R&D. In 2012, DBT established BIRAC with the chief goal of developing the Indian biotechnology industry and ushering a US$100 Billion bioeconomy by 2025.

The flagship 'Make in India' programme of the Indian Government, which was launched in 2014, aims to propel manufacturing excellence in 25 sectors. Appropriately two of the sectors, pharmaceuticals and biotechnology, have been identified amongst the 25 which will impact nation's health, food and energy security and environment.

India's current strengths lie in chemistry, biology, engineering and IT. The combinatorial power of these will impact biomanufacturing especially 'High Value' bio-manufacturing in several areas identified in this report such as biosimilars, vaccines, biopolymers & bioindustrial, agribiotech and Bio-IT.

It is important to note that the concept of 'Make in India' is a continuum and begins from support to innovation across the value chain of product development- from ideation, proof-of-concept, validation, scale and commercialization. Anchoring this foundational concept, BIRAC's programmes span the product development value chain and have been successful in extending support to biotech startups, SMEs and large companies resulting in 35 products in the market.

This report has identified key areas which are of importance for achieving our targeted goals of US $ 100 billion by 2025. The Recommendation for certain Policy initiatives and actions to be taken for strengthening the ecosystem are important and we will take necessary steps as distilled in the way forward. DBT and BIRAC are committed to the success of the pioneering 'Make in India' programme through a sustained joined-up effort from all stakeholders.

Prof. K. VijayRaghavan
Secretary DBT and Chairman BIRAC

Preface

Biotechnology sector has a major role to play in the flagship 'Make in India' programme of the Government of India that was launched in 2014 since it addresses all aspects of the country's needs- be it affordable medicine, food and energy security as well as clean environment. The Department of Biotechnology (DBT) and BIRAC have set a target to achieve US$100 billion by 2025. To achieve this ambitious target, biomanufacturing in India will play a major role.

DBT has established a 'Make in India Facilitation Cell' at BIRAC with the aim of co-ordinating various activities in the realm of Make in India. This report is an outcome of our need to understand the various opportunities for India can leverage in biotechnology within the'Make in India' umbrella, the current and emerging challenges and the policy instruments needed for the way forward. The report prepared by PwC has identified key areas of growth especially in the 'High Value' Manufacturing in Biosimilars, Vaccines, Regenerative Medicine, Bio-IT, Bioplymers, Biofuels & Enzymes and Agribiotech including Secondary Agriculture.

A sustained focus to 'High Value' manufacturing along with support to innovative R&D is a 360°approach that India should embark upon. This will not only create a pipeline for novel high quality products and allow for securing of intellectual assets through patents, but also improve manufacturing processes and boost ancillary industries.

DBT along with BIRAC is committed to work alongside all aligned partners to in the endeavour to create an innovation driven biotech ecosystem and amplify the growth of Indian biotechnology to global excellence.

We hope that these recommendations would be useful to develop a Key Action Plan for achieving our desired goal of India becoming a Global Biotech Hub.

Dr. Renu Swarup
Senior Adviser, DBT and MD, BIRAC

Overview

Make in India initiative aims to spur India's economic growth by the creation of new jobs, expanding export revenues, increasing FDI inflows, substituting imports and enhancing innovation. Biotechnology industry which includes Bio-pharmaceuticals, Bio-services, Bio-Agriculture, Bio-Industrials and Bio-IT is one of the focus sectors under the Make in India initiative.

The biotechnology industry has been playing an important role through the manufacture of low-cost vaccines, contract research for bio-pharmaceuticals and helping India achieve food security by enhancing yield from India's farmlands. Government of India has set an ambitious target of US$ 100 Billion for the Biotechnology industry by 2025.

This report looks at the evolution of the Indian Biotechnology industry in the last decade. Global opportunity for various constituent segments of Biotechnology in 2025 is also detailed. Opportunities for High value manufacturing to achieve the objectives of Make in India have been identified. The report looks at challenges which India needs to address if the Global Opportunities for Biotechnology have to be realized in practice.

The report then compares and contrasts the funding options and tax and fiscal incentives available in India with nine countries viz China, Finland, Germany, Israel, Japan, Singapore, South Korea, United Kingdom and the United States of America. Specific tax and fiscal incentives which will help the growth of Biotechnology industry in India

We thank BIRAC for collaborating to bring out this report and the National and International experts who provided us inputs for the reports.

Mr. Sujay Shetty
Partner and Pharma Lifesciences Leader
PwC India

1. Introduction

In the recent economic downturn, India is a shining star in the world economy which has seen unprecedented challenges since 2008. With its prowess in information technology and technology enabled services, India has emerged as the fastest growing large economy in 2015. India looks to embark upon an 8-10% growth trajectory over the next decade.

Biotechnology is a key component of India's growth story. The Green Revolution enhanced the yield from India's farmlands and enabled us to achieve self-sufficiency in food production. The White Revolution and the use of modern animal husbandry methods helped India become a milk-surplus nation and enhance nutrition levels. The Indian pharmaceutical industry through its process innovation has made low cost manufacture of pharmaceuticals possible which has helped improve health status in India and other developing countries. India's growing energy needs especially in rural areas have been facilitated by increase in biomass based energy production.

In 2012 ABLE and DBT along with BIRAC released a Roadmap Report for India's Biotechnology industry setting an ambitious goal of USD 100 Billion revenues by the year 2025. Government of India also published the National Biotechnology Development Strategy document in December 2015 which identifies the guiding principles for growth of the Biotechnology industry in India and also the instruments through which the principles will be implemented.

Entrepreneurial skills have contributed to India's economic growth in the last 25 years. In an effort to capture and stimulate these entrepreneurial skills, Government of India launched the Startup India campaign in January 2016. This initiative aims to nurture innovation and startups in India and is expected to contribute to employment generation and economic growth. This initiative is particularly relevant for Biotechnology in India since the growth of the global Biotechnology industry has also been fueled by startups.

India's economic growth has been driven by the services sector which today contributes approximately 55% of India's GDP. Realizing the importance of manufacturing sector in India's economy, Government of India has launched the Make in India initiative in September 2014. This initiative aims to grow the manufacturing sector by 12-14% per annum leading to an increase in the contribution of manufacturing in India's GDP from 16% to 25% and creating 100 Million additional jobs by 2022. Biotechnology is one of the focus sectors in the Make in India initiative.

This report explores various tools deployed by technologically advanced countries such as the USA, UK, Japan, Germany, Singapore and Israel. The report has identified common themes across these countries.

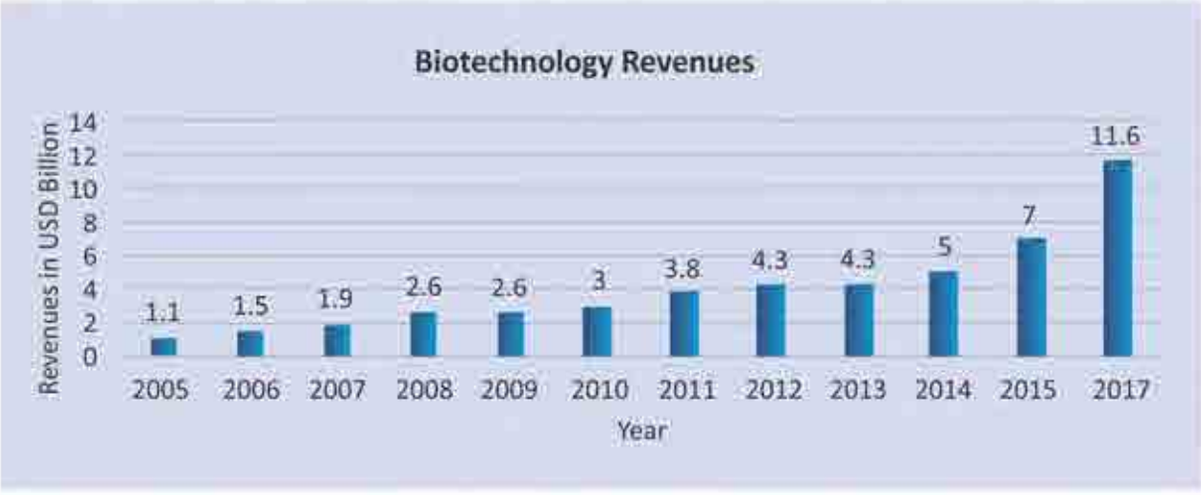
This report aims to landscape the opportunities in the Biotechnology sector in India, challenges faced by SMEs and startups, reforms needed to enhance access to capital for Indian startups and SMEs, fiscal and tax incentives to be offered by Government which will enhance Biotechnology manufacturing in India.

The report has identified major areas for high value manufacturing in the biotech sector which will propel its growth in the future.

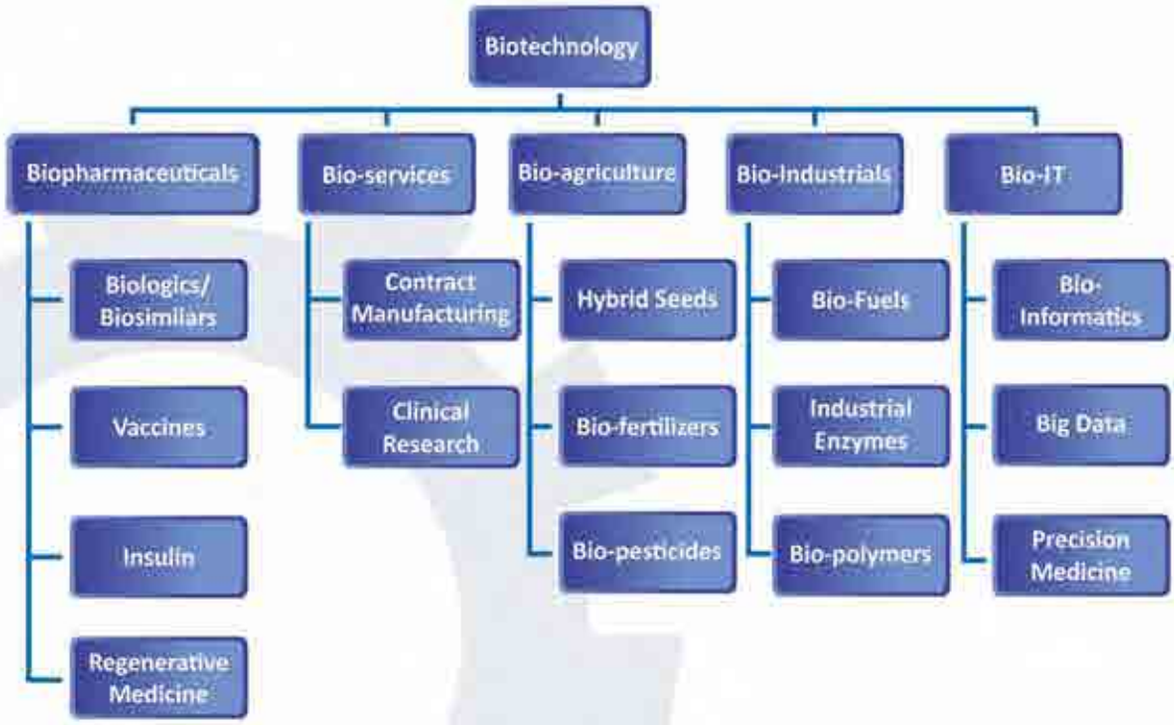
2. Biotechnology Industry: Global and Indian Landscape

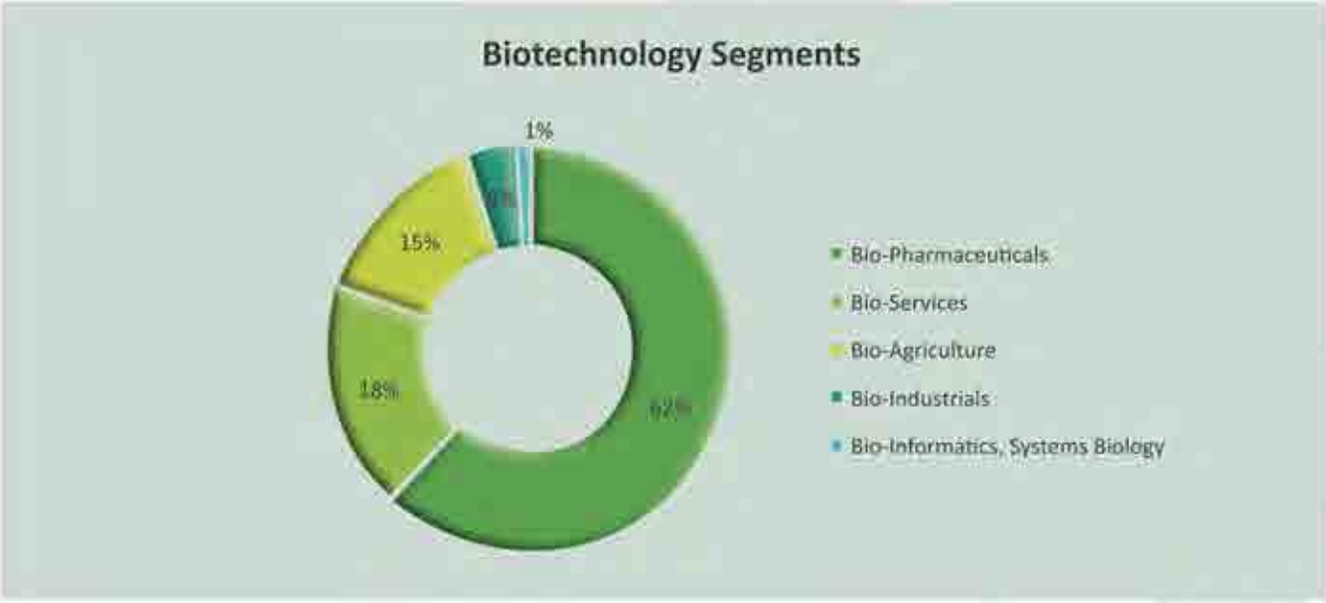
Biotechnology industry in India has been on a steady growth trajectory. From humble beginnings and USD 1.1 Billion revenues in 2005, the industry has grown to USD 7 Billion revenues at a CAGR of 20% in the last ten years and is expected to reach USD 11.6 Billion by 2017. The industry would need to shift to a higher growth trajectory (30% +) over the next 10 years to meet its ambitious target of USD 100 Billion by 2025.

The Indian Biotechnology Industry is categorized into Biopharmaceuticals, Bioservices, Bioagriculture, Bioindustrial and Bioinformatics including BioIT & Systems Biology.



Key segments in the Indian Biotechnology industry include





2.1. Bio-Pharmaceuticals

2.1.1. Bio-Similars

Market Dynamics

Globally, market from Biopharmaceutical products has grown from USD 78 Billion in 2006 to USD 179 Billion in 2014 and is expected to reach USD 278 Billion in 2020. Share of Biologic drugs in global prescription sales has also improved significantly from 14% in 2006 to 23% in 2014. Going forward biologics are expected to contribute approximately 27% to the global prescription sales in 2020. Also, the "Number of Biotech products in top 100" has been doubled between 2006 and 2014 (from 21% in 2006 to 44% in 2014). In terms of contribution to new products approved by USFDA, share of new Biologic drugs approved by USFDA was 40% in 2014.

Biosimilars constitute the biggest growth opportunity for Indian bio-pharmaceutical industry

Given the immense growth of Biologics products and payer pressures, opportunity for Biosimilars is quite evident and it has attracted variety of players in making investments in the sector which has given rise to higher competitive intensity.

Currently approximately 125 biosimilars are under development for top 5 key biologic products which are set to lose patent exclusivity. Players vying for the opportunity include Innovator companies such as Pfizer, Novartis, Merck, Amgen etc; large generic players such as Mylan, Teva, Actavis; DRL, Cipla; Emerging market players such as Biocon, DRL, Celltrion etc and other players such as Fujifilm and Samsung.

Current state of play in different markets

The US approved its first biosimilar product in March 2015 after issuing the guidelines in 2014. 12 products are expected to lose patent exclusivity in US by 2020 and biosimilars are expected to form 4%-10% of the biologics market by the end of this decade.

EU was amongst the first to issue and approve biosimilar products and till 2015 it had approved 19 biosimilar products for 9 separate branded biologic products. Going forward biosimilar for complex biologics such as mAbs are expected to drive the growth in the EU market. Japan, another developed market with important opportunity, has also approved 8 biosimilar products till now.

Biosimilars has seen higher adoption in Emerging markets such as China (350+ products) and India (50+ products) and this trend is expected to continue in the near future.

Opportunity size

Size of the Global biosimilar market is predicted to reach USD 25 Billion in 2020 and it depends largely upon the uptake of biologics in the U.S. market as it is largest market for biological drugs in the world.

- Domestic market opportunity: India has 50+ approved Biosimilar products and current market size of biologic products is USD 0.92 Billion. The Indian market for Biosimilars is expected to reach USD 2.2 Billion by 2025.
- Exports opportunity: approximately USD 70 Billion biologics drugs would go off patent between 2016 and 2020, which is a significant opportunity for exports.

Intrinsic strengths with India

Indian companies have significant experience in exporting pharmaceutical products to the regulated markets hence understand the stringent regulatory requirements, however, capturing biosimilar opportunity would require very high level of preparedness. Indian companies have already launched biosimilar products in the emerging markets and are key players in those markets e.g. DRL generated USD 94 Million between 2012 and 2015 by selling biosimilars in the Emerging markets. They have also been successful in securing partnerships with big pharma and leading generic companies for manufacturing/ development of biosimilars (e.g. Roche-Emcure, Biocon-Mylan, DRL-Merck KGaA).

