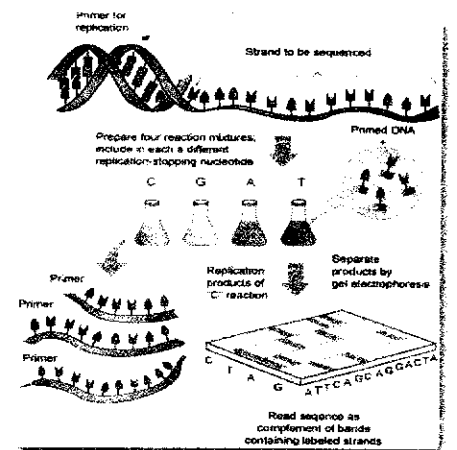
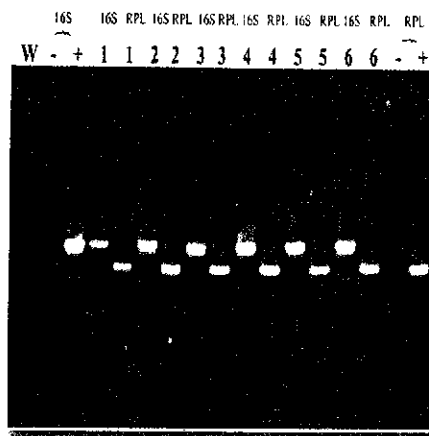
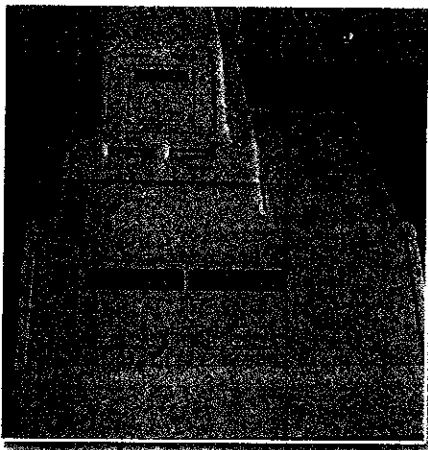
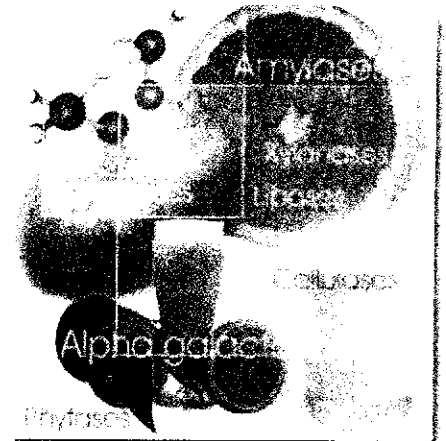
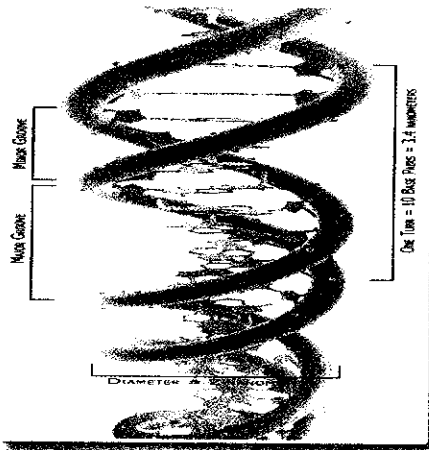




National State-of-the-Art Report on Biotechnology for Nepal



Jointly Prepared by

Nepal Academy of Science and Technology (NAST)

Khumaltar, Lalitpur, Nepal

And

Ministry of Environment, Science and Technology (MoEST)

Government of Nepal, Singha Durbar, Kathmandu, Nepal

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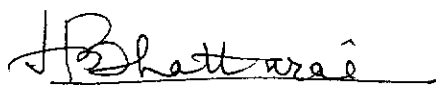
FOREWORD

It is now well acknowledged that Biotechnology holds great promise for all round economic development of any nation. Biotechnology/ Modern Biotechnology have now become crucial for sustainable development in every biological sector including agriculture, forestry, medicine and environment. Therefore, highest possible priority should be given to this frontier area of S & T by the government as well as private sectors. In this context, Nepalese industries have greater role to play in order to promote Research, Development and subsequent Business based on various biotechnological innovations in various sectors.

Present National State – of – the – Art (SoA) Report is the outcome of its long perceived need for the national, regional and international collaboration in various Biotechnology sectors of Nepal. I hope this report will provide a glimpse of the present status and future prospects of Biotechnology in Nepal.

I would like to sincerely thank Ministry of Environment, Science and Technology, Nepal Government for providing partial financial support for the national seminar in connection with the preparation of this report. I would also like to congratulate and thank NAST Biotechnology and Food Technology Scientific Sub-committee particularly, the Coordinator, Dr. Mukunda Ranjit and Member Secretary, Dr. Sangita Shrestha for the successful organization of the seminar and production of SAARC SoA report, National SoA report and the seminar proceedings.