Attracting investment in the sector

Given the requirements with respect to the financial, manufacturing and regulatory capabilities, this sector appears more amenable to large established players hence focus of the programs should be attracting them to invest

1. Help creating large industry parks with shared infrastructure e.g. Singapore Biopolis park where approximately 40 multinational companies have started their research operations.
2. Eliminating duty on import of large critical equipment.
3. Bringing clarity to regulatory guidelines, making the approval pathway at par with developed market pathways such as those in EU and US.
4. Making the tax incentives more relevant and attractive for Biosimilar companies. Current Incentives in manufacturing allow 100% tax exemption for first 5 years when companies don't make any profits whereas Bionexus scheme in Malaysia allows tax exemption for 10 years after company has started making profits.
5. Support for skill upgradation in the sector: Most of the courses are geared towards Science and R&D. There is a very little focus on Processes and Unit Operations, hence there is very little knowledge of manufacturing amongst job aspirants. Programs can be designed to bridge this gap. Companies can help with curriculum design and on the Job training and Government programs can support with Stipend for the students, Academia-Industry-Government partnership for these programs e.g. 'Workforce Training Fund' at Massachusetts which provides grants up to USD 100,000 to improve the skills of new or incumbent workers.

Indian companies have significant experience in exporting pharmaceutical products to the regulated markets hence understand the stringent regulatory requirements

2.1.2. Vaccines

Opportunity size

Globally vaccines are a USD 30 Billion market. The Indian vaccine market is valued close to INR 20,000 crores (approximately USD 3 Billion) with two-thirds being exported. With a growth rate of 10-15% over the next decade the Indian vaccine market has the potential to be an USD 8-12 Billion dollar industry by 2025. With 2/3rd coverage achieved under the Universal Immunization Program (UIP), there is sufficient domestic demand that needs to be catered. Apart from UIPs, penetration of optional vaccines can also be evaluated. This would require awareness drive to increase demand.

Intrinsic strengths with India

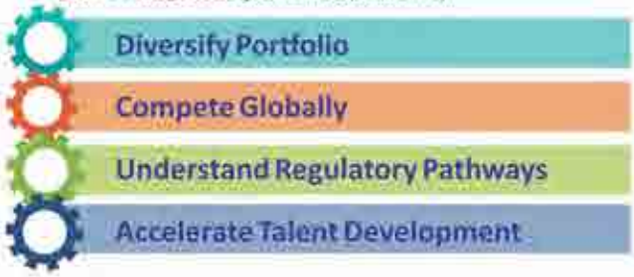
India has 12 major manufacturing facilities which manufacture vaccines which are used in 150 countries across the world. 16 vaccines manufactured by Indian companies are prequalified by WHO and exported through United Nations agencies and India is the leader in the supply of DPT and measles vaccines

Attracting investment in the sector

Apart from demand generation, there are efforts required in the following areas to increase the overall capacity and capability in the vaccine sector:

1. Diversification of vaccine portfolio to meet local and global needs

   Historically India has focused on vaccines under the immunization programs. The focus has been on volumes and low cost vaccines. But recently there are two things which India has done – developed Rotavirus vaccine and ventured into pentavalent vaccine in the Universal Immunization Program. Apart from the volume game, India also needs to strengthen its play in vaccines of future, such as IPV, Pneumococcal vaccine etc. Apart from this India needs to develop capabilities to address the immunization needs of other countries and leverage it as growth opportunity



2. Being globally competitive with emergence of new players

   With countries like China, South Korea also emerging as strong players in this market, it is important to keep the Indian vaccine manufacturing globally competitive. Regular industry government interaction is required to identify areas which can lead to potential cost increases and render Indian industry uncompetitive. Steps to reduce such risks through partnerships (Government-Government, Indian players-MNC etc), subsidies, incentives etc should be evaluated on a regular basis.

3. Regular review of Regulatory environment to ensure ease of vaccine development and manufacturing

   There have been steps taken to ease approval timelines. The potential in this sector would require a continuous review of regulatory processes in conjunction with the industry to ensure faster approval timelines for trials, products, UIP inclusion etc. Handling of Living Modified Organisms and handling bio-hazard risks also need to be strengthened.

4. Accelerate talent development in vaccinology and immunology

   A comprehensive and deep understanding of immunology is needed for implementing successful immunization programs. There is a demand-supply mismatch between the people trained in vaccinology and immunology and the available talent in India. Accelerating talent development in vaccinology and immunology is the need of the hour.

   Implementing immunization programme cannot be segregated from the 'knowledge-base' in immunology. The number of trained people in vaccinology and immunology in India is less than what country of this size requires. Globally, the practice of immunology has slowly become part of vaccinology; however, in India there is still limited focus on training in vaccinology and immunology.

2.1.3. Insulin

Market dynamics

Globally diabetes is one of the most prevalent disorders. The burden of diabetes in India is very high and increasing. It is estimated that India will have more than 100 Million diabetics by 2030. At the same time it is estimated that close to 50% of the cases are undiagnosed indicating the enormity of the problem.

Opportunity size

The global anti-diabetes market is worth more than USD 50 Billion growing at approximately 15% of which Insulin is close to USD 28-30 Billion in 2015 and is expected to reach USD 57 Billion by 2025. The anti-diabetes market of India is close to USD 1 Billion of which Insulin is worth approximately USD 250 Million. The diabetes market is growing at a CAGR of +20% and insulin market is growing at approximately 16%. With the current growth rates, the domestic insulin market has a potential to reach USD 1 Billion by 2025. However given the increase in patient population and the fact that close to 50% of the cases are undiagnosed, the domestic market opportunity is much more. At the same time, there is a significant global opportunity that can be tapped by Indian players. The recent approval of Biocon's Insulin Glargine in Japan is a positive signal in this regard.

Attracting investment in the sector

To tap the opportunity, there are few steps required to address the challenges in uptake of Insulin:

1. Reduce the cost of treatment with Insulin for patients

   Insulin (bulk or finished) is predominantly imported in India. The cost of treatment with insulin is high. Steps to reduce the cost to patient like co-pay for insulin, incentives for local manufacturing (for both domestic and global market) and reducing cost of import eliminating import duty on insulin which today attracts 10% duty in addition to counter-vailing duty (CVD), special CVD can be taken.

2. Direct research efforts to improve patient compliance

   Insulin needs to be taken on regular intervals. Research efforts in the direction of long acting insulins can increase patient treatment compliance.

3. Direct research efforts to ease storage conditions for Insulin

Insulin needs to be stored in refrigerator. Insulin stored at room temperature lasts approximately one month. Research efforts to produce insulin suitable for storage in ambient conditions can be taken.

2.1.4. Regenerative Medicine

Market Dynamics

The regenerative medicine market can be categorized into three major categories: tissue engineering, biomaterials/biomolecules, and stem cell therapy. Rise in prevalence of chronic disease is driving the demand for regenerative medicines whereas technological advances in cell therapies and scaffolds are enabling fulfilment of the demand, for example, use of tissue engineering along with 3D bio printing can prove move effective for reconstructive surgery. Ethical issues and lack of clinical data to establish the safety, quality, and efficacy of regenerative medicines are the main challenges restricting the growth of this sector.

Current state of play in US market

Gene therapy: There is no marketed product as of now but there are about 50 companies in the field of gene therapy

- Cell based immunotherapy: 1 marketed product
- Stem cell and progenitors cell-based therapeutics: 9 marketed products
- Primary cell-based therapeutics: 17 marketed products

Opportunity size

Size of market for Regenerative medicine in the US was USD 1.7 Billion in 2015 and it is expected to grow to USD 7 Billion in 2020 (CAGR approximately 33%). Stem cell banking market in India is expected to grow from USD 95 Million in 2014 to USD 473 Million in 2019

Attracting investment in the sector

1. Funding the research and development programs: As this is a research intensive field, funding research is one of the pre-requisites for driving the growth of this sector. For example, in the US, seven federal agencies led by NIH, funded USD 2.89 Billion in regenerative medicine research during the period 2012 -2014.

2. Establishing the approval pathway for newer category of products and approval of products which has a combination element e.g. biologic/device (e.g., bioartificial organs), drug/device (e.g., drug-eluting stent), drug/biologic (e.g., recombinant proteins), or drug/device/biologic (e.g., orthopedic implant with anti-inflammatory drugs and growth factors) that are combined chemically, physically, or otherwise or mixed and produced as a single entity is another critical requirement in this sector

2.2. Bio-Services

2.2.1. Contract manufacturing

Current state of play

Total biologic production capacity worldwide was estimated at approximately 2800m in 2010, 2000m of it was meant for captive use. This is expected to be augmented to approximately 3900m^3 in 2017. Industry saw some consolidation of assets/ fresh capacity creation with Boehringer Ingelheim purchasing Amgen's Fremont (CA) Biomanufacturing facility in 2011, Fujifilm acquiring Merck & Co's contract manufacturing business in February 2011 and Samsung announcing plans to create manufacturing capacity of 120m by 2017.

South Korea has taken the lead in active biologics, biosimilars and contract manufacturing whereas contract Biomanufacturing in India, China and Brazil is yet to reach scale.

Multiple factors are driving the outsourcing of Biomanufacturing. Biologics API demand is expected to grow aggressively as biological drugs' market will continue to expand and more biologic products go for late stage clinical trials. Organizations trying to reduce their fixed costs and reduce their time to market will continue to outsource.

Opportunity size

The global market for Contract Manufacturing was USD 4 Billion in 2015 and is expected to reach USD 8.8 Billion by 2025. India has been a major player in contract manufacturing with USD 1.3 Billion market in 2015. The Indian contract manufacturing market is expected to grow to USD 4 Billion by 2025.

India can leverage its success in small molecule manufacturing in creating facilities for high quality bio-manufacturing

Intrinsic strengths with India

Indian manufacturers have strong experience of exporting pharmaceutical products to regulated markets. It is widely reported that India produces 40% of all generic and over the counter drugs consumed in the US. Indian companies are already supplying biosimilar products in the emerging markets and are key players in those markets e.g. DRL generated USD 94 Million between 2012 and 2015 by selling biosimilars in the emerging markets.

Attracting investments in the sector

Government can consider the following initiatives in order to drive investment in the sector

1. Reducing duty on import of large critical equipment, including disposable equipment used by leading contract biomanufacturers
2. Making the tax incentives more relevant and attractive for CMOs. Current incentives in manufacturing allow 100% tax exemption for first 5 years when companies don't make any profits whereas 'Bionexus' scheme in Malaysia allows tax exemption for 10 years after company has started making profits
3. Support for skill upgradation in the sector

2.2.2. Contract/ Clinical Research

Current state of play

Patent expiries, lower R&D productivity, cost and time pressures have driven the contract research market till now. Over the years the nature of relationship between sponsors and service providers has also changed. CROs have moved from being a service provider to being a preferred vendor and now acting as strategic partners with innovative companies across the globe.

Opportunity size

Global contract research market is estimated at approximately USD 30 Billion and is expected to reach USD 95 Billion by 2025. Preclinical services form less than one fourth of the market whereas clinical services form more than 3/4th of the market. Clinical Research in India suffered a decline in 2013 and 2014 due to regulatory uncertainty. However with recent initiatives by Government aimed at bringing predictability and transparency in regulations, clinical research activity in India has resumed and is expected to be a driver of Bio-services growth

Intrinsic strengths with India

India has a large genetically diverse patient pool and a treatment naïve population. It has English speaking researchers and medical Infrastructure to conduct clinical trials. It has large cost advantage over western countries.

Attracting investments in the sector

Lack of clarity on regulations and delays in obtaining regulatory approvals are the major barriers to growth of the Contract research in India. However government has taken number of steps to improve the regulatory ecosystem for clinical trials in India. Initiatives which the Government is in the process of considering include :

1. An online system for submission and tracking of clinical trial applications
2. Increasing the number of personnel available at CDSCO Delhi and Regional Offices to oversee clinical trials

3. A separate cadre of professionals for regulating clinical trials distinct from those regulating manufacturing quality

4. Create standards for accrediting clinical trial sites and principal investigators

2.3. Bio-Agriculture

Market Dynamics

The global market for Bio-Agriculture is expected to grow from USD 20 Billion to USD 59 Billion by 2025 with USD 43 Billion contributed by genomic based products. Bio-Agriculture in India at USD 0.9 Billion forms the third largest and fastest growing segment within the industry and is expected to reach USD 5.4 Billion by 2025. The segment comprises of primarily hybrid seeds, GM crops, bio-fertilizers and bio-pesticides.

Given the government focus on food security and agriculture with increased allocation of budgets[4], bio-agriculture segment is well positioned to be an important contributor for growth of the Indian biotechnology industry.

Secondary Agriculture includes "all practices and process which add value to primary agricultural commodities by using efficient technologies, market information and consumer preference". Key examples of secondary agriculture products include bio fuels, enzymes, processed foods and beverages, fertilizers, lubricants, oils, paints, cosmetics, agriculture chemicals, nutraceuticals, medicines, solvents, fuel additives, etc. Secondary agriculture has the potential to enhance farm incomes by 30-40% and create additional jobs while improving the nutrition levels in the population

Given the government focus on food security and agriculture with increased allocation of budgets, bio-agriculture segment is well positioned to be an important contributor for growth of the Indian biotechnology industry.

Intrinsic Strengths in India

1. Agricultural Land

   India has 61.6% agricultural land that is arable, under permanent crops, and under permanent pastures. At a value of 157 Million hectares, India has the second largest agricultural land in the world. This also comprises of 11.6 Million hectares of land under GM crops, which is 6% of worldwide land under GM crops.

   India is the largest producer of cotton (2015-16) and second largest producer of rice and wheat, however the overall yield is 2.7 tonnes per hectare, much lesser than countries such as China and Brazil, with yield rates of 4.7 tonnes per hectare and 3.6 tonnes per hectare respectively. If adequate measures are taken to improve yield rates, India has the potential to emerge as the biggest producer of major crops increasing its global share of exports.

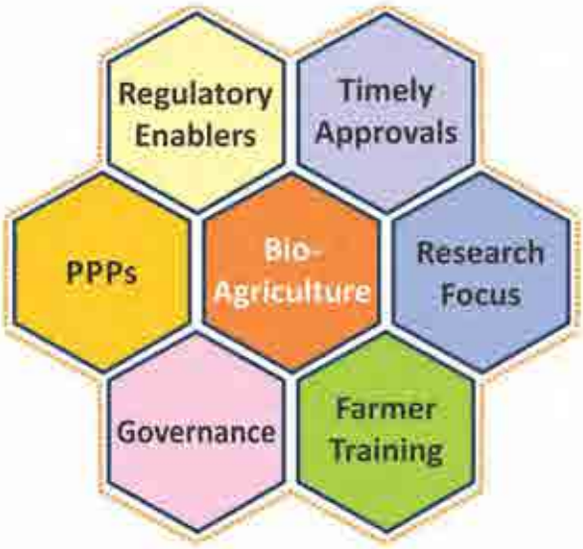
Secondary Agriculture can improve farm incomes, improve nutrition levels and be an important source of jobs

2. Government focus on agriculture

   India's Union budget 2016-17 shows government focus on agriculture with emphasis on irrigation, crop insurance, interest subvention, rural infrastructure, and fertilizer subsidy. This will be conducive to the growth of bio-agriculture. The Indian Government plans to substantially increase farm productivity.

3. Bio-Agriculture fund allocation

   The 12th five year plan to accelerate research lays special emphasis on bio agriculture and allocates 22% of total fund allocation, only second to 26% in medical biotech.



Attracting investments in the sector

To tap the opportunity in bio-agriculture segment, few areas need focus

1. Regulatory Enablers

   The regulations around intellectual property, GM crops, royalty payments, pricing are not very clear. This could be a deterrent for global players to enter and launch products in India, which could result in reduced yield. At the same time, the pricing of these products need to be governed to avoid foreign players monopolizing the market. The regulations and policies need to protect the interest farmers while providing enough opportunities for foreign players to ensure sustainable development.

2. Research focus

   India needs to invest and develop its own research infrastructure to reduce reliance on foreign players. This will encourage innovation which would contribute in revenue generation within India and globally.

3. Approval process

   The regulatory standards and approval process for new research needs to be in line with global guidelines and convention. This will avoid asynchrony internationally and will enable acceptance of the product at a global level.

4. Training programs

   The government needs to expand reach to train more farmers on the use of bio-fertilizers, bio-pesticides and techniques to expand yield as well as to initiate a shift towards secondary agriculture.

Bio-fuels can help India achieve energy security, help reduce oil imports, ensure cleaner environment and provide rural employment

5. Improvement in Governance

   A system to prevent leakages of subsidies provided by government to farmers to promote the bio-agriculture industry.

6. Encouragement to Public-Private-Partnership (PPP)

   PPPs for promoting development as well as transfer of commercialization models/technologies along with the required financing will also help growth especially in secondary agriculture

2.4. Bio-Industrials

2.4.1. Bio-Fuels

Current state of play

Given the current and future energy and transportation needs of India and its current import dependence for fossil fuels, Biofuels are of strategic importance for India. It can help meet multiple objectives concurrently viz. energy security, oil import substitution, cleaner environment and rural employment.

To this end, Government has allowed 10% bioethanol blending in Petrol to achieve 5% ethanol blending across the country as a whole. However, for the year 2014-15, Oil Marketing Companies (OMCs) have achieved 2.3% aggregate ethanol blending. This is very far off from the "20% Biofuel blending by 2017" target of "National Policy of Biofuels" published in the year 2009.

Most of the current production of ethanol in India happens from sugarcane molasses (First generation technology) which is a byproduct in sugarcane production. As the feedstock production (molasses) is cyclical in nature, ethanol production is also cyclical. Additionally sugarcane production needs ample water supply which is also becoming a constraint in some regions in the country. These factors and competing requirements from Liquor and chemical industry have kept the blending target of 5% elusive over the years.

In this context, commercialization of cost efficient second generation biofuel technologies (which uses lignocellulosic biomass/ agricultural waste) is crucial for India.

In case of biodiesel production, India's policy of using non-edible tree borne oils has met with very little success thus far. Though the initial developments in last decade suggested significant potential of Jatropha based bio-diesel production, Jatropha cultivation and bio diesel production has never really been close to meeting targets set in five year plans. Problems with seed collection, extraction infrastructure and capacity building among farmers have hampered progress in this sector. Institutional push through railways, shipping, and road transport and defense sector is already initiated by Government. Railways' plans to blend 5% biodiesel in high speed diesel for traction purpose and plans for setting up two biodiesel plants in the country are encouraging for the sector. Measures have also been taken to sell the biodiesel B5 blend to retail customers in some part of the country which is expected to drive production and sale of biodiesel.

Intrinsic strengths with India

India has largest arable land after US and seventh largest coastline (which can be used for cultivating feedstock provided efficient technologies are developed) which makes raw material availability relatively easy. Need of the hour is to create and commercialize cost efficient, carbon neutral technologies which can leverage the natural resources available with India.

2.4.2 Enzymes (Industrial + Specialty)

Industrial enzymes cater to Food and Beverages, Cleaning products, Biofuel, Animal feed needs whereas Specialty caters to Research / Biotech and Diagnostics needs.

Current state of play

Globally, North America and Europe together form more than 60% of the Enzymes' market. Indian market is relatively small and contributes to approximately 2% of the overall enzymes market.

Indian market has a mix of both, global players as well as local players operating in this space. Novozymes leads the market with 48% market share and develops some India specific products from its Bangalore R&D center. Second largest player in India, Advanced Enzymes is in the process of tapping equity markets.

Opportunity size

Global industrial enzymes market is valued at USD 6 Billion currently (70% contribution from Industrial enzymes and 30% contribution from specialty enzymes) and it is projected to reach USD 10.3 Billion in 2025. The Indian market is expected to grow from USD 0.4 Billion to USD 1.4 Billion by 2025

Globally, costs associated with DNA manipulation and gene sequencing are falling, which is expected to drive the growth of the specialty enzymes market. Share of specialty enzymes are expected to grow from 30% to 35% in next 5-7 years.

Indian industrial enzymes market was valued at approximately 140 USD Million in 2012 and is growing at double digit rate since then. While approximately 80% of it was domestic production, approximately 20% was exported to other countries.

Attracting investments in the sector

Biofuel and Enzyme sectors are driven largely private players but there are limited fresh investments in the sector. Government bodies should consider following measures for attracting more investments

1. Government funding for R&D/field demonstration projects of 2nd generation technologies from biomass
2. Assured policy of long term biofuel off-take arrangement: Long term biofuels blending policy mandate and implementation mechanism, Long terms off-take contracts with OMCs for biofuel blending
3. Agencies such NABARD, NREGA, Rural development board in cooperation with Private banks can also come up with innovative financing models
4. Extension of IT/ITES policies to Bio-Industrial sector
5. Treating Biotech Projects as Infrastructure projects
6. Priority sector funding for Bio-industrial sector

2.4.3 Bio-Polymers

Bio-based polymers are commonly found across many applications varying from commodity to hi-tech applications owing to major advancements in biotechnologies as well as public awareness. Some examples of biopolymer usage includes: Biopolymers in Drug Delivery, Marine Sources, Stem Cell Technology, and Ceramics and applications

Opportunity Size

The market for biodegradable polymers in North America, Europe and Asia is expected to be nearly 525 KMT in 2017, with an average CAGR of 15% in the period 2012 to 2017. The global bioplastics market size by 2020 is expected to be approximately USD 10 Billion by 2020 and would account for 30% of total plastic demand

Attracting Investments

1. Need to ensure technology transfer and knowledge exchange mechanisms with end-user industries
2. Increased focus on R&D in biopolymers at research and educational institutions
3. Increased cooperation between industry and academia for development of commercially viable as well as application oriented solutions

Big Data and Analytics can play a profound role in the development of efficacious, personalized and cost-effective therapies

2.5. Bio-IT

The combination of biology with information technology is emerging to be an interesting industry segment called as Bio-IT. The growth can be attributed to the rising need for technology to make sense of the huge database that is being generated across segments like R&D labs, hospitals, clinics etc. Over the last decade, India's government has played a key role in the development of the country's Bio–IT sector. By funding research initiatives across bioinformatics institutes, R&D laboratories, and autonomous organisations, Indian government has been driving the sector's growth

Bio-IT has its application in bioscience in the form of Bioinformatics. An emerging segment which is also at the confluence of technology and biopharma is big data. Biopharma organizations generate data from a large number of disparate sources across the value chain. With rapid increase in data generation, computation capacity and accessibility of data, big data and analytics will redefine the way we work

2.5.1. Bio-Informatics, Genomics & Precision Medicine

Market Dynamics

Globally, the bioinformatics market is expected to grow from USD 4.11 Billion in 2014 to USD 12.54 Billion by 2020 with a CAGR of 20.4% during 2014-2020. Major growth drivers include the need for integrated database, increased government initiatives and funding, growing use of bioinformatics in drug discovery and biomarker development and rising interest in genomics and proteomics. The global bioinformatics market is still at a nascent stage with few large players occupying the major market share. Geographically, Western Europe and EU have been the hub of bioinformatics companies accounting for 55% and 30% respectively. However, Asia is the fastest growing market due to rising number of R&D activities and rising government fund for research and developments. The global market for Genomics was USD 11 Billion in 2013. With increasing awareness among people, inclusion in clinical care pathways and sophistication in data analytics the market is expected to reach USD 20 Billion by 2020. There is a growing precision medicine market in US led by Foundation Medicine and others.

Intrinsic strengths with India

Bioinformatics is one of the fastest growing fields in the biotechnology sector of India with over 200 companies in Bangalore, Delhi, Hyderabad, Pune and Chennai. Some of the growth drivers are:

1. Vast pool of skilled human resources: India currently has 10% of the global professional and skilled bioinformaticians. There is a lot of demand for these skilled personnel as major companies have been operating as outsourcing partners
2. Increased public and private sector investments: Increase in public funding towards research and development along with increased investments by private companies
3. Rising use of bioinformatics in drug development and clinical diagnostics

Attracting investment in the sector

The personalised medicine space is gaining ground in India led by several companies such as Strand Life Science, Medgenome, hospitals such as HCG. India, with its large

skilled human resources and strength in IT sector, enjoys a distinct advantage in bioinformatics. However, efforts are required in some areas to overcome the limitations and grab the opportunities. These include:

1. Create.Creating a robust human capital network: Help create trained professionals by launching various specialized programs in bioinformatics (bringing biology, IT and statistics together) and collaborating with the industry players to offer academic internships. The curriculum needs to be tailored based on industry needs and the skill gaps. A dedicated body to ensure collaboration between industry and academia can help create meaningful resources.

2. Align infrastructure to global capabilities: Invest in strengthening infrastructure to enable connectivity and collaboration among research centres and engage with global research hubs. Capability and capacity to enable collaboration on virtual platforms is required to bring global expertise and learnings into India
3. Establish a national level bioinformatics institute: For efficiently storing the increasing amount of data generated through high-speed sequencing technologies, there is a need to build a national level bioinformatics institute
4. Sector specific funding: Enable participation and growth in the sector through availability of sector specific early and growth stage funding mechanism. The new disruptive technologies such as CRISPR will impact all aspects of biotechnology & should be given importance.
5. Enabling regulatory environment: Establish separate regulatory frameworks for this sector to ensure stringent rules and policies which can be world class. With rapid advancement in genomic research, legal and ethical issues are likely to emerge. Proactive steps in creating guidelines and making the community aware about it is essential in order to make the sector outcomes acceptable and implementable in future
6. While high cost of genomic testing has been a deterrent to widespread acceptance in the Indian market. Development of alternate financial models which help reduce the patient's financial burden would also spur the growth of the sector in India

2.5.2. Big Data

Market dynamics

Big data analytics will transform the biopharma industry, however, adoption and execution have been slower than anticipated due to the size and complexity of data sets and rapidly changing advances in medicine. Biopharma data is differentiated by its complexity in terms of variety and veracity. Creating insights and extracting value from big data can be challenging – resulting in slow adoption to date. Despite the challenges, advances across the industry are reinforcing the promise of big data for the future like emergence of personalized medicine and genomics, unprecedented levels of collaboration and data sharing, advances in technology and availability of data scientists. The size and complexity of the data we generate and that are useful and available will continue to expand exponentially. The biopharma industry will continue to adopt and embed the use of new data in stages as capabilities grow and new uses are found.

Intrinsic strengths within India

The Government of India has helped the development of high performance computing technology for use in Bio-informatics – C-DAC. PARAM Biochrome and Bio Blaze with 5 and 10.65 Teraflops of computing capacity respectively are focused on bio-informatics. One of the supercomputing system and facility of C-DAC called Bioinformatics Resources and Applications Facility (BRAF) are used to solve problems in many areas including computational biology.

The government of India has recently recommended standards for electronic medical records. Some state governments in India have also stated their willingness to share aggregate data from public hospitals with biopharma companies for research and development purposes.

India has all of the elements required to be a big data and analytics global leader in biopharma. India is a leader in IT outsourcing. With approximately 700K graduates and approximately 300K post graduates passing out every year in science and mathematics, India can address the global big data resource requirement. There is focus on necessary technology infrastructure with Government also taking steps to set up such facilities. There is a growing start-up sector with Bio-informatics focused start-ups providing solutions to global biopharma clients.

Attracting investment in the sector

1. Establish big data programs based on top health priorities: PPP between government, biopharma, academia, IT, insurance etc. together can be launched to identify and fund right programs
2. Develop talent pool: There is a need to identify emerging analytical tools and develop world class capabilities in all big data technologies pertaining to biopharma. Collaboration with academic institutes to develop pool of data scientists in this sector would be required.
3. Make EHR data available: In 2013, EHR standards were finalized and approved by the Ministry of Health and Family Welfare. However, this needs to be implemented country wide. Creating a certification body for electronic medical records similar to Certification Commission for Health Information Technology (CCHIT) would also be helpful. Access to reliable and well-linked data is one of the biggest challenges facing biopharmaceutical R&D. EHR can provide real-time observational data from the hospitals and diagnostics centres. This information can bring considerable improvement in biopharmaceutical R&D.
4. Create data protection laws: Big data can bring enormous insights helping the entire sector however there needs to be clear data protection roadmap.

Despite the challenges, advances across the industry are reinforcing the promise of big data for the future like emergence of personalized medicine and genomics

3. Make in India

In the years following independence, the agriculture sector contributed approximately 52% of the GDP with industry and services accounted for 18% and 30% respectively. Liberalization of the Indian economy, globalization initiated by the end of the cold war and growth of information and communication technologies brought about a significant increase in the share of services. The share of services rose steadily from 44% of GDP in the 1990s to nearly 60% of the GDP in recent years. The share of agriculture in GDP has fallen to 14% while the share of industry has grown to 26% in the same period. Within the industry sector, the share of manufacturing has grown from 14.5% in the 1990s to 16% of GDP in recent years.

Year	% share in GDP		
	Agriculture	Industry	Services
1950s	52%	18%	30%
1990s	28%	27%	44%
2010s	14%	26%	60%

Government of India has realized that the share of manufacturing in India's GDP needs to increase from 16% to 25% if the Indian economy is to grow at 8-10% annually on a sustained basis. It is estimated that nearly 120 Million people would enter the workforce during the period till 2024. Growth in manufacturing is needed to provide employment to this workforce.

Make in India initiative inaugurated by the Government of India in September 2014 aims to enhance the competitiveness of Indian manufacturing to achieve these goals. The program aims to enhance the manufacturing growth which has been negative in the last few years to between 12-14% in the medium term and provide 100 Million additional jobs in the manufacturing sector by 2022. Along with the Skills India initiative, the program hopes to create appropriate skills among the rural migrants and urban poor for ensuring inclusive growth.

Biotechnology is one of the focus sectors in the Make in India initiative. The strategic objectives of the Make in India initiative for Biotechnology are

- Increase the number of jobs available in the manufacturing sector
- Help enhance the access to drugs
- Reduce dependence on Imports especially in the medical devices segment
- Drive Biotechnology exports from India

Make in India looks to leverage India's strengths in Biotechnology including

- A large domestic market for Biotechnology products which at USD 7 Billion is the third largest in the Asia Pacific region and 12 largest overall
- India's low cost manufacturing capabilities in pharmaceuticals with the largest number of USFDA approved plants outside the United States
- Increased Government expenditure on Biotechnology including National Research Laboratories, and Centers of Excellence

- India's capabilities in agriculture including new improved crop hybrids and GM (food and non food) crops.
- Supportive regulatory framework including Foreign Direct Investments, Intellectual Property, pathways for Biosimilars, National Guidelines for Stem Cell Research
- Support from Biotechnology Industry Research Assistance Council for funding (USD 225 Million spent), mentoring (384 companies and 583 projects), hand holding (120 new start-ups) and infrastructure support (175,000 sq. ft. incubation space, 15 incubators, 5 university innovation clusters, 1 regional Innovation Centre and 3 Bio-Industrial facilities

Make in India looks to involvement from a wide range of agencies related to Biotechnology including

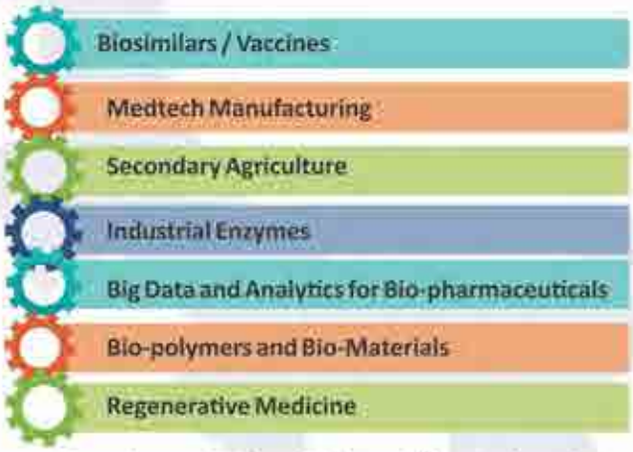
- Department of Biotechnology, Ministry of Science &

Technology, Government of India (DBT)

- Department of Science and Technology, Ministry of Science and Technology, Government of India (DST)
- Biotechnology Industry Research Assistance Council (BIRAC)
- Council of Scientific and Industrial Research (CSIR)
- Association of Biotechnology Led Enterprises (ABLE)
- Confederation of Indian Industry (CII)
- Federation of Indian Chambers of Commerce and Industry (FICCI)

Make in India also puts an emphasis on High Value Manufacturing. Specific High Value opportunities within Biotechnology which could focus on as part of the Make in India campaign are

- Biosimilars / vaccines– this would involve investments in analytical process development including fermenter design and technologies for fill & finish of products
- Medtech Manufacturing including high end 3D printing & design



- Secondary agriculture (Value addition to the primary commodities produced in India on a large scale) and Production of transgenic crops
- Industrial Enzymes
- Big Data and Analytics for Bio-pharmaceuticals
- Bio-polymers/biomaterials using synthetic biology
- Regenerative Medicine & Stem cells: especially automation and manufacturing of stem cells and bio-printing and injectable scaffolds

4. Biotechnology in India: Issues and Challenges

Indian Biotechnology industry has grown by 20% CAGR in the period from 2005 to 2015 to reach USD 7 Billion in 2015. If the industry has to reach its ambitious target of USD 100 Billion by 2025, it needs to embark on a higher growth trajectory of 30% CAGR during the next ten years.

Challenges that need to be addressed in the pursuit of this growth rate include

1. Need to boost demand for biotechnology products
2. Reforming the regulatory system
3. Improving the 'Ease of Doing' business in India
4. Providing the right policy environment including fiscal and tax incentives to boost R&D and manufacturing
5. Providing the right infrastructure for biotechnology companies
6. Improving the access to capital for biotech companies
7. Enhancing the skills needed for biotechnology research and manufacturing
8. Enabling Indian companies to acquire world class manufacturing quality

4.1. Boosting demand for Biotechnology

India spends around 3.7% of its GDP on healthcare which is much lower than its developing country peers. Public expenditure on health which is currently at 1.2% of GDP is also very low. Health insurance penetration in India is low now but is growing on the back of initiatives from the Central Government, several State Governments and penetration of private health insurance. Notwithstanding such initiatives, out of pocket expenditure on health is approximately 70% of the overall health expenditure. Catastrophic health expenditures often push vulnerable sections of India's population into poverty. Lack of affordability limits access to life saving drugs and devices.