Finally, I thank organizing committee, paper review committee, editorial committee, NAST volunteers and staffs for their great effort in organizing this national seminar as well as for bringing out this publication.



Prof. Dr. Hom Nath Bhattarai
Vice Chancellor
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LIST OF ACRONYMS

AFLP	:	Amplified Fragment Length polymorphism
BCH	:	Biosafety Clearing House
BINASIA	:	Biotechnology Information Network for Asia
BSP	:	Biogas Support Program
CAT	:	Centre for Agricultural Technology, Gwarko
CBD	:	Convention on Biological Diversity
CITES	:	Convention on International Trade of Endangered Species of Flora and Fauna
CPB	:	Cartagena Protocol on Biosafety
CVL	:	Central Veterinary Laboratory, Tripureswor
DFTQC	:	Department of Food Technology and Quality Control
DNA	:	Deoxyribonucleic Acid
DPR	:	Department of Plant Resources, MoFSC, Thapathali
ELISA	:	Enzyme Linked Immuno Sorbent Assay
ENPHO	:	Environment and Public Health Organization
FFP	:	Food, Feed and Processed products
GE	:	Genetic Engineering
GLP	:	Good Laboratory Practice
GM	:	Genetically modified
GMO	:	Genetically Modified Organism
GREAT	:	Green Research and Technology
HCV	:	Hepatitis C virus
HEV	:	Hepatitis E virus
HICAST	:	Himalayan College of Agricultural Science and Technology
HIV	:	Human Immune-deficiency Virus
HLB	:	Citrus Huanglongbing disease
IAAS	:	Institute of Agriculture and Animal Science, Rampur

IFS	:	International Foundation for Science
INGO	:	International Non Governmental Organizations
IOM	:	Institute of Medicine, Maharajgunj
IOST	:	Institute of Science and Technology
IPGRI	:	International Plant Genetic Resources Institute
IPR	:	Intellectual Property Rights
JE	:	Japanese Encephalitis
KU	:	Kathmandu University
LMO	:	Living Modified Organism
MMR	:	Measles, Mumps, Rubella
MOAC	:	Ministry of Agriculture and Commerce
MoEST	:	Ministry of Environment, Science and Technology, GON/N
MoFSC	:	Ministry of Forestry and Soil Conservation, GON/N
NAFOL	:	National Forensic Laboratory
NARC	:	Nepal Agriculture Research Council
NBF	:	National Bio-safety Framework
NBN	:	Nepal Biotech Nursery
NAST	:	Nepal Academy of Science and Technology
NGO	:	Non-Governmental Organization
NHPL	:	National Herbarium and Plant Research Laboratory
NPHL	:	National Public Health Laboratory, Teku
NPV	:	Nuclear Poly- hydrosis virus
NRL	:	National Reference Laboratory, New Baneshwor
PBS	:	Pre Basic Seed of Potato
PC	:	Physical Containment
PCR	:	Polymerase Chain Reaction
PCR-RFLP	:	Polymerase Chain Reaction - Restriction Fragment Length Polymorphism

PPR	:	Peste de Petits Ruminants Vaccine
R & D	:	Research and Development
RAPD	:	Random Amplified Polymorphic DNA
rDNA	:	Recombinant DNA
RECAST	:	Research Centre for Applied Science and Technology
RFLP	:	Restriction Fragment Length Polymorphism
RNA	:	Ribo Nucleic Acid
SAARC	:	South Asian Association for Regional Cooperation
SPPL	:	Siddhi Poly-Path Laboratory, Dillibazar
SQCC	:	Seed Quality Control Center
SSR	:	Simple Sequence Repeats
TCARV	:	Tissue Culture Anti Rabies Vaccine
TLMI	:	The Leprosy Mission International
TU	:	Tribhuvan University
US	:	The United States
UV	:	Ultra Violet
WARUN	:	Walter Reed/ Affirms Research Unit, Nepal
WTO	:	World Trade Organization

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1.0 INTRODUCTION

1.1 Identification

This is a national state-of-the-art report (SoA report) on Biotechnology for Nepal prepared jointly by Nepal Academy of Science and Technology (NAST) and Ministry of Environment, Science and Technology (MoEST).

The report presents the background, objectives, approach, methodology, contextual review on biotechnology and its importance for national development, list of biotechnology stakeholders, key stakeholder institutions, human resources and infrastructure available in key institutions and current biotechnology-related projects/ programs or activities in various sectors, review of current policies/ legislations regarding application of Biotechnology, Priority areas for cooperation in the South Asian Association for Regional Cooperation (SAARC) region, areas of expertise available for cooperation, recent biotech products and processes developed for transfer and finally the issues and challenges of Biotechnology development in Nepal.