Public spend on healthcare should increase to 2.5% of GDP over the next 5 years

Tamil Nadu Medical Supplies Corporation (TNMSC)

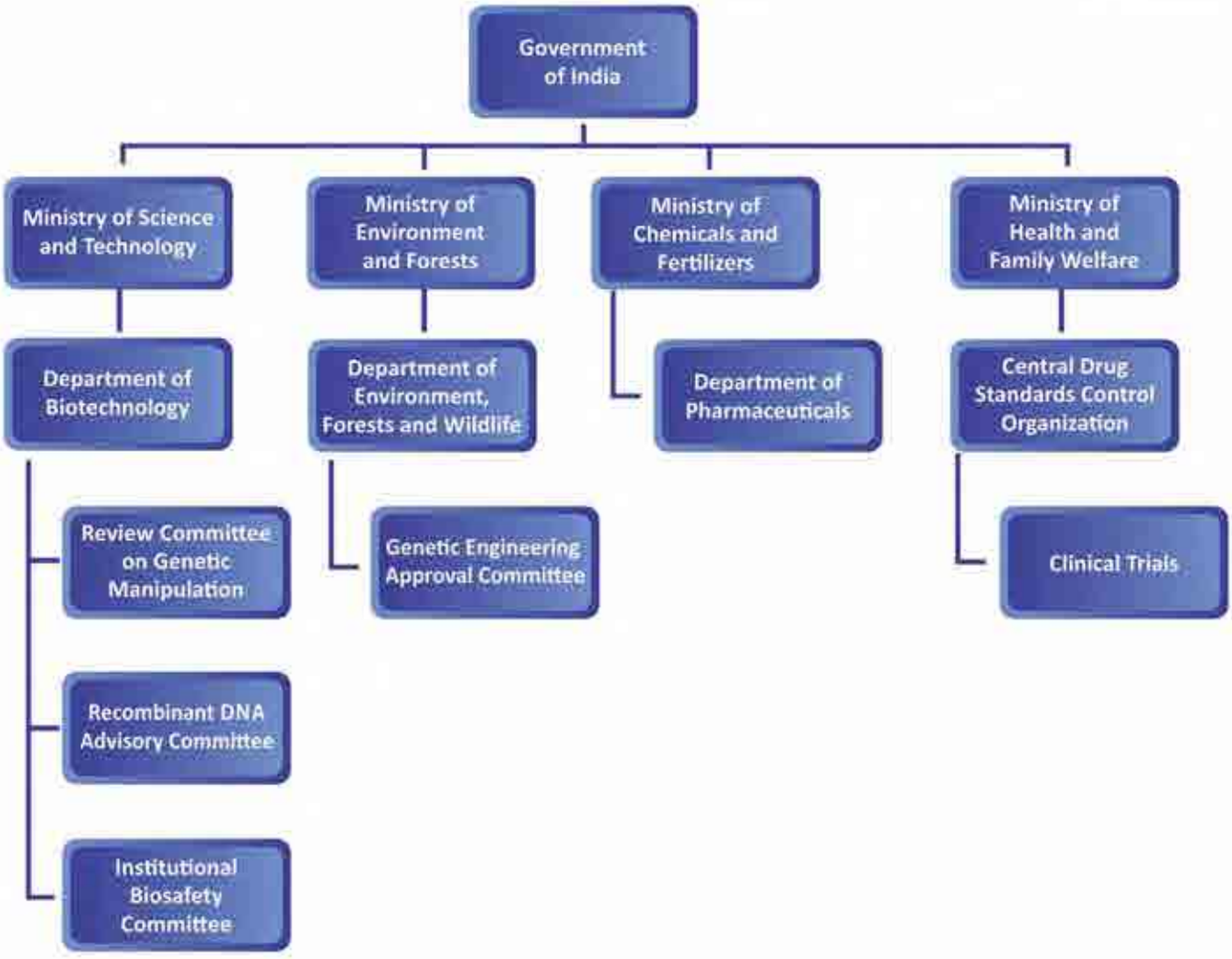
- Autonomous organization set up by Tamil Nadu Government
- Responsible for procurement of essential drugs, medical equipment and supplies to public health facilities
- Creates customized essential drug list for the State
- Essential drug list is revised every year
- 90% of the drugs are procured centrally with 10% procurement happening at district / facility level
- E-tendering done for all medical products
- Vendor Manufacturing Quality assessed periodically
- Laboratories empaneled to conduct quality assurance tests

Japan Case Study

- Public health insurance provides universal primary health coverage
- Base cover for health care and prescription costs for employee and non-employee (government) insurance are capped. For episodes that cost more than the cap, majority of the adult population has private health care insurance
- Patients can receive necessary medical services, including drugs covered on the reimbursement list by making certain co-payments (10% for the elderly, 30% for the general public and 0 - 10% for children)

4.2. Reforming the regulatory system

There are multiple agencies which control Biotechnology regulations in India as shown below.



Bio-services especially clinical trials come under the purview of Ministry of Health and Family Welfare. Clinical trials in the case of biotechnology need to be reviewed by Review Committee on Genetic Manipulation under the Department of Biotechnology. Approval for Genetically modified crops needs to come from the Genetic Engineering Approval Committee which functions under the Ministry of Environment and Forests. In addition, manufacturing licenses fall under the purview of the State Governments. There is a need for coordination between these agencies to ensure a robust regulatory mechanism for biotechnology in India

Clinical trials are the gold standard for measuring the safety and efficacy of new drugs, vaccines and medical devices. Clinical Research in India suffered a decline in 2013 and 2014 due to regulatory uncertainty. In the last two years Government of India has taken several steps to reform the regulatory ecosystem for clinical trials.

- Timelines for approvals of clinical trials have become shorter and predictable. Number of experts included in the Subject Expert Committees (SECs) has increased. Lack of quorum which could impact consideration of proposals has been corrected. Meetings of SECs are taking place regularly. Registration of Ethics Committees has been made mandatory.
- Rules have been relaxed to make audio visual recordings mandatory only for "vulnerable patients and new medicines". Definition of "vulnerable patients and new medicines" would be clarified through a guidance document.
- Formula for computing compensation published in consultation with industry experts thus alleviating a major concern of clinical trial sponsors. Criteria for number of trials which Principal Investigators can supervise are likely to be left to the Institutional Ethics Committees. Relaxation of requirement for 50 bed hospital for clinical trials is likely for some kinds of trials.
- Additional personnel are being recruited to strengthen the regulatory capacity for clinical trials. Laboratories for testing are being strengthened and new Labs being set up. Accreditation of Labs using guidelines for National Board for Accreditation of Laboratories (NABL) is being done.
- Online system for submission, monitoring and tracking of clinical trial applications has been developed and some modules have been implemented – Status reports are now available on website. CDSCO is expected to be fully online by 31.12.2016 to make the regulatory process efficient, transparent and responsive.
- Some concerns like lack of uniformity in functioning of SECs are being addressed through workshops. Replication of the pre-clinical toxicology tests is being minimized. Processing of the applications to CDSCO and Review Committee on Genetic Manipulation (RCGM) will be done in parallel (rather than serially) to improve approval timelines for biologics / vaccines.

Patent regulation is another area of concern in India. Only 40 drugs which are patent protected are being marketed in India. Delays in patent processing are a challenge which needs to be addressed. 130 examiners have been recruited and an additional 350 will be recruited to address the problem of delays. Patent litigation will be addressed by Commercial Courts and timelines for adjudication will be defined. Patents office will work closely with NIPERs on increasing pharma patents from India.

Singapore Case Study

- In 1999, the Genetic Modification Advisory Committee (GMAC) was established under the country's Ministry of Trade and Advisory to oversee and provide evidence based advice on R&D, production, release, use and handling of Genetically Engineering (GE) matters
- GMAC works closely with agencies like AVA (Agri-Food & Veterinary Authority) and Ministry of Health (MOH)
- Singapore does not have any on-going field trials for Genetically engineered products nor does it manufacture any agricultural-related GE plants or animals
- Singapore promotes R&D in agricultural technologies through agro-technology parks
- Field trials are permitted only in specified areas

4.3. Improving the Ease of doing business in India

India ranks 130 out of 189 countries in the World Bank Ease of Doing Business score. Government of India has declared its goal of improving the ease of doing business in India to move India into the top 50 countries in the world.

ParameterSingaporei n RankRank	d	i a
Overall Ease of Doing Business	1	130
Starting a Business	10	155
Dealing with Construction Permits	1	183
Getting Electricity	6	70
Registering Property	17	138
Getting Credit	19	42
Protecting Minority Investors	1	8
Paying Taxes	5	157
Trading Across Borders	41	133
Enforcing Contracts	1	178
Resolving Insolvency	27	136

While there is a need for India to improve its scores on all dimensions, specific areas which need attention are

- Reduce the number of procedures (14) and time taken (29 days) to start a business – recent reforms announced as part of the Startup India initiative would facilitate this
- Reduce the number of procedures (40) and time taken (147 days) for obtaining construction permits – this would need reforms at individual states
- Improve the quality of land administration – ongoing initiatives for computerization of land records at individual states would be helpful
- Reduce the number of tax payments to be done in a year (33) and the total tax rate – initiatives by the Government to reduce the corporate tax rate to 25% and other measures announced in this year's budget will improve this rank
- Reduce the time for border compliance in exports (88) and imports (311) – this would need infrastructure development at ports and airports
- Reduce the time taken for trials and judgements (1095 days) and enforcement of judgement (305 days) – this would require strengthening the judicial system
- Reduce the time taken for resolving insolvency (4.3 years) – the new provisions of the Bankruptcy and Insolvency code are a step in the right direction

4.4. Right Policy Environment

An enabling policy environment that is stable is a pre-requisite for growth of the Biotechnology industry in India. Challenges associated with the current policy environment include:

- Weighted deduction on Research and Development expenditure is proposed to be reduced to 100% by 2021 in Budget 2016. This reduction should be reversed and weighted deduction on R&D should be increased to 300% of R&D
- R&D Expenses incurred outside India should be included under the definition of expenses allowable for weighted deduction
- A preferential pricing policy (with 15%-20% premium) in line with World Bank guidelines for products made in India in government procurements
- Contribution to SEBI registered Biotech focused funds to be eligible for weighted average tax deduction
- Import duty exemption for capital goods used in Biotechnology manufacture
- Modifying the announcement in Budget 2016 on flat 10% tax on royalty income derived from Intellectual Property (IP) to flat a 10% tax on all revenues from commercialization of IP

A detailed analysis of the policy environment in developed countries is included in the Chapter 6

weighted deduction on R&D should be increased to 300% of R&D

4.5. Access to Infrastructure

Biotechnology industry requires access to world class physical infrastructure (roads, power, and ports) as well as research infrastructure like incubators, analytical instrumentation, animal breeding facilities etc. Specific challenges around infrastructure include:

- Biotech parks & incubators in India are smaller in size as compared to their counterparts in developed countries. For example a Biotech park in the US typically has between 100-1000 companies including multinationals which employ 20,000 to 50,000 employees . Biotech incubators in India on the other hand have fewer than 20 companies and have 100-1500 employees
- Clinical Trial Infrastructure is limited – India has 1.3 beds per 1000 population ; South Korea by contrast has 13.2 beds per 1000 population

- Limited availability of supporting infrastructure such as animal breeding facilities, GLP labs- India has 71 registered animal breeders and 36 GLP certified test facilities and 1 GLP certified protein characterization facility. There is no large animal breeding facility in India. Indian biotechnology companies are forced to seek services outside India which increases the cost of research
- Lack of a clear roadmap for adoption of electronic health records and absence of a certifying authority like CCHIT in United States hamper the availability of health outcomes data for research purposes

Case Study: Singapore Biopolis Park

- Biomedical Sciences along with electronics, engineering and chemicals were identified as the four key pillars of economic growth in Singapore
- Singapore Biomedical Sciences (BMS) was started in 2000 to develop Biomedical Sciences in the country
- The BMS cluster has 3 agencies working in close co-ordination with each other:
- BMRC: Funding and supporting public research initiatives
- Biomedical Science Group: Promote private sector manufacturing and R&D activities
- National Medical Research Council: Medical research fellowship for development of medical research manpower

Biopolis Park: Location

- Biopolis which was inaugurated in 2003, has facilities which transcend the entire spectrum of biomedical sciences from research and development to manufacturing and healthcare
- Biopolis is located in One-North which has been planned in a holistic manner to include space for research and business in Fusionopolis and Mediapolis, academic facilities in Nepal Hill, residential facilities in Wessex and entertainment and recreational facilities in Rochester Park
- Multi-sectoral collaboration between biomedical sciences and associated information technology, physical sciences, engineering disciplines is facilitated by Biopolis

Biopolis Park: Scale of Operations16

- No of employees - approximately 4000
- No of companies – 40 Corporate Research labs (several MNCs)
- No of Academic institutes - approximately 20
- Chugai, one of Japan's leading biopharmaceutical companies is one of the leading companies in Biopolis with a USD 200 Million investment

Biopolis Park: Success Stories

- In the twelve year period since the inauguration of Biopolis, manufacturing output from biomedical sciences has increased at a CAGR of 14% to reach USD 29.4 Billion
- Number of jobs increased 250% to reach 15,700 in the same period
- Biomedical Sciences with Biopolis as the anchor is the last contributor to manufacturing value add in Singapore
- SARS detection kit was jointly developed by A*STAR's Genome Institute of Singapore (GIS) and Roche Diagnostics

UK Case Study: Catapults

Catapults are not-for-profit, independent physical centers which connect businesses with the UK's research and academic communities

Objectives:

- Reduce the risk of innovation
- Accelerate the pace of business development
- Create sustainable jobs and economic growth
- Improve skills and knowledge base and enhance UK's global competitiveness

Centers under the program offer space, facilities and expertise for collaborative research, development and commercialization. Cell and Gene Therapy, Medical Technologies, Precision Medicine and High Value Manufacturing are some of the centres

Funding: Centers gain access to funds from a mix of competitively earned commercial funding (2/3rd) (1/3rd won though business funded R&D projects and 1/3rd won through collaborative applied R&D projects) and core Innovate UK investment (1/3rd).

4.6. Improving the access to capital

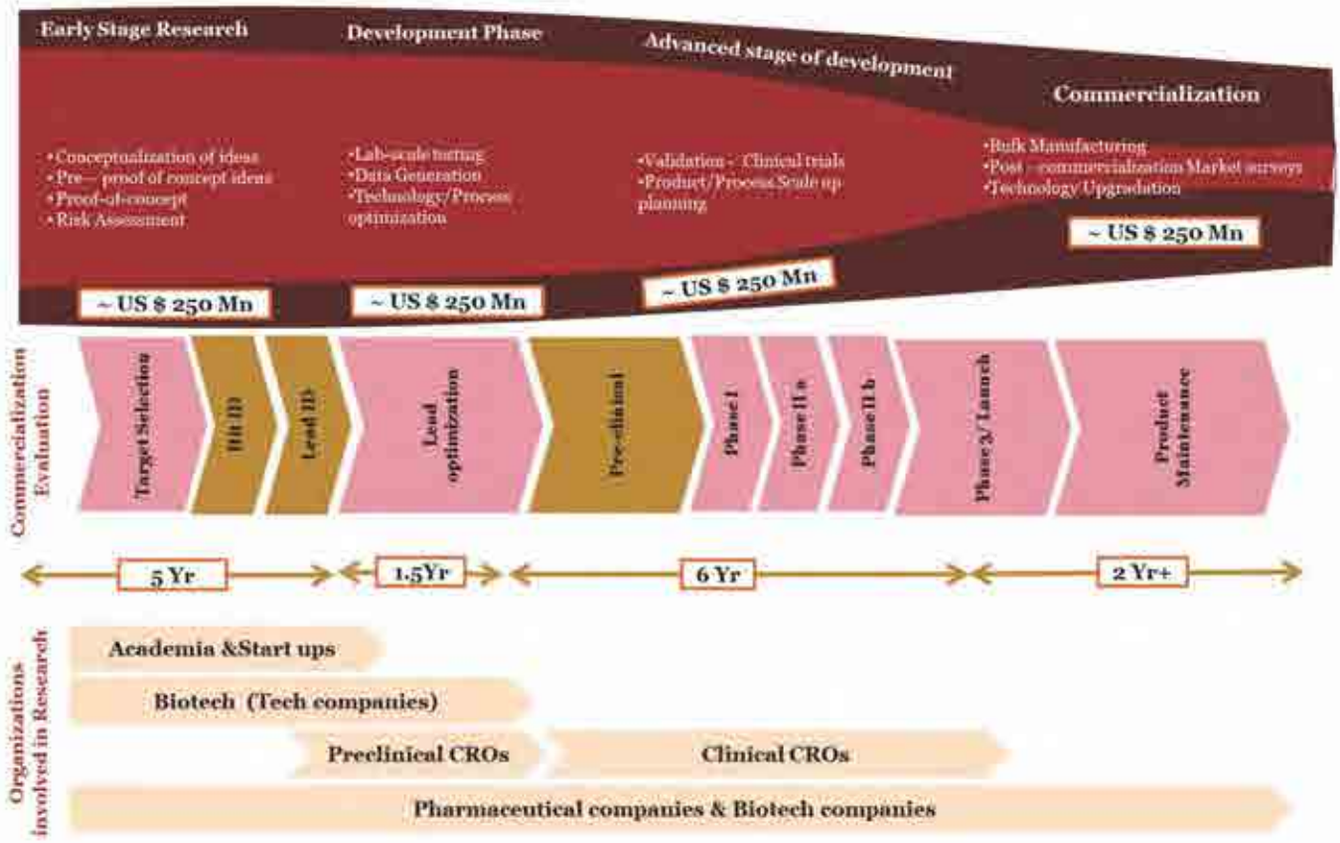
Biopharmaceutical drug development is a costly and risky proposition. Estimates vary but it can cost as much as USD 1 Billion to get a new drug to market. The high costs of drug development and the risks associated with the process had restricted innovative drug development to large pharmaceutical companies with huge cash reserves and the ability to manage the risks.

This conventional R&D model is undergoing a change as large pharmaceutical companies with smaller drug pipelines are looking to innovative biotech companies to fill the void. Biotech companies which often have origins in academic research are tasked with conducting the basic research, pre-clinical development and establish safety and proof of concept through pivotal Phase 1 and Phase 2 studies. Once the proof of concept is established, large Pharmaceutical companies in-license these novel molecules, conduct the large multi-centric Phase III trials and help navigate the regulatory pathways towards commercialization. The innovative Biotech companies are compensated through a hybrid model which includes an upfront license fee, additional fees related to achievement of specific milestones and a royalty fee linked to revenues from commercialization.

As shown below, activities performed by the small biotech companies can take as much as 6 years of effort and incur USD 250 Million in costs. Providing a constant source of funding throughout this period is fundamental to success of the small biotech companies.

Biopharmaceutical drug development is a costly and risky proposition. Estimates vary but it can cost as much as USD 1 Billion to get a new drug to market

Graphic showing stages of R&D and commercialization in Biotech



Funding arrangements available in countries with developed Bioscience economies and reforms needed to address the funding challenge in India for Biotech are addressed in the next chapter

4.7. Enhancing the skills needed for biotechnology research and manufacturing

The Indian higher education system has 634 universities and university level institutions and 33,023 colleges hosting around 16 Million students . The talent pool for science and technology is less than a third of China's. The ratio of post graduates to graduates and the ratio of doctoral students to post graduates is very low in India. 13,00018 PhDs are awarded each year in India which is equivalent to less than 2 per cent of post graduates. India produces three times as many postgraduates as the UK, but the UK produces 1.5 times more PhDs than India. Students of graduate programs in Biotechnology also seek employment in other disciplines like information technology because of better compensation. Clearly there is a need to make Science and Technology an attractive career option in India.

Human resources available for clinical research is also low in India with only 0.6 doctors per 1000 population and 1.7 nurses per 1000 population. United Kingdom by contrast has 2.8 physicians per 1000 population and 9.5 nurses per 1000 population.

Specific skill gaps exist in designing manufacturing processes for biologics such as fermentor design and optmization. There is a need to expand the number of initiatives like Young Biotechnologist Award, DBT Wellcome Trust Fellowship, Tata Innovation Fellowship and Ramalingaswami fellowship to attract and retain scientists of Indian origin.

China Case Study

- The Organization Department of the Chinese Communist Party Central Committee (ODCCP) invites highly qualified overseas talent to set up innovative and entrepreneurial ventures under the Recruitment Program of Global Experts Two sub-programs include:
  - The Thousand Talents Program (launched in 2008) : aims to attract about 2,000 leading academic / research talent under age 55over a period of 5–10 years
  - The Thousand Youth Talents Program for Distinguished Young Scholars (launched in 2011) aims to attract about 2,000 excellent young overseas scholars, under age 40, by 2015
- In addition to visas, residence permits, healthcare, insurance, accommodation, tax and salaries the talents also receive a 1 million yuan subsidy from the Chinese government

US Case Study

- The number of doctoral students in science and engineering has declined in the US
- Research has also shown that 15-year-olds perform below the OECD median in science
- In an effort to provide a highly skilled workforce, The US federal government aims to improve STEM education at all levels
- US aims to prepare 100,000 STEM teachers and launched a Five Year Strategic Plan in 2013
- The Federal budget for 2014 set a goal of increasing by one million the number of graduates with STEM degrees over the next ten years
- USD 3.1 Billion outlay from the Federal budget for STEM education

Finland Example: Catch them young

- Tutki-Kokeile-Kehitä (Research-Experiment-Development) is a Finnish science and technology competition supporting children and young people, and encouraging long-term research and development activities. It is an annual competition for young people below 20 years of age.
- Viksu – The annual Science Competition ("Viksu") for senior secondary students aims to increase enthusiasm for science among senior secondary students. Winners of the competition are granted automatic entry to several Finnish universities if their essay is directly related to the field of study they apply on completion of the matriculation examination.

4.8. Enabling Indian companies to acquire world class manufacturing quality

India has been recognized as a global powerhouse for low cost pharmaceutical manufacturing. As Indian biopharmaceutical companies focus on the opportunities provided by Bio-similars, they need to adapt themselves to the quality requirements of biologics. Biotechnology manufacturing is more complex than small molecule manufacturing and would require a fresh approach to quality standards in manufacturing.

In addition, the bio-similars manufacturing is likely to see competition from innovative pharmaceutical companies like Amgen, Pfizer, and biotechnology companies like Celltrion and new entrants like Samsung which have made significant investments in Biotechnology. Indian companies should focus on quality manufacturing, integral to the growth strategy in bio-similars.

India would also need to innovate in manufacturing processes to reduce the price of life saving drugs. Mimicking the manufacturing processes at established companies would mean that reduction in end user prices would be driven only by labor cost arbitrage which is not sustainable. Department of Biotechnology can facilitate the innovation by funding new manufacturing technologies which improve efficiency. Academic Institutes in India have taken the lead in developing curriculum for manufacturing technology for biologics and such initiatives need to be replicated to enhance the quality of talent for biotechnology manufacturing.

Indian companies should focus on quality manufacturing, integral to the growth strategy in bio-similars

Department of Biotechnology can facilitate the innovation by funding new manufacturing technologies which improve efficiency

5. Access to Capital for Biotechnology: The Global Experience

Biotechnology Research and Development is a costly and time consuming process. Investments are needed at different stages of the R&D cycle. The gestation period of the investments is typically long (8-10 years). The uncertainty associated with the investments is high with likelihood of approvals from Phase 1 stage is 10.4%. The regulatory challenges associated with Biotechnology are higher. The Biotechnology sector has to compete with other sectors like information technology and digital businesses where the investments required are low, gestation periods shorter and the regulatory challenges are minimal. These challenges necessitate a fresh look at funding for Biotechnology.

The International Experience:

5.1. Israel

Israel focused on the development of the Venture Capital ecosystem particularly focusing the high technology startups through the Yozma program . Key objectives of the Yozma program started in 1992/93 include

- Establishment of Israeli VC funds for investments in high tech start-ups
- Learn from foreign partners (Supply side)
- Acquire a network of international contacts

The Yozma program made Investment of USD 100 Million through Investments in Private VC funds (Yozma funds): USD 80Million and Direct investments in High tech companies (Yozma 1: USD 20 Million).

Yozma funds featured compulsory investments from one foreign institution and a well-established Israeli financial institution. The Government investment was approximately 40% (USD 8 Million) of the fund size. Call options were available for the fund to buy government stake at cost plus interest for a period of 5 years. Demand side support was provided by technological incubator programs. In all, 10 funds were started between 1993 and 1997 and a total investment of USD 250 Million was made out of which USD 100 Million was contributed by government. Over 200 companies benefitted from investments under the Yozma program.

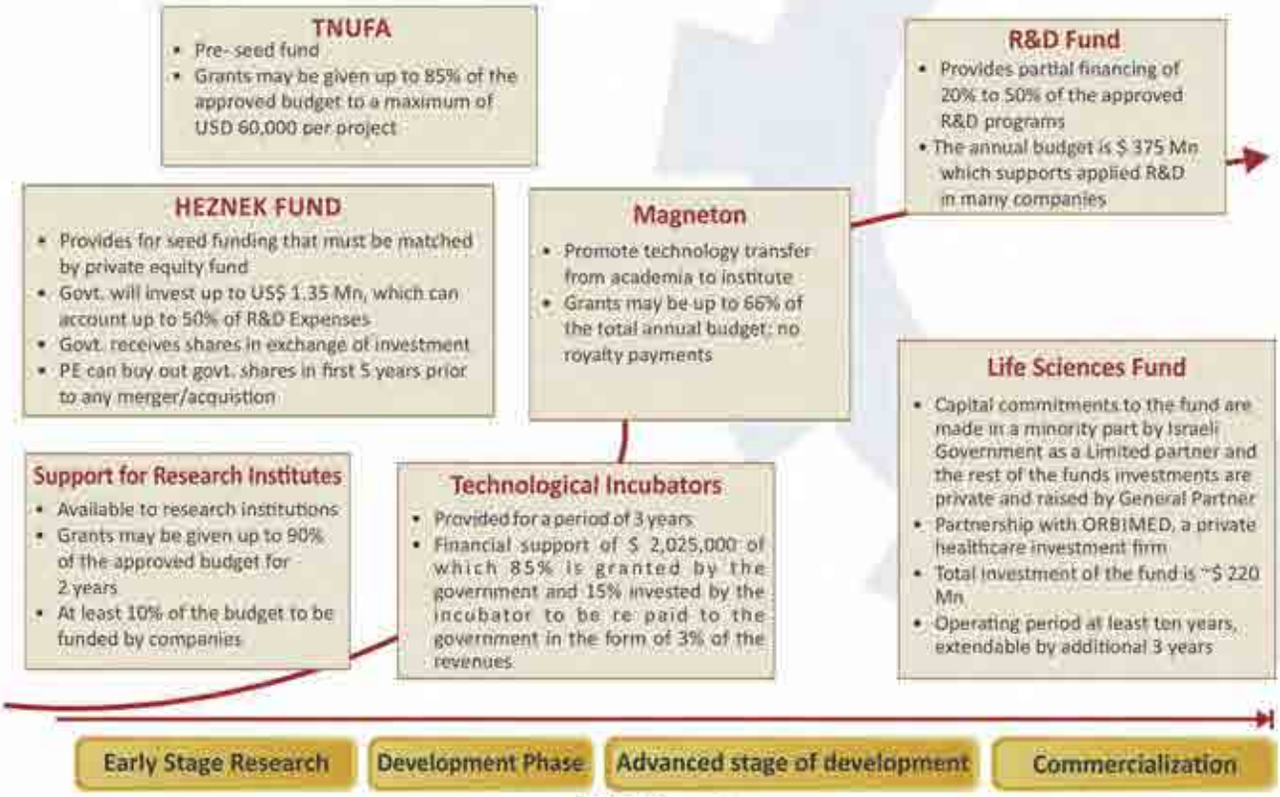
Israel launched its Biotechnology Plan called "Bioplan 2010" in the year 2009. The goals of Bioplan 2010 were

- Enhance academia-industry cooperation so that biotechnology innovation from Israel can be commercialized across the world
- Enable efficient transfer of technology from basic research to the industry
- Support state-of-the-art physical, regulatory and scientific infrastructure

The main initiatives under Bioplan 2010 included the following

Initiatives	Upgrading The Physical Infrastructure	Establishing dedicated biotechnology clusters	Supporting and Encouraging R&D in Israel	Providing seed funding for promoting commercialization	Supporting investments in Israel
Brief Description	• Support pre-clinical infrastructure needs such as labs for providing GLP analytical, bio analytical & histopathology services, physical & technical facilities for conducting GLP tests, GLP Toxicology etc.	• Providing entrepreneurs' with pre seed funding of up to 85% of the R&D program and up to $2 million per project of the R&D budget • Provide funding support for acquiring dedicated equipment to support R&D	• Operated on a yearly budget of $ 430 Mn • Includes Grants of up to 50% for market driven competitive R&D Projects, up to 66% for start up companies, up to 66% for advanced genetic technology and up to 85% for technological incubation	• Establish, along with domestic & internatinoal private investors, a pre-seed fund to support the development of innovations possessing commercial potential to improve odds of a successful technology transfer	• Offers Capital Investment Benefits to both the companies and their investors in the form of various Tax incentives and grants • Initiatives to encourage foreign investors in Israel

Funding of Research and Development at different stages of the life cycle , was facilitated through a series of funding options as mentioned in the graph below.



R&D Life cycle

In addition to domestic investments, Israel also focused on International investments, to foster R&D

Project Centres of MNC's

- Locating and forming R&D collaborations between Israeli partners and MNC's
- Government financing through one of the following
  - 40% of the Project centre's operating expenses
  - 50% of the accumulated investment funding given to the Israeli partner in the project
  - Accumulated investment funding given to Israeli partner in national preference zone

International Financial Community

- Encouraging leading MNC's financial institutions to establish R&D centres in Israel
- The government will supports 40% of the total budget for the 1st and 2nd year, 30% for the 3rd year and 4th year and 25% for the 5th year

ISERD The Israel-Europe R&D Directorate 2004 - 2013

- Promoted cooperation between Israel and Europe in thematic and/or Bi-National Programs
- Israel is the only non- European country to be a part of the Framework program
- Funding through various instruments such as Integrating Projects, Networks of Excellence and Specified Targeted Research Projects
- At the beginning while Israel transferred over 150 Mn Euros, it received only 50 Mn Euros. However, as time passed, during the 5th Program onwards, Israel started receiving a larger share as compared to that invested
- In the 7th FP, Israel received 243 Mn Euros, while it invested 160 Mn Euros

US Israel Binational Industrial Foundation (BIRD)

- Provides conditional grants for joint development of projects on risk sharing basis
- The foundation funds 50% of company's R&D expenses associated with the project
- Repayments are due only if commercial revenues are generated as a direct result
- IF project fails, BIRD claims no repayments; BIRD requires no IP rights nor any equity in the companies
- Since it's inception in 1977, BIRD has approved 800 projects amounting to approx. US $ 10 Bn

5.2. The Singapore Experience

Singapore Biomedical Sciences (BMS) initiative was launched to anchor basic biomedical research in Singapore. During the latter part, emphasis was on bolstering translational and clinical research competences, while continuing to build up basic research capabilities.

The Singapore government played a crucial role during the phase to ensure sufficient funding opportunities across the R&D life cycle.

Funding in Singapore

Several initiatives have been rolled out by the Singapore Government to enable access to start up financing mentioned viz.

Fund	Start-up Enterprise Development Scheme (SEEDS)	Business Angel Scheme (BAS)	Sector Specific Accelerator Program	ACE Start ups	Early Stage Venture Funding Scheme (ESVF)	Technology Incubation Scheme (TIS)
Year of Launch	2001	2005	2015	2003	2008	2008
Type of funding	Equity Financing Scheme	Equity Financing Scheme	Equity Financing Scheme	Cash Grant	Equity Financing Scheme	Incubation scheme
Stage of Funding	Seed funding	Seed funding	Seed funding	Seed	Early Stage funding	Development
Investment Quantum	When Started: A co-financing scheme whereby the government matches up to a dollar for every dollar raised up to a maximum of S$300,000 per company Currently: The government matches the 3rd party investment dollar to dollar up to a maximum of USD 2 MILLION . The total sum invested in trenches based on identified milestones Subject to company's specific progress and performance additional investments can be considered at a later round for up to USD 1 Million inclusive of initial investment	Start-ups that obtain investment commitment from any of the angel investors can apply for matching investment from SPRING SEEDS Capital, SPRING may match the investment up to a maximum of S$2 Million	$70 Million has been earmarked for medical technology innovation under the Sector Specific Accelerator (SSA) Programme SPRING SEEDS Capital, SPRING's co-invests with SSA on a 1:1 basis	SPRING will match S$7 to every S$3 raised by the entrepreneur for up to S$50,000	The dollar amount awarded to each proposal depends on the strength of the proposal. For the ESVF III the fund limit is capped at USD 40 Million	Up to USD 500,000 per company

Investment Mode	Both SPRING SEEDS Capital (SSC) and the third party investors take equity shares in the company in proportion to their investment The third party can be Singaporean and/or foreigner based in Singapore SPRING SEEDS Capital can also co-invest with overseas investors who can demonstrate ability to add value to startups by functioning as a Board Member The investment horizon period is about 5 years. Exit options include (trade sale, merger & acquisition, redemption or cash offer for SSC's share, and initial public offering	Both SPRING SEEDS Capital and the angel investors will take equity stakes in the company	Clearbridge BSA, Singapore Medtech Accelerator, Zicom MedTacc and Medtech Alliance identify and co-invest with SSC in promising medical technology start-ups Besides co-investing, the accelerators take a hands-on approach to help the start-ups build up their management teams, meet regulatory requirements and connect with potential customers	Spring does not get equity in the investment company The grant will be disbursed over 2-3 years tranches based on pre - determined milestones	Under this initiative, the NRF Singapore invests on a 1:1 match basis to seed venture capitalist funds (Large local Enterprises LLE) that invest in Singapore based early high tech companies ESVF can be used to source for overseas startups but the startup must relocate to Singapore or be involved in a joint venture with a local company The NRF unilaterally caps profits on revenues based on the capital contributions it makes and the hurdle rate. Any profits made beyond this are distributed to the companies If the LLE prefers not to liquidate its investments at the end of the fund life, it will need to include in the proposal its plan to take over/liquidate NRF's stake in the fund	As per the TIS scheme, the National Research Foundation (NRF) can co-invest 85% of investment (up to USD 500,000 per company) into Singapore based startups on the recommendation of the Technology incubator The remaining 15% has to be co-invested into the start-up by the technology incubator .In addition to the funding, the technology incubator is required to provide active mentorship and guidance to the startup. The technology incubator can buy the NRF's stake in the startup within three years by repaying the capital plus interest
Sponsor	SPRING Singapore, Ministry of Trade and Industry	SPRING Singapore, Ministry of Trade and Industry	SPRING Singapore, Ministry of Trade and Industry	SPRING Singapore, Ministry of Trade and Industry	National Research Foundation, Singapore	National Research Foundation, Singapore
Companies funded	Startups, Entrepreneurs	Startups, Entrepreneurs	Startups, Entrepreneurs	Entrepreneurs		Business Incubators

Impact	Cumulative number of innovation startups supported by SEEDS: 10 in 2001 to 148 in 2005 Cumulative number of private sector co-investors: 17 in 2001 to 226 in 2005 Cumulative number of foreign sector co-investors: 3 in 2001 to 70 in 2005 Cumulative investments: USD 2.5 Million in 2001 to 45.3 in 2005					The NRF has selected 14 Technology incubators including a couple of Biotechnology incubators under the TIS scheme

5.3. United States: California Bioscience Economy

California's Bioscience Economy is built around its academic centers of excellence. Academic research from these centers of excellence attract the attention of funding from both public and private sources.