For the preparation of present report, two main activities were performed 1) Technical survey on use and application of biotechnology in various sectors and 2) two days national seminar on Biotechnology. For the entire activities, **Steering Committee and Working Group** was formed involving the Scientific Sub-committee on Biotechnology and Food Technology, NAST, senior scientists and other scientists of Biotechnology Department NAST and a member from MoEST.

NAST scientific Sub-committee on Biotechnology and Food Technology comprises of following members from various scientific institutions:

Dr. Mukunda Ranjit – Coordinator, academician, NAST
Mr. Uttam Kumar Bhattarai – Member, Head, DFTQC
Dr. Tribikram Bhattarai – Member, Professor, Amrit Science College
Dr. Janardan Lamichhane – Member, Head, Biotechnology Department, KU
Dr. Anjana Singh – Member, Central Department of Microbiology, TU
Dr. Sangita Shrestha – Member Secretary, Scientific Officer, NAST

The Steering committee comprised of following members:

All the above mentioned Sub-committee members and
Dr. Kayo Devi Yami – Invited member, Chief Science Faculty, NAST
Dr. Chiranjivi Regmi – Invited member, Chief Scientific Officer, NAST

Working Group members comprised of following members:

Dr. Sangita Shrestha – Team Leader, Senior Scientific Officer, NAST
Ms. Jaishree Sijapati – Team member, Senior Scientific Officer, NAST
Ms. Neesha Rana – Team member, Senior Scientific Officer, NAST
Ms. Prabina Rana – Team member, Scientific Officer, NAST
Ms. Deepashree Rawal – Team Member, Senior Scientific Officer, NAST
Ms. Anjana Giri – Team member, Senior Scientific Officer, NAST
Mr. Padma Devkota – Team member, Officer, MoEST
Ms. Trishna Manandhar – Volunteer, Research Associate, NAST

1.2 Background, History and Definition of Biotechnology

1.2.1 Background

The global population is growing by more than 73 million people each year. Global population size is currently 6 billion and is expected to reach 7 billion by 2013 and 8 billion by 2028 (US Census Bureau, 2005/ www.teachingscience.org). It is estimated that in 1995-1997 there were roughly 790 million undernourished people in developing countries (and 34 million in developed countries), i.e. whose food intake was insufficient to meet basic energy requirements on a continuing basis. The majority (524 million) was in Asia, including 204 and 164 million in India and China respectively. Therefore, it's a big challenge for the scientists and technologists around the globe to develop such technologies, which in the long run are able to overcome the ever-increasing problem of hunger throughout the globe, in the meantime conserving and utilizing their rich agro, forest, microbial diversity and their respective ecosystems. Biotechnology in general and modern biotechnology in particular is now rapidly evolving to address the existing problem of food, health and environmental security for the sustainable human civilization and existence on earth.

A central problem for sustainable development is striking a balance between resource use and conservation so that high levels of development can be ensured. Therefore, conservation and wise use of natural resources has been an important global issue to be addressed from individual, community, national as well as international levels. In this concern, various biotechnological tools hold great promise in different areas of medicine, agriculture, forestry and environment to enhance food productivity as well as in the meantime maintaining human and animal health, environmental integrity and biological diversity at ecosystem, species and intra-specific levels.

Besides conventional biotechnologies, the manipulation of genetic constitution of living organisms by using modern biotechnological tools (modern biotechnology or recombinant DNA technology) has opened new avenues in scientific world for medicine and food production. Some of the examples include 1) the production of disease, and pest resistant crop varieties, stress tolerant and salt tolerant crops etc. 2) production of crops with desired traits (such as Golden rice with increased vitamin A supplement, Flavr Savr Tomato with enhanced shelf life etc.), 3) production of new therapeutic agents (antibiotics and a number of other high value medicines such as insulin), diagnostics and vaccines and 4) development of new biotechnological products (enzymes and other products for foods and feeds, environmental bioremediation agents etc.) (Glick and Pasternak, 1998). However, debate on the use and application of products of modern biotechnology with regard to their potential adverse impacts and risks to human and animal health, biodiversity and environment, socio-economy, culture and ethics is on rise, and it demands a rigorous scientific knowledge and commitments.

Apart from Genetic Engineering techniques, modern DNA based molecular marker techniques and technologies based on genomics and proteomics has opened up new avenues in drug and diagnostic development for genetic diseases, gene therapy, marker assisted selection, breeding, introgression, molecular systematics studies etc.. The technology provides a range of benefits ensuring food security, and therefore could make an important

contribution to poverty alleviation and sustainable agricultural development in developing countries.

1.2.2 History of Biotechnology

History of Biotechnology probably dates back to human civilization on Earth. Man has been manipulating bacteria and fungi since time immemorial for producing food items such as alcoholic beverages, fermented food items, cheese and bread. Plants and animals were selectively bred for overall improvement. During late eighteenth and beginning of nineteenth century, vaccines were invented. During last quarter of nineteenth century, a number of inventions in Biology took place when micro organisms were discovered and a number of investigations in plant genetics, fermentation technology and other microbial processes led to the establishment of various genetic and microbial phenomena by scientists such as Gregor Mendel, Robert Koch, Louis Pasteur and Joseph Lister (Yadav and Singh, 2005).