In 2014, California labs were awarded 7,328 grants worth USD 3.3 Billion from the National Institutes of Health (NIH) to drive pioneering research.

NIH also invests in US start-up life sciences industry through their small business grants. Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs provide significant support for emerging companies who are not yet positioned for VC. California ranks first among US states in attracting Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) funding from the NIH, bringing in USD 144 Million in 2015.

The strong public investments are complemented by a vibrant private funding ecosystem. Venture Capital firms invested USD 7.4 Billion in Biotechnology up from USD 6.3 Billion in 2014 and an additional USD 2.7 Billion in Medtech firms in 2015 (same levels as 2014).

In 2015, entrepreneurs in California were projected to attract more than USD 4.7 Billion in life science investment, a 30% increase from the USD 3.6 Billion received in 2014. There has been an increase in funding across all stages of investments

Initial public offerings (IPOs) generate risk capital for growth stage companies and provide exit options for existing investors. In 2015, there were 16 life sciences IPOs, which generated USD 122 Billion. In addition, there were 27 mergers and acquisitions which produced another USD 1.2 Billion.

5.4. Finland

Biotechnology got off to a start in the mid -1980s with a major role being played by large-scale programmes run by the Academy of Finland, the National Technology Agency (Tekes) and the Finnish National Fund for Research and Development (Sitra). The National Technology Agency (TEKES) was established in 1983 which became the main channel for public funding. Tekes operates under the Ministry of Trade and Industry. In addition to Tekes, the Academy of Finland implements public financing of innovations in Finland.

Overview of programs as shown below

TEKES

- Funding is targeted to projects that create long-term benefits
- Tekes does not derive any financial profit from its activities, nor claim any intellectual proprietary rights
- Tekes works with companies and research units in Finland.

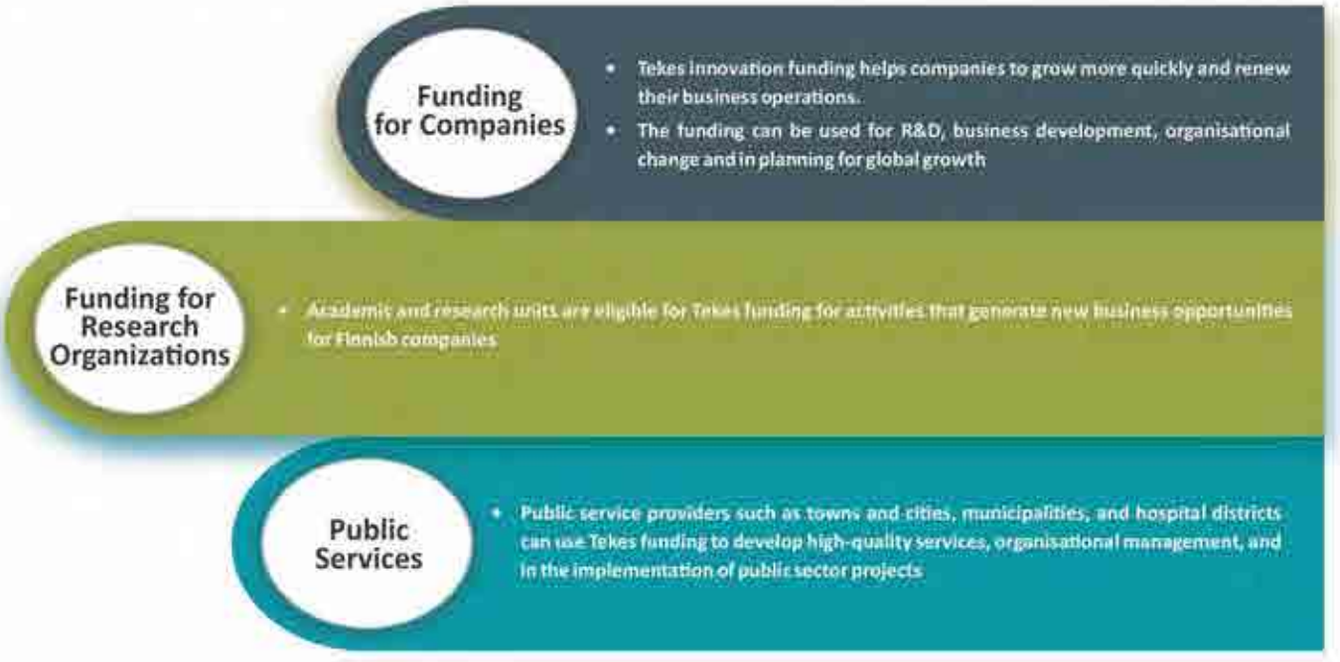
SITRA

- Operated as a fund directly under the Finland Parliament
- Sitra has an broad network of Finnish and international partners.
- Sitra has an extensive network of Finnish and international partners. Currently, Sitra is involved in more than 40 active funds
- Sitra commits to the owning and developing a portfolio company for 4 to 10 years on an average

Academy of Finland

- Aid and expedite training, globalization and the application of research results

TEKES main target group for funding is SMEs though they provide innovation funding for companies, research organizations, and public sector service providers



TEKES Research and Development Funding is available both during the Research Stage and during the Development / Pilot Stage. The nature and quantum of funding varies between the two stages

Project Types and Funding Levels	Research Projects	Development and Piloting
SMEs (targeted competitive advantage at International Level)	Grant max 50%	Loan 50% or 70%
Mid Cap Companies Revenue not greater than Euro 300M (targeted competitive advantage at International Level)	Grant max 40%	Loan 50%
Large Corporations (targeted competitive advantage at global Level)	Grant max 40% TEKES requires large corporations to buy services from SMEs or implement projects jointly with them Share of services bought from SMEs has to be a minimum of 40% of the total project costs	Loan 50% TEKES requires large corporations to buy services from SMEs or implement projects jointly with them Share of services bought from SMEs has to be a minimum of 15% of the total project costs

TEKES also provides funding for young innovative companies

TEKES provides different categories of funding for bringing public research and companies to collaborate.

Public research networked with companies

- Tekes funds typically 60 % of the project costs.
- Interest expressed by businesses in the project contents is a precondition for being granted Tekes research funding
- A company participating in a project may demonstrate its commitment by
- participating in the preparation and application phase
- project management and activities of the steering group
- providing funding for project costs

New knowledge and business from research ideas

- Tekes assists the translation of ideas from research stage to commercialization by provding funding

Strategic Research Openings

- The research projects create new high-level competences in areas expected to be important for businesses in the future

TEKES Success Measures

Funding done so far	Euro 575 Million
Company Projects	Euro 366 Million
University Research	Euro 209 Million
Positive Decisions	2600
New Customers	625
Startups Financed	702

5.5. United Kingdom

Funding for early stage research is available through both public and private venture capital

Public Funding

- Innovate UK: Started in 2007 this program has invested over £1.5 Billion in innovation, matched by a further £1.5 Billion in partner and business funding. Program helped more than 5,000 innovative companies in projects estimated to add £7.5 Billion to the UK economy and create 35,000 extra new jobs.
- BBSRC (Biotechnology and Biological Sciences Research Council) and Medical Research Council (MRC) look after the biotech funding in the UK. They are two of the seven research councils (RCUK) in UK.
- Industry partnership awards: One of the collaboration of the BBSRC. Responsive mode grants where an industrial partner contributes in cash at least 10% of the full economic cost of the project.
- British Business Bank: Government owned financing partner having multiple programs.
- Startup Loans: UK Government's flagship programme, provides a low cost loan with mentoring and support, both pre-start-up and for businesses that have been operational for a year.
- Angel CoFund for angel investors: Equity investments of between £100,000 and £1 Million are made in smaller businesses in the UK in combination with syndicates of angel investors to support businesses with good growth potential. Investments are subject to limits of 49% of an investment round and 30% of the equity in a business.
- Enterprise Capital Funds: combine private and public money to make equity investments in high growth businesses.

- Growth Loans: addresses the financing needs of smaller businesses which are struggling to raise sufficient senior debt to fund their growth opportunities. It is currently a pilot programme
- Credit Reference Agencies (CRA): Equifax, Experian and Creditsafe are designated as CRAs through the Small and Mediums Sized business (Credit Information Regulation) 2015. Reliability of credit scores is improved, enabling alternative finance providers to make informed decisions about financing smaller businesses and removing the information asymmetry between the lender and the small business

Private Venture Capital

- In 2014,The UK did better than other European countries, where biotech companies raised £923.7 Million in initial public offerings (IPOs) and USD 2.4 Billion (£1.54 Billion) in venture capital funding
- During the year, nine biotech companies listed by raising over £408 Million – which is almost half the total capital raised through IPOs in the decade
- Also, venture capital financing saw 71% improvement in 2014 on the back of fewer, bigger rounds at an earlier stage

UK Case Study: Biomedical Catalyst

The Biomedical Catalyst (BMC) is a partnership between the Medical Research Council and Innovate UK, and aims to provide responsive and effective support to the innovative opportunities in drugs and medical devices. The main focus of the program is to in allow innovative ideas coming out of academic collaborations to reach commercialization by providing funding and support. This bridges "the valley of death" and helps in accelerating the progress of novel products to market.

Support is provided to academically-led feasibility research through the Confidence in Concept Initiative. Academic-led applications for Early and Late Stage awards are administered through the Developmental Pathway Funding Scheme (DPFS).

Since April 2012, £250m funding has been awarded, matched by approximately £150m of private finance, to more than 300 projects seeking to develop a wide range of therapies, diagnostics and devices.

5.5. South Korea

Direct and in-direct lending to SME

Korea Finance Corporation (KFC) and the Small and Medium Business Corporation (SMBC) are the key sources for public lending. SMBC do indirect lending where they fund the banks. The banks in turn choose the SMEs who they want to finance. KFC unlike SMBC does not fund the complete 100% to banks for SME lending. They provide 40% or less fund and the remainder is to be funded by the bank. SMBC and KFC also lend directly to SMEs. In total, the two institutions provided credit of 11.8 trillion KRW to SMEs in 2011.

Government Venture funding

SMBC established the Korea Venture Investment Corporation (KVIC) in 2004 for investing into SME. It runs the Korea Fund of Funds, which participates in funds created by private venture capitalists. At the end of 2012, this Fund, which is to set to continue until 2035, amounted to 1.5 trillion KRW (USD 1.4 Billion). It provides an option to start-ups particularly those where there is high uncertainty like in R&D. The equity investment in such cases can be more attractive than debt where it leads to risk sharing rather than paying interest cost on loan. Loan become more preferential when the company has grown and there is stable cash flows.

Credit guarantees

The government also supports SMEs through provision of Credit guarantee to encourage lenders to provide funds to SMEs by minimizing the risk exposure of the lender. From 2007 to 2011, public support in the form of credit guarantees amounted to 100 trillion KRW (8% of 2011 GDP) compared to 42 trillion KRW of direct lending. In Korea, guarantees are provided through the Korea Credit Guarantee Fund (KCGF), the Korea Technology Finance Corporation (KOTEC), the SMBC and 16 Local Credit Guarantee Foundations established and controlled by the government.

SME funding for Technology SMEs

KOTEC was established in 1989 to support SMEs possessing new technology. KOTEC has technology appraisal infrastructure to select companies for financing. Thus they have dual role of selecting the right technologies

to fund and provide credit guarantees. This increases the success rate of funding since there is a strong evaluation mechanism before funding a SME.

Moral suasion to protect SMEs during crisis

As a support mechanism the government uses moral suasion techniques and persuades banks to extend loan terms to protect SMEs from defaulting in difficult times. Giving priority to SME lending, the government also negotiates with bank to increase SME lending in return of them fulfilling banks demands. In 2009 around 160 trillion KRW of loans and 30.9 trillion KRW credit guarantees were rolled over.

Preferential rates to banks for SME lending

The Bank of Korea also has a voluntary scheme for banks run through its Bank-Intermediated Lending Support Facility where it provides funds to banks at lower rate provided they agree to have a certain percentage of loans being given to SMEs. The conditions and rates are revised periodically.

5.6. China

In China, funding happens through variety of ministries and government bodies which include both national and local government bodies and it spans from basic research to commercialization. Some of the key bodies are

- Ministry of Science and Technology (MOST)
- Ministry of Agriculture and Ministry of Health
- National Nature Science Foundation

Local governments supports by way of providing quality infrastructure through industry parks. Large parks offer incentives for starting operations in their city and also offer incubation space, funds and tax concessions and provide expert advice in return.

A slew of funding initiatives are available in China. Examples of these initiatives are

- **Support for basic research:** Includes programmes under Natural Science Foundation programmes, 973 programmes (started after High tech program 863), also focusing on developing Human resources in particular, such as the Yangtze River Scholars Programme, CAS Hundred Talents Programme, NSFC National Distinguished Young Scholars Programme, etc.
- **Support for high technology R&D:** Includes the High Technology R&D Programme (863 Programme), and the National Key Technology R&D Programme.
- **Support for technology innovation and commercialization:** Important here is the funding program under "Significant New Drugs Development" (SNDD) which was built into the five-year plan for supporting pre-commercialization, setting up technology transfer infrastructure under the important "Torch Programme", "Spark Programme", the "S&T Achievement Dissemination Programme" are some of the important measures. Important funding measures include.
    - o **Innovation Fund for Technology based firms (IFT):** Started by MOST in 1999, this programme has focused on firms dealing in agriculture, medical, animal projects and environmental biotechnology. The programme requires private sector recipients of this fund to make equal amount of investment for R&D purposes.
    - o **Venture capital through Guidance Fund (or Fund of Funds):** These are Government supported venture funds created with the objective of supporting early stage companies. Established in 2010, China's national fund of funds, "Cdb Kai Yuan Capital," is one of the most notable of these and it has fund size of USD 10 Billion.
- **Support for the construction of infrastructure for scientific research:** Includes the National Key Laboratories Programme and Government support through MOST for sharing of research facilities including large equipment, biological resources, Science and Technology publication and important databases.
- **Development of human resources in science and Technology:** in addition to those mentioned above, multiple programmes and rewards initiated by the Ministry of Education are aimed at developing human resource in science and Technology, such as the "New Century Talents Training Programme" and the "University Young Scholar Awards".

Case Study Torch Program (Started in August, 1988)

Objectives

Program for developing innovative and high-tech industries in China

Impact:

- Over 25000 projects entitled as Torch Projects over last 25 years
- The SITP housed under Torch program contributed 7% of China's GDP and close to 50% of all of China's R&D spending
- Over 100 National High Tech zones created and 126 Provincial High Tech zones created

Main components

This program has four major components

- Innovation Clusters
- Technology Business Incubators (TBIs)
- Seed Funding (Innofund)
- Venture Guiding Fund

Innovation clusters

- Established by creating national Science and Technology Industrial Parks (STIPs); Software Parks and Productivity Promotion Centers in the clusters
- 50+ STIPs and approximately 40 software parks created under the scheme
- Industry and academic research collaboration is facilitated through over 2000 Productivity Promotion Centers
- Technology specific clusters were created under this program; Zhangjiang in Shanghai in integrated circuits and pharmaceuticals, Tianjin – biotech and new energy, and Zhongshan – medical devices and electronics are some examples

Technology Business Incubators (TBIs)

- Technology incubation service institutions were strengthened including
- University Science Parks
- Technology Business Incubators
- Regional Incubation Centers
- In 2012, there were 1239 Technology Business Incubators including 435 as National incubators, hosting nearly 70,000 companies
- 95 university science parks were also created for encouraging development at university level itself
- Sector-specific incubators include Biomedicine Incubator in Shanghai, Advanced Material Incubator in Beijing and a Marine Technology Incubator in Tianjin.
- Some of the startups which started at these incubators have grown to reputed firms in their field including Lenovo, Huawai, Suntech Power

Innofund- Seed funding

- Set up in 1999, China's InnoFund was aimed bridging early stage funding gaps for technology firms. Program is on similar lines as that government sponsored SBIR and STTR programs in the US
- Support under the program happens through loan interest subsidies and equity investment which ranges from USD 150,00 – USD 250,000
- Qualifying criteria attracted Chinese owned firms operating in high-tech R&D, having less than 500 employees, at least 30% of the employees in technical functions
- Since establishment, the program funded 30000 SMEs are funded through this program

Venture guiding fund[48]

- Started in 2007 this fund was aimed at attracting more capital into growing startups
- The Venture Guiding Fund worked in different ways- by investing directly into VC funds, co-investing with VC's, providing risk subsidies in some VC bets and providing grants for portfolio reserves.

5.7. Germany

Biotechnology companies in Germany are funded via venture capital, the stock market (capital increases and/or floatation (IPOs)) and grants from federal and Länder governments. Funding programmes provide sufficient start-up financing and project financing for SMEs.

While adequate sources of financing are available for early stage investments, follow-on which require a higher financial commitment uses is a challenge.

The public-sector funding programmes outlined below have been initiated by the German government and the EU to finance company start-ups or research.