The term “Biotechnology” was coined in 1917 by a Hungarian engineer, Karl Ereky to describe an integrated process for the large scale production of pigs by using sugar beets as a source of food. According to Ereky, biotechnology is “all lines of work by which products are produced from raw materials with the aid of living things”. This fairly precise definition was ignored till 1961 when Swedish microbiologist Carl Goran Heden recommended the title of a scientific journal “Journal of Microbiological and Biochemical Engineering and Technology” be changed to “Biotechnology and Bioengineering”. From that time on, Biotechnology has clearly and irrevocably been associated with the study of “**industrial production of goods and services by processes involving biological organisms, systems and processes**” (Glick and Pasternak, 1998).

1.2.3 Definition of Biotechnology/ Modern Biotechnology

There is a wide array of “biotechnologies” with different techniques and applications. **The Convention on Biological Diversity (CBD)** defines **Biotechnology** as: “*any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use*” (www.biodiv.org). Interpreted in this **broad sense**, the definition of biotechnology covers many of the tools and techniques that are commonplace in health, agriculture and food production such as various microbiological, biochemical, serological, immunological and other animal and plant based techniques. Interpreted in a **narrow sense** however, the definition covers modern biotechnological techniques or recombinant DNA (rDNA) techniques, which cover a range of different technologies such as gene manipulation and gene transfer, DNA typing and cloning of microbes, plants and animals.

The Article 3 of **Cartgena Protocol on Biosafety (CPB)** of CBD has defined “**Modern Biotechnology**” as the application of (a) In vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (rDNA) and direct injection of nucleic acid into cells or organelles, or (b) Fusion of cells beyond the taxonomic family that overcome natural physiological, reproduction or recombination barriers and that are not techniques used in traditional breeding and selection. The Modern biotechnological methods used for the production of GMOs are called **transformation techniques or recombinant DNA technology**. Recombinant DNA technology involves in vitro introduction of different segment of DNA (one being the vector and other normally unrelated DNA sequences) that

are capable of replication in a host cell either autonomously or as an integral part of host's genome and maintenance of their continued propagation.

1.3 Justification of Work and Objectives

A number of national State of the Art report on Biotechnology for Nepal have been prepared in the past for various objectives, which give a good picture of status of biotechnology at different times in the past (Tuladhar, 1994; Rajbhandari and Ranjit, 2001; Ranjit and Yami, 2004; .Bajracharya *et. al.*, 2005; Tuladhar, 2006; Yami, 2006). The latest status report on use and application of Biotechnology/ modern Biotechnology in Nepal was prepared by MoFSC in connection to the preparation of National Biosafety Framework (NBF) for Nepal (Bajracharya *et. al.*, 2005).

As Modern Biotechnology has evolved with highly sophisticated and highly expensive technologies, it is very difficult for a least developed countries like Nepal to afford much for Infrastructure and HR development by its own, despite its utmost importance in national development. Therefore, in the regional context SAARC could be a relevant forum to exchange cooperation in various areas of Biotechnology among various member countries of this region. The present national state-of-the-art Report on Biotechnology is aimed at producing such a report that can be shared by all relevant personnel, R & D institutions and industries for exchange of existing knowledge and expertise available in the region as well as Internationally.

Present state-of-the-art report was prepared on the basis of 1) a **National Survey on use and application of Biotechnology in various sectors** and 2) **National Experts presentation from different Biotechnology sectors during two days National Seminar on Biotechnology (March 14-15, 2007)**. Therefore, the overall objective of the study was to prepare National state-of-the-art report on Biotechnology for Nepal, SAARC and for the International forum as well as to produce a proceedings with experts papers and resolutions in order to enhance biotechnological capabilities of Nepal for all round National Development. The specific objectives were to:

- Identify key stakeholders in different biotechnology sectors of Nepal.
- Assess the current national status in the use and application of the biotechnology in terms of Human Resources, Infrastructure and Ongoing Research Projects/ Activities in various sectors.
- Identify various government policy/ legislation regarding application of Biotechnology in national development.
- To identify priority areas for cooperation in the SAARC region.
- To identify areas of Expertise available for cooperation.
- To identify recent biotechnology products/ processes developed in Nepal to be transferred.
- To identify issues and challenges in this frontier area.