"GO-Bio", administered by the BMBF was started in 2005 to promote life sciences research. The funding recipients are university and non-university research institutes/start-ups and the program aims to enable a company to be started out of a research project and facilitate commercial exploitation. The successful applicants receive their funding in two phases, each lasting a maximum of three years. Technology validation is the objective of the first phase which is fully funded by BMBF. For the second phase, a private investor has to be funded by the startups to provide co-financing.

"INVEST – Zuschuss für Wagniskapital": Key objective is to mobilize venture capital for start-ups. Investors can invest a minimum of EUR 10,000 per company and a maximum of EUR 250,000 per year. Companies are eligible to receive grants of EUR 1 Million per year. By mid-2014, however, only around EUR 7 m of the EUR 150 m set aside for the INVEST-Zuschuss programme in the federal budget had been drawn down.

KMU Innovativ: Launched in 2007 by the BMBF, this is an R&D project funding initiative for small and medium-sized companies Biotechnology, medical equipment, information and communications technologies, nanotechnology, production technology and clean and energy efficient technologies are focus sectors under this program. Funding (and support to complete grant applications) are offered to SMEs. Applications are assessed twice a year and approved applications receive 50% of the total fund needs from KMU Innovativ (with the applicant needing to chip in with the remaining 50%). Projects usually run for three years.

The EU research promotion programme "Horizon 2020" as well as Germany high-tech strategy consider biotechnology as a focus sector for funding. International cooperation between research institutions or firms is a precondition for receiving funding from the programme.

BioChancePlus is a financial instrument through which the German Federal Ministry for Education and Research (BMBF) is supporting the high risk development of young biotech companies. The BMBF programme makes available €100 Million in project funds. Together with a further €150 Million in private capital, this is to encourage in particular cooperation and networking between companies. The aid is specifically aimed at helping spinoffs and startups establish themselves for the purpose of bringing new biotechnology products to market.

In addition to the Government funding, BASF, Deutsche Telekom, Siemens, Daimler Chrysler, Carl Zeiss and Robert Bosch have formed a partnership with the federal government and the KfW development bank to provide venture capital funding for technology sector startups. The HighTech Gründerfonds is directed at "young high opportunity technological companies implementing promising research results in an entrepreneurial manner"– including biotech companies. In addition to providing €272 Million in venture capital funding, the program provides young startups with managerial supervision.

5.8. Summary

Innovation driven economies offer a slew of fiscal and tax incentives for investments in Research and Development, Capital Investment, Employment Generation and Workforce Training. These include:

1. Angel Investments are eligible for deduction from income for purposes of tax computation
2. Weighted deduction upto 400% available for investments in research and development
3. Venture Capital are companies eligible for concessional tax rate
4. Sales Tax exemptions are available for equipment used in Biotechnology Research or Manufacturing
5. Tax credits are available for companies which generate jobs

6. Tax Credit are available for fees paid to regulatory bodies for approvals
7. Tax Credits are available for expenses incurred in work force training
8. Corporate Income Tax rate is lower for income from exploitation of IP

Study of the model practices of innovation driven economies suggests the following common themes

1. Need to Fund Broadly: Biotechnology Research is resource intensive and funding at different stages across entire R&D cycle is important
2. Need to Fund Deep: There is a need for adequate funding at each stage from early to scale up
3. Need to Fund Long: Given the long research and development cycle, funding mechanism should have patient cycle of 8-10 years.
4. Need to have Fund Choice: Given the different maturity levels of companies within the Biotechnology spectrum, options for Grant, Equity, Debt funding should be available
5. Need to Support a Fund of Fund Model: Fund of Funds Model allows a range of projects to be funded and also allows for private sector participation in areas which are aligned to their strategic interests
6. Need to foster Public Private Partnerships: which allow for private sector funding to augment Government initiatives
7. Need to Support Capacity Development: Alongside funding there is a need for capacity development in Researching and Selecting Investees. External advisors can complement Internal capacities within Governments/funding organizations
8. Need to protect Intellectual Property Rights: Allowing the IPR to remain with the inventor provides an incentive to attract talent and creates a convenient path to commercialization
9. Need to foster Startups and Small and Medium Enterprises (SMEs): Given the preponderance of small firms and startups in Biotechnology, there is a need to have Credit Ratings, Concessional Credit Terms, Credit Guarantee and Equity Funding for the growth of the industry

The Common Global Themes for Building an Innovation Economy

6. Fiscal, Tax and Policy Incentives for Biotechnology: The International Experience

This report studied various fiscal, tax and policy tools deployed by Israel, Singapore, the USA and Germany

Israel

- Corporate taxes in priority areas is 6% while that in central areas is 12%
- Investment grant in priority areas is 20%
- Approved Enterprise (located in priority areas) Grant of 20% to foreign companies
- Employment grants to small and large companies based on their location wherein the government shall bear a percentage of each new employees cost of monthly salary for the first 4 years
- Angels Law: The Amendment allowed Israeli and foreign individuals who invest in qualifying "Target Companies" between January 1, 2011 and December 31, 2015, to deduct the invested amount from their overall taxable income from all sources. The amount of the deduction was capped at NIS 5 Million per Target Company. There was no limit to the number of companies that an investor can invest in - an investor can thus invest in more than one company and enjoy the tax benefit several times.

Singapore

- **Land intensification incentive :** The LIA incentive is available to businesses in industry sectors which have the need for large land banks Approved LIA incentive recipients get an initial allowance of 25% and annual allowances of 5% on qualifying capital expenditure incurred for the construction or renovation/extension of a qualifying building or structure. At least 80% of the total floor area of the approved LIA building or structure must be used by a single user
- **Angel Investors Tax Deduction (AITD) Scheme :** Angel investors investing minimum of USD 100,000 in a startup can claim a tax deduction of 50% from the investment at the end of a 2 year holding period. For each year, the eligible investment is capped at USD 500,000
- **Productivity and Innovation Credit (PIC) Scheme (this scheme ended in 2015) :** The PIC scheme introduced in 2010 allows businesses to enjoy up-to 400% deduction or allowances on up to USD 400,000 of expenditure incurred in Research & Development; Intellectual Property registration; Intellectual Property acquisition; Design activities, Automation through technology or software; and training of employees
- Tax incentives for VCs : Approved venture capital fund management companies managing Section 13H funds will be charged a 5% concessionary tax rate on their specified income for the period 1 Apr 2015 to 31 Mar 2020

United States: California

- **California Competes Credit** - This credit is an investment incentive to attract businesses to California or expand or retain businesses already located in the state. The State GO-Biz Program can now negotiate the offering of credits, to companies, based upon job creation, location and capital investment.
- **Industrial Development Bond (IDB):** Industrial Development Bond (IDB) financing is available for the acquisition of manufacturing facilities and equipment. IDB provides a financing option for manufacturers to access private capital markets at tax-exempt rates.
- **Manufacturing Sales Tax Exemption** – Businesses involved in Biotechnology Research and Development or manufacturing, located in California are eligible to receive a sales tax exemption of 4.19% for the period January 2014 to June 2022. This tax exemption is

applicable to equipment purchases of up to USD 200 Million by a company

- **Research & Development Tax Credit** - This State Tax Credit aims to encourage companies to increase their basic R&D in California. Under this credit, the companies receive a 15 percent credit against their bank and corporation tax liability for specified in-house research expenses, and a 24 percent credit for basic research payments to external organizations.
- **New Employment Credit (NEC)** - Taxpayers who own companies located in a designated geographic area (DGA) that have net increases in jobs on a year-on-year basis are eligible for a 35% tax credit. To receive this credit, employees must be hired between 1/1/14 and 1/1/20, and earn wages between USD 12 and USD 28 per hour, and be one of the following categories:
  - not employed for the previous six months;
  - a Veteran who left service within the last year;
  - an ex-offender convicted of a felony;
  - A recipient of CalWORKS or general assistance.
- **Small Business Loan Guarantee (SBLGP):** The California Small Business Loan Guarantee Program (SBLGP) encourages investment into low- to moderate- income communities. The SBLGP assists small businesses in obtaining a loan as well as establishing a favourable credit history with banks so that the businesses can obtain loans in the future on their own merit
- **California Capital Access Program**

  The California Capital Access Program (CalCAP) urges participating banks and other lenders to extend loans to small businesses that may not meet conventional underwriting standards. Small business owners that have difficulty in obtaining conventional financing may qualify for a CalCAP loan through any CalCAP lender.
- **California Capital Access with Collateral Support (CalCAP - CS)**

  CalCAP CS commits cash to cover the collateral shortfall of loans of USD 50,000 or more for any small business owner in California. Loans can be used to meet start-up costs, capital equipment purchases, inventory, renovating a place of business etc. The borrower's main business and a minimum of 51% of its employees or business income, sales or payroll must be in California.
- **Pollution Control Tax-Exempt Bond Financing Program**

  Tax-exempt bond financing to businesses based in California for acquiring qualified pollution control, waste disposal or waste recovery facilities or the acquisition and installation of new equipment.

United States: Massachusetts

- **Cooperative Research Grant–** Grants up to USD 250,000 per year for 3 years with a 1:1 matching support from industry partner to facilitate scientific discoveries that lead to medical applications
- **Accelerator Loan Program–** Offers up to USD 750,000 as matching funds for early-stage life sciences companies to help leverage additional sources of capital.
- **Internship Challenge** – Aims to expand the life sciences workforce talent pipeline in the state. The program enables the placement of students and recent graduates into paid internships in life sciences companies. Salaries paid are then reimbursed by the Massachusetts Life Sciences Centre (MLSC) to the companies where internships happen
- **Small Business Matching Grant (SBMG) Program—** Applicable to firms on the verge of commercializing new technologies developed using Phase II or Post-Phase II Small Business Innovation Research (SBIR) awards or Small Business Technology Transfer (STTR) grants from the federal government. Provides matching support capped at USD 500,000 per firm.
- **Job Creation Tax Incentive Program** – Only Certified Life Sciences Company (as per MSLC guidelines) receive the benefits

The incentives include:

- Refundable Investment Tax Credit of 10%
- Refundable Research Tax Credit
- Special Exemption from Sales Tax
- Concessions in Let Operating Losses to 15 years
- Credit for FDA User Fees
- Special Deductions for clinical testing of Orphan Drugs
- Exemption from Construction Sales Tax

In addition to these incentives which are specific to Life Sciences, other Massachusetts Incentives include:

- **Workforce Training Fund (WTF) –** Provides grants up to USD 100,000 to improve the skills of new or incumbent workers. A variant of this fund, The WTF Express program offers grants of up to USD 15,000 for approved off-the-shelf worker training programs.
- **Investment Tax Credit (ITC) –** A 3% ITC for investments in fixed assets to all manufacturers located in the State. Massachusetts also provides an exemption from Sales & Use Tax for companies engaged in R&D.
- **Economic Development Incentive Program –** In specified Economic Target Areas, expansions can be made with Tax Increment Financing (TIF) agreements which provide for exemptions on the value added to a property in the expansion process and a 3-5% Investment Tax Credit approved by the State.
- **Research and Development Tax Credit –** 10% Massachusetts R&D credit for Costs that qualify for the Federal R&D tax credit. Tax Credit of 15% is available for costs related to research done in universities
- **Single Sales Tax Treatment –** Apportions corporate income based solely on the ratio of in-state sales to total sales thus providing a significant, relative advantage to Massachusetts manufacturers with multi-state operations.
- **Financing –** The Emerging Technology Fund provides up to USD 2.5 Million in low-cost financing to eligible technology-based firms. In addition, export assistance loans, equipment loans, and guarantees to growing manufacturers are available under MassDevelopment
- **Infrastructure Grants –** Municipalities can seek grants to assist with the costs of job creation activities like roadway, water and sewer projects construction through the MassWorks Infrastructure Program.

United Kingdom

R&D incentive: "Super deduction" for both large companies and SMEs

Large Companies

- From 1 April 2013 option to claim the 10% R&D expenditure credit (RDEC) instead of 130% super deduction.
- From April 2016, RDEC will be mandatory. RDEC will be payable to loss-making companies.

Small and medium Enterprises (SMEs):

- 175% pre 1 April 2011
- 200% from 1 April 2011 to 31 March 2012
- 225% from 1 April 2012
- Provision of Cash backs to SME's in case of losses
- **Patent Box:** provides a reduced corporate income tax rate for certain income arising from the exploitation of IP (Patents, supplementary protection certificates, regulatory data protection, and plant variety rights)
- **Seed Enterprise Investment Scheme (SEIS):** Helps small, early-stage companies raise equity funding by offering tax reliefs (of 50% of the cost of shares subject to a maximum annual limit of £100,000) to individual investors who purchase new shares in those companies. These shares have a holding period of 3 years. Relief is not eligible if the shares are disposed of within that 3 year period, or if any of the qualifying conditions are not met during that period

South Korea

Incentives Offered for Investors by the Central Government

- Tax reduction or exemption for 5-7 years
- Rent for land use reduced 50-100%
- Cash grant not less than 5% of the invested amount
- Employment subsidy
- Education / training subsidy

Supportive Measures for Foreign Investors Taken by the Seoul Metropolitan Government

- Income tax: 100% for 5 years after income creation and 50% for next 2 years
- Acquisition & Registration tax: 100% for 10 years after income creation and 50% for next 5 years
- Property tax: 100% for 5 years after income creation.50% for next 2 years
- Cash grant for business employing large number of people (50-300)
- Training subsidy of USD 902 per month per employee for 6 months (limit of USD 180,000 per company)

Germany

- **Early Stage Investment Project Financing:** Venture capital (VC) partners can be found through the German Private Equity and Venture Capital Association (BVK). Events like the German Equity Forum provide a platform for interaction between young enterprises and potential VC partners. Public institutions such as development banks and public VC companies may also offer partnership programs at this development stage.
- **Later Stage Investment Project Financing:** Working capital loans, bridge loans or investment loans are available from Commercial Banks or through publicly subsidized loan programs in Germany. These programs usually offer loans at an attractive interest rates in combination with repayment-free start-up years, in particular for small and medium sized companies. State-owned KfW development bank and regional development banks provide such loans.
- **Cash Incentives for Investment Projects:** Most important cash incentives provided are in the form of non-repayable grants applicable to co-finance investment related expenditures such as new buildings, equipment or machinery.
- **Labour-related Incentives:** Companies can receive subsidies for building up a workforce or the implementation of R&D projects. Labour related incentives play a significant role in reducing the operational costs incurred by new businesses and are applicable for recruitment support, training support, and wage subsidies
- **R&D Project Grants:** Pan-European, National and Regional project grants are available in addition to investment incentives. . R&D project funding at the National Level has been concentrated in the High-Tech Strategy areas to push the development of cutting edge technologies.

In the UK, the Patent Box provides a reduced corporate income tax rate for certain income arising from the exploitation of IP

7. Access to Capital for Biotechnology: The Indian Experience

The Indian Biotech startups and SMEs access capital through several routes. Over the last few years, the Government of India has taken a focused approach to support Innovation in Biotechnology besides public financing, there is now a growing numbers of private funders.

7.1. Debt Funding

1. Raising debt from Banks

Bank lending is the most common source of external finance for many SMEs which are often dependent on traditional debt to fulfill their financing needs.

However bank lending has the following challenges

- The approach adopted by banks to evaluate the business case for lending is very restrictive and risk averse. Most banks provide loans only against collateral and adequate security of assets. Consequently, startups and asset-light SMEs face challenge in meeting such requirements. This is particularly important for Biotech SMEs which have asset light models using existing infrastructure at biotech parks and have their Intellectual Property as their main asset
- High risk of NPAs also force banks to adopt a very cautious approach in sanctioning loans to Startups and SMEs

2. Raising debt from Private Lenders / Institutional Finance

SMEs in India rely heavily on private money lenders and the unorganized financial sector for their requirements. The terms of financing are however unclear in many cases and the interest rates are high.

3. Overseas lenders (External Commercial Borrowings)

External Commercial Borrowings (ECB's) can be raised by borrowers from international banks and international capital markets, multilateral financial institutions.

Challenges associated with ECBs include

- Difficult for SMEs and Startups to adhere to the stringent norms / evaluation criteria set by such internationally recognized sources.
- Various end use restrictions for ECB
- All-in Cost Ceilings
- In case approval route is sought for, then the process become time consuming affair
- Cost Ineffective for SME's as small amount of loan attract higher margins over LIBOR

4. Foreign Portfolio Investment – Non-convertible debt

The government has been cognizant of the funding gap which plagues Indian SMEs. In the 2012-13 Budget, the government announced an India Opportunity Fund of USD 878 Million to support Indian SMEs. This entire amount will be routed to Small Industries Development Bank of India (SIDBI) and is divided into specific targeted sectors. Government also introduced the Credit Guarantee Fund Trust Scheme for SME's and specialized MSME bank branches for providing better service to this sector permitting Composite Loan limit of Rs. 1 crore to be sanctioned by Banks.

5. Hybrid Products

Hybrid products have features of both debt and equity. Risk Capital is an important instrument for start-ups, innovative/ fast growing companies as well as those companies looking at growth. Risk capital reduces the capital to be brought by the entrepreneurs. Whilst initially hybrid products were only provided to late stage ventures, in recent times, seed funding / angel funding have also started picking up.

7.2. Equity Funding

1. Bootstrapping

Very early stage funding is usually provided from the personal savings of the founders and from contributions from friends and family. Additional sources of funding in the form of grants from Governments, cash prizes from winning in initiatives like Grand Challenges and support from philanthropic organizations and development partners are also available.