2.0 APPROACH AND METHODOLOGY

Approach and methodology for the preparation of present state-of-the-art report included following steps:

- **Biotechnology Sector Identification:** Eight major areas of Biotechnology (viz. Medical, Agro-forestry, Food and Industrial, Environmental, Forensic, Bio-

- energy/Bioconversion, Biotechnology Education and Biotechnology Information network) Sectors were identified for the technical survey.
- Stakeholder Identification: Possible Stakeholders from among the governmental, semi-governmental, R & D institutions and institutions from public, private sectors were identified and listed.
 - Key Informant Stakeholder listing: Key Informant stakeholder listing was carried out on the basis of their direct or indirect involvement in Biotechnology/ modern biotechnology related R & D activities, implementation of policies and decision makings in the subject matters and beneficiary groups/ consumer group for direct or indirect use of biotechnology and modern biotechnology products.
 - Questionnaire/ Checklist Preparation: Based on the format provided by the SAARC Secretariat, key Informant questionnaire/ Checklist were developed for different Biotechnology Sectors. The questionnaires were developed by the working group members which were also interacted and discussed among the Scientific Subcommittee members as well as with the experts from various sectors. The questionnaires were finalized following incorporating experts comments, pre tested and bulk produced for the field survey.
 - Key Informant Interview and Survey: Key informant listed for various sectors were interviewed using the questionnaire. For many of the institutions personal visits were carried out whereas with some others, questionnaires were dropped, faxed, or emailed.
 - Data Compilation and Presentation: Acquired data were checked, compiled in tabular form following simple qualitative analysis in various areas intended by SoA report format. Survey findings were presented in two day interactive seminar on Biotechnology (March 14-15, 2007) held at NAST premise.
 - Preparation of Final state-of-the-art Report: Final SoA report was prepared using information obtained from the survey as well as incorporating Experts input obtained during two day Biotechnology Seminar.

3.0 NAME AND ADDRESSES OF MAJOR STAKEHOLDER INSTITUTIONS OF BIOTECHNOLOGY IN NEPAL

3.1 Concerned High Level Government Institutions/ Ministries of Biotechnology in Nepal

Concerned High Level Government Stakeholder institutions for Biotechnology/ modern biotechnology in Nepal are:

- National Planning Commission, Singha Durbar, Kathmandu Nepal.
- Ministry of Environment, Science and Technology, Nepal Government
- Ministry of Forests and Soil Conservation, Nepal Government
- Ministry of Agriculture and Cooperatives, Nepal Government
- Ministry of Industry and Commerce, Nepal Government
- Ministry of Health and Population

3.2 Major Key Stakeholder Institutions of Various Biotechnology Sectors

Biotechnology being a multidisciplinary subject, it directly or indirectly encompasses a wide range of institutions in the civil society. In the present report, Biotechnology stakeholder institutions in Nepal have been categorized according to various disciplines.

3.2.1 Agriculture and Forest Biotechnology Sector

A. Plant Biotechnology Sector

A number of research institutions such as governmental, semi-governmental and private institutions/ their divisions are major stakeholders of plant biotechnology sector in Nepal. From the survey, **fourteen** were found to be the key institutions of this sector (Table 3.2.1 A).

Table 3.2.1 A. Identified Key Stakeholder Institutions/ Divisions in Plant Biotechnology Sector of Nepal.

S. N.	NAME, ADDRESS/ ESTD. YEAR	TYPE OF INSTITUTION	LEVEL OF OPERATION	TYPE OF SERVICE
1.	Biotechnology Unit, Nepal Academy of Science and Technology (NAST), Khumaltar/ 1982	Semi-government/ MoEST	National and International	Research and Development/ public service
2.	Biotechnology unit, Nepal Agriculture Research Council (NARC), Khumaltar/ 1997	semi-government/ MoAC	National, International and Global	Research and Education
3.	Agriculture Botany Division, NARC, Khumaltar/ 1966	semi-government/ MoAC	Local, national, International, Global	Research
4.	National Potato Research Program, NARC/ 1972	semi-government/ MoAC	National	Research and Service
5.	Plant Pathology Division, NARC, Khumaltar/ 1963	semi-government/ MoAC	National	Research
6.	National Citrus Research Program, Paripatle Dhankuta, NARC/ 1961	Semi-government	National	Research
7.	Regional Agricultural Research station, Lumle, Kaski/ 1964	government	Regional	Research
8.	Seed Quality Control Centre, Department of Agriculture, Harihar Bhawan/ 2000/	Government/ MoAC	National	Research and Development
9.	Plant Protection Directorate, Harihar Bhawan/ 2049 B. S.	Government/ MoAC	National	Plant Protection Services
10.	Department of Plant Resources (DPR), Thapathali/ 1974	Government/ MoAC	National	Research and development
11.	National Herbarium and Plant Research Laboratory (NHPL), Godawari/ 1960	Government/ MoFSC	National	Research, Development and Education
12.	Green Research & Technology (GREAT),	Private	National	Research & Development,

	Nepal/ 1997			Education and Private institution
13.	Green Energy Mission, Nepal/ 1994	Non Governmental Organization	National	Research & Development
14.	Research Centre for Applied Science and Technology (RECAST)/ 1977	Semi-Government	National, affiliated to Tribhuvan university	Research & Development, Education and consultancy

B. Animal biotechnology Sector

Various departments of NARC and veterinary laboratory are the key institutions of this sector. **Eight** institutions have been identified as key stakeholder institutions in animal biotechnology Sector of Nepal (Table 3.2.1 B).

Table 3.2.1 B. Identified Key Stakeholder Institutions/ Divisions in Animal Biotechnology Sector of Nepal.

S. N.	NAME, ADDRESS/ ESTD. YEAR	TYPE OF INSTITUTION	LEVEL OF OPERATION	TYPE OF SERVICE
1.	Animal Breeding Division, NARC, Khumaltar/ 1991	Semi government	National	Research and Development
2.	Animal Health Research Division, NARC, Khumaltar/ 1991	Semi government	National	Research and Development
3.	Animal Nutrition Division, NARC, Khumaltar/ 1991	Semi government	National	Research and Development
4.	Fisheries Research Division, NARC, Godawari/ 1993	Semi government	National	Research
5.	Entomology Division, Khumaltar/ 1991	Semi government	National	Research and Development
6.	Central Veterinary Laboratory, Tripureswor/ 2052 B.S.	Government	National	Research and Development
7.	Rabies Vaccine Production Laboratory Tripureswor/ 2001	Government	National	Research and Development
8.	Department of Biotechnology, KU, Dhulikhel/ 1991	Public	National-Global	Education and Research

3.2.2 Medical Biotechnology Sector

A number of Medicine related institutions such as Governmental and private Hospitals, Pharmaceutical companies, Pathology laboratories, and University departments are the stakeholders of medical Biotechnology Sector. Of the listed stakeholders, **ten** institutions were found to be the **key institutions** in this sector. Name and addresses of the institutions

along with type of institution, level of operation and kind of service provided by respective institutions are shown (Table 3.2.2).

Table 3.2.2. Identified Key Stakeholder Institutions in Medical Biotechnology Sector

S. N.	NAME, ADDRESS, ESTD. YEAR	TYPE OF INSTITUTION	LEVEL OF OPERATION	TYPE OF SERVICE
1.	Institute of Medicine (IoM), Tribhuvan University Teaching Hospital, Maharajgunj/ 1972 / www.iom.edu.np	Semi Government	National and International	Education, Research and public service
2.	National Public Health Laboratory (NPHL), Teku/ 2024 B. S.	Government	National	Education, Research and public service
3.	Leprosy Mission, Nepal, Anandaban	The Leprosy Mission International (TLMI) Founded	National	Research and public service
4.	Siddhi Poly Pathology Laboratory (SPPL), Dillibazar Kathmandu/ 2058 B.S./ www.ilshrestha.com.np	Private	Local	Public Service
5.	Everest Biotech Pvt. Ltd., Maharajgunj/ 2000	Private	International/ Global	Private institution
6.	Department of Biotechnology, Kathmandu University (KU), Dhulikhel/ 1991/	Public	International/ Global	Education and Research
7.	Walter Reed/ Affirms Research Unit, Nepal (WARUN), Koteshwor/ 1995/	Bi-national (US mission to Nepal)	International/ Global	Education and Research
8.	National Reference Laboratory, (NRL) Pvt. Ltd. New Baneswor/ 2005	Private	National	Public Service
9.	Om Hospital, Chabahil Kathmandu	Private	National	Public Service and Research
10.	Nepal Aushadhi Limited, Babarmahal, 2029 B. S./	Semi-Government	National	Drug Production and Sale

3.2.3 Food and Industrial Biotechnology Sector

Of the listed institutions, six have been identified as key stakeholder institutions in this sector (Table 3.2.3).

Table 3.2.3. Identified Key Stakeholder Institutions/ Divisions in Food and Industrial Biotechnology Sector of Nepal

S. N.	NAME, ADDRESS, ESTD. YEAR	TYPE OF INSTITUTION	LEVEL OF OPERATION	TYPE OF SERVICE
1.	Department of Food Technology and Quality Control (DFTQC), Babarmahal/ 2018 B. S.	Government	National and has linkages with Tribhuvan University and Purbanchal University affiliated institutions	Research and Development
2.	Central Campus of Technology, IOST, Hattisar Dharan/ 1972	Government	National, Regional and International	Education and Research
3.	Centre for Agricultural Technology (CAT), Gwarko	Private	National	Research, Education (Training), Production and Business
4.	Nepal Dairy Private Ltd. Mahabouddha, Kathmandu/ 2037 B. S.	Private	National	Research, Development, Production and Business
5.	Nepal Biotech Nursery, Pvt. Ltd., Lalitpur Nepal/ 1989	Private	National	Production and Business
6.	Biotechnology Department, KU	Public	National	Research & Development

3.2.4 Environmental Biotechnology Sector

Of the listed institutions, **four** have been identified as key stakeholder institutions in this sector (Table 3.2.4).