2. Angel / Seed Funding

Early stage funding requirements are met through an ecosystem of seed funds and angel investors. Recent years have seen the emergence of angel networks in leading Indian cities which have funded startups in the Biotech sector. In the last few years, Indian Angel Network and Accelerators have been investing in the Indian Biotech startups. Privately managed Seed Funds have also invested in the medical technology sector in India though the quantum of funding is low. SEBI has recognized the importance and growth of angel funds and thereby has inserted a specific chapter under the India Fund Regulations specifically governing angel funds.

3. Venture / Private Equity Funding

Growth capital is provided by Venture Capital organizations and Private Equity Investors to medium sized enterprises. While valuations continue to be a challenge, established companies with stable revenue models are beginning to attract the attention of growth capital firms with investments coming in across all segments of Biotechnology industry.

For research focused Biotech companies without a revenue model, the growth capital stage is often the period when funding becomes a challenge. The scientist-entrepreneur has exhausted his sources of funds – investors are however unwilling to invest in the company at this stage given the lack of revenues and negative cash flows. This critical phase sees the closure of many Biotech companies and is often referred to as the Valley of Death. Innovative financing schemes are required to address this challenge. Advance Market Commitment (AMC) and Priority Review Vouchers are a couple of initiatives which have been proposed to address the challenges in the Valley of Death especially for investments in diseases found in the developing world.

Advance Market Commitment for Vaccines

An AMC is a legally binding funding agreement through which a country or organization agrees to purchase at an agreed price, a specified quantity of vaccines target diseases with high mortality and morbidity. This commitment is made when the vaccine is under development (and hence the term "advance") and is designed to help the vaccine company invest in research and development and manufacturing of vaccines by guaranteeing a demand for the vaccines.

AMCs can be designed both for products at an early stage of development (such as malaria, HIV/AIDS vaccines) and for late stage products (such as vaccines against rotavirus, human papillomavirus, and pneumococcal disease).

Through the AMC mechanism, donors subsidize the purchase of vaccines by developing countries, for a specified number of units or total amount. Once this limit is reached, manufacturers would be contractually obligated to either sell to developing countries at an affordable price or to license their technology to other low cost manufacturers.

An AMC for the development of the pneumococcal vaccine has been proposed by the Global Alliance for Vaccines and Immunizations. Funding of USD 1.5 Billion for the AMC has come from the Governments of Italy, UK, Canada, Russia and Norway and the Bill and Melinda Gates Foundation. GAVI has estimated that 200 Million doses of Pneumococcal vaccine would be required annually. UNICEF does the procurement of these vaccines for GAVI. Manufacturers intending to participate in this AMC (who have to be pre-qualified by WHO) should agree to supply a certain committed number of doses at a price not higher than USD 3.5 per dose. In return, the manufacturers will receive a share of the total funding of USD 1.5 Billion in proportion to their supply commitment. Four vaccine manufacturers including two from India have signed up for this AMC.

4. Capital Markets

Access to capital markets provided higher levels of funding as well as an exit option for growth capital investors. In the last 12 months organizations in the Biopharmaceutical and

Bio-services segments have had successful Initial Public Offerings and raised money from capital markets.

7.3. SME Exchange

Small Biotech companies without a record of profitability have difficulty in accessing capital markets. The SME exchange has been initiated in an attempt to expand the opportunities for startups and SMEs to access capital markets. NASDAQ in the US started as an SME exchange. Other dedicated stock exchanges for SMEs like AIM (Alternate Investment Market) in UK, GEM (Growth Enterprise Market) in Hong Kong, TSX Ventures in Canada, MOTHERS (Market of the high-growth and emerging stocks) in Japan, Catalist in Singapore, Chinext in China provide access to capital markets for SMEs.

These SME exchanges follow a set of model practices which include

- Focus / incentivize SMEs with a sizeable growth rate
- Have the SME exchange legally related to the main exchange
- Do not dilute disclosure content to reduce costs
- Allow private placements
- Have well-regulated advisors to vet issuers and provide comfort to investors about the quality of the issue
- Have public awareness campaigns and training for SMEs and
- Provide tax incentives for investors.

In India, startups and SMEs are provided with 2 platforms for accessing capital market viz. SME listing platform and BSE Hi-tech listing platform.

SME Listing platform is an initiative to provide SME's with equity financing opportunities to grow their business. Equity financing lowers the need for Debt which in turn leads to lower interest costs and a healthier balance sheet. In addition to the above benefits, a listing platform also makes investment in the SMEs and startups more attractive with lower tax rates on capital gains on disposals, continuity of losses even in case of change in shareholding, non-applicability of tax on receipt of shares for lower consideration etc.

BSE Hi-tech is another platform that offers capital raising opportunity for innovative, new age companies that require funds.

There are challenges associated with listing on the SME Listing Platform / BSE Hi-Tech platform viz.

- Requirements in SME listing platform including threshold for paid up capital, minimum net worth, minimum tangible assets and track record of profitability.
- BSE Hi-tech listing requirements include pre-issue capital to be held by institutional investors
- Number of allottees in case of a public offer shall be 200 or more
- Limiting the quantum of funds that can be raised to Rs. 25 Crores
- Compliance with disclosure requirements
- Retail individual investors allowed to invest only after 2 years (SME Listing) and 3 years (BSE Hi-tech)
- Requirement to dilute at least 25% of the capital by the promoters

These challenges have limited the number of SMEs that use these platforms and 125 companies in total have been listed on the BSE SME Platform. 19 of these companies have migrated to the main BSE Board. Out of the remaining 109 companies, 33 companies are being traded on the BSE SME Platform

Enhancing access to SMEs for public capital would require the following:

- Relaxation of eligibility norms by SEBI for startups
- Additional exit options
- Reduce minimum trading lot size could enhance liquidity in the system
- Reducing routine compliances
- Waiving the requirement for minimum public shareholding for listing by SME/ startups

SMEs can also prepare themselves better for listing on the SME exchanges by arranging for balance sheet highlighting the adherence to the requisite conditions, making sure that the documentation needs are fulfilled and having a clear business plan for the future cash flows which will enable ease in valuation.

Government initiatives for private funding of SMEs

Government can come up with following initiatives to create a conducive environment for private funding:

- Reducing compliances and approval mechanisms for attracting the foreign investors to invest in attractive and high growth potential companies and ideas.

- Providing a single window clearance for raising funds by startups and SMEs
- Making legal, tax and regulatory environment smoother to operate by bringing relaxed norms for the new initiates and startup with innovative ideas.
- Relaxation towards number of approvals those are required for a foreign investor to infuse capital in the new and innovative idea.
- Relaxation towards disinvestment by overseas investors which provides foreign investors/ funds, an easier exit route

Lack of understanding of the biotechnology industry commercial models and paucity of skills in valuing intellectual property associated with biotechnology have hampered the ability of Indian Biotechnology firms in accessing capital. This situation is however changing with the support from Government funding, successful biotechnology entrepreneurs who have come forward to fund biotech startups and biotech sector focused growth capital funds.

7.4. Funding from Biotechnology Industry Research Assistance Council (BIRAC)

BIRAC has emerged as a significant source of funding for biotechnology entrepreneurs in India and helping them make a successful transition from scientists to entrepreneurs

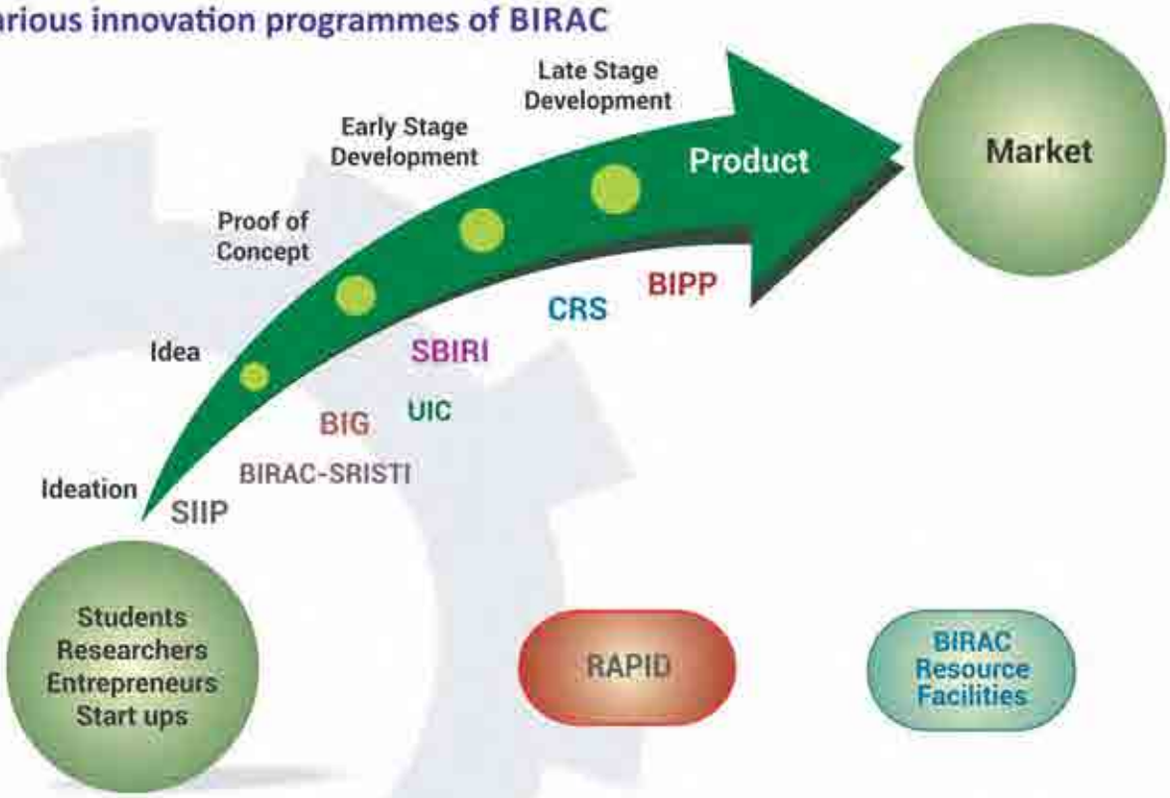
Biotech Ignition Grant (BIG) is a flagship grant funding programme available to biotech startups, scientist entrepreneurs from research institutes and academia. BIG is designed to stimulate commercialization of research discoveries by providing very early stage grants upto 50 lakhs to help bridge the gap between ideation and proof of concept

Small Business Innovation Research Initiative (SBIRI) provides grant in aid up to Rs. 50 Lakh for early stage pre-proof of concept research. SBIRI has prioritized early stage funding for high risk innovative research in small and medium companies led by innovators with science backgrounds to get them involved in development of products and processes which have high societal relevance

Biotechnology Industry Partnership Program (BIPP) is a dual contribution funding (in PPP mode) mechanism for product and technology development for validation and scale up of highly innovative projects.

Contract Research Scheme (CRS) provides support to Academia in the form of grant-in-aid for taking proof of concept (PoC) of their solutions towards commercialization in partnership with industry for a fee which is governed by a specific contract

The various innovation programmes of BIRAC



8. Conclusion

Biotechnology is one of the sunrise sectors and an intrinsic component of the 21st century knowledge economy. Indian Biotechnology industry has set an ambitious target of USD 100 Billion by 2025. Achieving this target would enable the Biotechnology industry to increase its share of India's GDP from 0.35% to 2.5% of India's potential USD 4 Trillion economy in 2025.

Make in India has been launched to improve India's manufacturing competitiveness. India's strengths in Biotechnology can be leveraged by the Make in India initiative to achieve major development which include

- Health Security through advances in Biopharmaceuticals, Bio-Services and Bio-IT
- Food Security through advances in Bio-Agriculture
- Energy Security and Clean Environment through Bio-Industrials

Specific opportunities within Biotechnology which are amenable to High Value Manufacturing include the following:

- Biosimilars / vaccines– this would involve investments in analytical process development including fermenter design and technologies for fill & finish of products
- Medtech Manufacturing including high end 3D printing & design
- Secondary agriculture (value addition to the primary commodities produced in India on a large scale) and Production of transgenic crops
- Industrial Enzymes
- Big Data and Analytics for Bio-pharmaceuticals and Precision Medicine
- Bio-polymers/biomaterials using synthetic biology
- Regenerative Medicine & Stem cells: especially automation and manufacturing of stem cells and bio-printing and injectable scaffolds

In addition, Make in India campaign will help in achieving specific objectives like the following:

1. **Job Creation**

   Make in India campaign looks to create 100 Million additional jobs by 2022. Biotechnology sector can provide highly skilled jobs in the areas of research and development, engineering design and bioprocess manufacturing.

2. **Foreign Investment**

   The Bio-pharmaceutical sector has received inflows of USD 13.3 Billion in the period from 2000-2015. Make in India will see additional investments by Multinational corporations and investors in Biotechnology infrastructure development, research and development facilities and manufacturing plants.

3. **Export Revenues**

   Bio-pharmaceutical exports from India reached USD 2.2 Billion in 2015. With the opportunities provided by Bio-similars and investments in manufacturing quality system improvement, the export revenues can be expected to increase substantially in the coming years.

4. **Import Substitution**

   Over 70% of India's medical technology needs are met through imports. Many life-saving drugs for oncology, auto-immune disorders are also imported into India. Domestic manufacturing as part of the Make in India initiative, will help reduce import dependence and reduce the cost of drugs and devices for the common man.

5. **Innovation**

   India's share of patents filed globally is very small in comparison to developed countries as well as developing countries like China. Make in India along with the Startup India initiative aims to improve the Innovation ecosystem in India. Biotechnology sector which, globally, has been propelled by startups and SMEs is expected to lead the march towards IP creation and innovation

For these objectives to be realized in practice, India needs to address the following challenges

- Boosting demand for biotechnology products including through catalytic procurement
- Reforming the regulatory system
- Improving the Ease of doing business in India
- Providing the right policy environment including fiscal and tax incentives to boost R&D and manufacturing
- Providing the right infrastructure for biotechnology companies especially catalyze a vibrant VC funding landscape
- Improving the access to capital for biotech companies
- Enhancing the skills needed for biotechnology research and manufacturing
- Enabling Indian companies to acquire world class manufacturing quality

Access to capital remains a challenge for biotechnology companies especially Startups and SMEs. Government can support access to capital through

- Enhance funding available through BIRAC
- Innovation Fund for financing Biotechnology research and development

Government can also come up with following initiatives to create a conducive environment for private funding:

- Reducing compliances and approval mechanisms for attracting the foreign investors to invest in attractive and high growth potential companies and ideas
- Providing a single window clearance for raising funds by startups and SMEs
- Making legal, tax and regulatory environment smoother to operate by bringing relaxed norms for the new initiates and startup with innovative ideas
- Relaxation towards number of approvals that are required for a foreign investor to infuse capital in the new and innovative idea
- Relaxation towards disinvestment by overseas Investors which provides foreign investors / funds, an easier exit route

In addition, the following policy reforms can help in growth of Biotechnology sector in India

- Modifying the announcement in Budget 2016 on flat 10% tax on royalty income derived from Intellectual Property (IP) to flat a 10% tax on all revenues from commercialization of IP
- All Biotech SEZs should be exempt from Minimum Alternate Tax (MAT) from the current 20.5% effective MAT and tax holidays for 10 years
- Import duty exemption for capital goods used in Biotechnology manufacture
- A preferential pricing policy (with 15%-20% premium) in line with World Bank guidelines for products made in India in government procurements
- Weighted deduction on Research and Development expenditure is proposed to be reduced to 100% by 2021 in Budget 2016. This reduction should be reversed and weighted deduction on R&D should be increased to 300% of R&D
- R&D Expenses incurred outside India should be included under the definition of expenses allowable for weighted deduction
- Contribution to SEBI registered Biotech focused funds to be eligible for weighted average tax deduction

Achieving the target of $US 100 billion would enable the Indian Biotechnology industry to increase its share of India's GDP from 0.35% to 2.5% of India's potential USD 4 Trillion economy in 2025

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KK Narayanan - Founder Metahelix

Chandrasekhar Nair - Founder Director of Bigtec

Ranjan Patnaik - Director, DuPont Knowledge Center

Anurag Rathore - Professor, IIT Delhi

Kavitha Iyer Rodrigues - Founder Theramyt

Ganesh Sambasivam - Founder, Anthem

Nandakumar S - Founder Perfint

Srini Srinivasan - MD, Hospira

Shyam Suryanarayanan - CEO, C-Drive

Suri Venkatachalam - Founder Connexios

Premnath Venugopalan - Head NCL Venture Center, Pune

Contributors - PwC

Sujay Shetty - Partner and Pharma Lifesciences Leader

Krishnakumar Sankaranarayanan - Director Pharma Lifesciences

Deepak Manot - Associate Director Pharma Lifesciences

Rahul Ambadkar - Manager Pharma Lifesciences

Poonam Shirke - Manager Pharma Lifesciences

Contributors - BIRAC

Satya Prakash Dash - Head Strategy, Partnerships and Entrepreneurship Development, Co-ordinator Make in India (MII) Facilitation Cell, BIRAC

Ankur Gupta - Senior Manager, Business Development

Chhaya Chauhan - Manager, MII Facilitation Cell, BIRAC

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For further information please contact:

Biotechnology Industry Research Assistance Council

1st Floor ,MTNL Building ,9 , CGO Complex, Lodhi Road, New Delhi-110003

Phone: 011-24389600 **Fax**: 011-24389611

E-mail: birac.dbt@nic.in, **www.birac.nic.in**

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