Table 3.2.4 Identified Key Stakeholder Institutions/ Divisions in Environmental Biotechnology Sector in Nepal

S. N.	NAME, ADDRESS, ESTD. YEAR, WEB ADDRESS	TYPE OF INSTITUTION	LEVEL OF OPERATION	TYPE OF SERVICE
1.	Department of Environmental Science, Kathmandu University, Dhulikhel/ 1991	Private	International-Global	Education and Research
2.	Environment Laboratory, Nepal Academy of Science and Technology,	Science academy	National-International	Research, Development, Education and

	Katipur Environment and Public Health Organization (ENPHO), New Baneswor/ 1990	Non-Governmental Organization	National	public service Education and Research, Analytical service provider, implementation of Research findings.
4.	RECAST, Kirtipur	Semi-government	National	R & D, education and consultancy

3.2.5 Biotechnology Education Sector

Twelve institutions (department of various universities) have been identified as key stakeholder institutions in Biotechnology Education sector in Nepal (Table 3.2.5).

Table 3.2.5 Identified Key Stakeholder Institutions/ Divisions in Biotechnology Education Sector in Nepal.

S. N.	NAME, ADDRESS/ ESTD. YEAR	TYPE OF INSTITUTION	LEVEL OF OPERATION/ TYPE OF SERVICE	DEGREE GRANTED BY 2006
1.	Central Department of Botany, Tribhuvan University/ 1965 as Botany department	Semi-Government	National/ Education and Research	3 – Ph. D. 55 – M. Sc. as special paper in Biotechnology
2.	Central Department of Microbiology, TU, Kirtipur/ 1990	Semi-Governmental	National/ Education and Research	1- Ph. D. 241 – M. Sc.
3.	Central Department of Zoology, TU, Kirtipur	Semi-Governmental	National/ Education and Research	-
4.	Department of Biotechnology, KU Dhulikhel/ 1991	Public	National- Global/ Education and Research	B. tech. (Biotech.) – Fourth year being produced
5.	Microbiology Department, Trichandra Multiple Campus, Kathmandu/ 2036 B. S.	Government	National/ Education and Research	B. Sc. Microbiology being taught
6.	National College, National Institute of Science and Technology, Lazimpat/ 1998	Private and affiliated to Tribhuvan University	National, International and Global/ Education and Research	120- B. Sc. granted since 1998 and M. Sc. – started since 2005
7.	Lord Buddha Education Foundation, Maitidevi/ 1998	Private and affiliated to Sikkim Manipal University, India	National/ Education and Research	1- M.Sc. (2004) granted in Bioinformatics B. Sc.

				biotechnology (2004) – Fifth semester running
8.	SANN International College, Kathmandu/ 2000	Private and affiliated to Purbanchal University, Nepal	Local	B. Sc. Biotechnology started from 2005
9.	Institute of Agriculture and Animal Science (IAAS), Rampur	Semi-Governmental/affiliated to Tribhuvan University, Nepal	National/ Education and Research	Biotechnology taught in different disciplines of B. Sc. Ag., B. V. Sc. & A. H.; M. Sc. Ag. M. SC. An. Sc., M. Sc. Aq., M. Sc. Vet. Sc.; Ph. D. An. Sc., Plant path., Pl. Br. Etc.
10.	Hattisar Campus Dharan/ 1972	Government	National/ Education and Research	-
11.	Universal Science College, Maitidevi	Affiliated to Pokhara University	Education and Research	B. Sc. Biochemistry
12.	Himalayan College of Agriculture Science (HICAST)	private	National	B. Sc. Agriculture honors (4 years) B. V. Sc. And A. H. (5 Years) M. Sc. Agriculture (2 years)

(-): data not available.

3.2.6 Forensic Biotechnology Sector

National Forensic Laboratory (NAFOL) is the only key institution in Forensic Biotechnology sector in Nepal (Table 3.2.6).

Table 3.2.6 Identified Key Stakeholder Institution/ Divisions in Forensic Biotechnology Sector in Nepal.

S. N.	NAME, ADDRESS/ ESTD. YEAR	TYPE OF INSTITUTION	LEVEL OF OPERATION	TYPE OF SERVICE
1.	National Forensic Laboratory (NAFOL), Kumaltar / 1986	Semi-Government/	National	Forensic public Services/ and Research

3.2.7 Bio-energy and Bioconversion Technology Sector

Four key stakeholders have been identified which are involved in R & D activities pertinent to bio-energy and bioconversion technologies (Table 3.2.7).

Table 3.2.7 Identified Key Stakeholder Institutions/ Divisions in Bio-energy and Bioconversion technology Sector in Nepal.

S. N.	NAME, ADDRESS/ ESTD. YEAR	TYPE OF INSTITUTION	LEVEL OF OPERATION	TYPE OF SERVICE
1.	Research Centre for Applied Science and Technology (RECAST), Kirtipur	Semi-Government/	National	Research and development
2.	Biogas support program (BSP) Nepal/ SNV Netherlands	INGO	National	Provide subsidies to farmers using biogas
3.	Different Banks such as Agriculture development bank, Rastriya Banijya bank, Nepal Bank limited etc.	Government, semi-government and public Banks	National	Public service (provide loans to biogas users)
4.	Over 40 Biogas construction private companies	Private	National	Biogas construction companies

3.2.8 Biotechnology Information Network Sector

Biotechnology related information retrieval system for scientific community in Nepal is still in infancy. Various public and academic institutions have library, Internet and PERI journal access, which is insufficient for full-fledge research in various fields. Two main mechanisms have been identified in relation to biotechnology related information network in Nepal (Table 3.2.8).

Table 3.2.8 Biotechnology Information Network Sector in Nepal.

S. N.	NAME, ADDRESS, ESTD. YEAR	TYPE OF INSTITUTION	LEVEL OF OPERATION	TYPE OF SERVICE
1.	BINASIA	A collaborative web-based network to facilitate networking and developing cooperation among biotechnology stakeholders in Asia	Regional	Information networking
2.	National Biosafety Clearing house (BCH)	Provisioned by MoFSC, National Biosafety Framework (NBF) preparation project	International	Information sharing system regarding use and application of modern biotechnology (GE) products.

4.0 PRESENT STATUS OF BIOTECHNOLOGY IN DIFFERENT SECTORS OF NEPAL

4.1 Agricultural and Forest Biotechnology Sector

A. Plant Biotechnology Sector

Status of HR, infrastructure and current Biotechnological projects and / activities in key Plant biotechnology institutions are presented in the following section (Table 4.1 A, 4.1 B).

Table 4.1.A. Human resources and Infrastructure Facility of Key Institutions in Plant Biotechnology Sector of Nepal.

S. N.	NAME AND ADDRESS OF THE INSTITUTION	BIOTECHNOLOGY RELATED HR	INFRASTRUCTURE RESOURCES / INFORMATION RESOURCES
1.	Biotechnology Laboratory, Nepal Academy of Science and Technology, Khumaltar	1 – Ph. D. – Microbiology – abroad 1 – Ph. D. – Plant Pathology –abroad 1- Ph. D. – Mycology – abroad 1 – Ph. D – Natural Product chemistry – abroad 1 – Ph. D. –Molecular Biology and Molecular Systematics - abroad 10 – M. Sc. – microbiology, Biochemistry, environmental science, botany, agriculture science, chemistry – abroad and Nepal	<ul style="list-style-type: none"> • Common Biotechnology Laboratory with associated facilities • Natural product chemistry lab and environment laboratory • PCR laboratory with associated facility • Glass house and small screen house • NAST has a library, Internet facility and PERI-journal access.
2.	Biotechnology, Unit, Nepal Agriculture Research Council (NARC), Khumaltar	1 – Ph. D. Molecular Biology and genetics – Abroad 1 – Ph. D. Plant breeding and genetics – Abroad 4 – M. Sc. – Breeding and Genetics – Abroad and Nepal	<ul style="list-style-type: none"> • Four Lab rooms • One glass house • Thermal cycler, gel photograph assembly, deep freezer, water baths, centrifuges, Ice maker, gel electrophoresis units, power pack, autoclave, distillation units etc.

3.	Agriculture Botany Division, NARC, Khumaltar	1- Ph. D. –Molecular Biology – Abroad 1- Ph. D. –Plant Physiology – Abroad 2 – Ph. D. – Plant breeding 12 – M. Sc. – Plant breeding, plant physiology and Plant Genetic Resources 8 – B. Sc. Ag. Horticulture, plant breeding, agronomy etc.	<ul style="list-style-type: none"> • Molecular laboratory and associated facilities shared with biotechnology unit of NARC. • Crop improvement labs • Seed laboratory, glass house, storage facility, seed cold storage (gene bank). Quality laboratory
4.	National Potato Research Program, NARC, Khumaltar	1 – Ph. D. Pathology – Abroad 2 – M. Sc. Ag – horticulture – Abroad	<ul style="list-style-type: none"> • Plant tissue culture laboratory and associated facilities • Glass house with 20 benches • Screen houses with 8 benches
5.	Plant Pathology Division, NARC, Khumaltar	6 – Ph. D. Plant pathology – Abroad 3 – M. Sc. Botany (plant pathology) – Nepal 3 – B. Sc. – Nepal	<ul style="list-style-type: none"> • Laboratory, green house, screen houses, growth room, incubation room, teaching lab, mushroom growing rooms • Laminar air flow hood, autoclaves, and other associated facilities
6.	National Citrus Research Program, Paripatle, Dhankuta	1- Ph. D. Horticulture 1- B. Sc. Ag. Horticulture	<ul style="list-style-type: none"> • Tissue culture laboratory with associated facilities, ELISA reader, sterio-microscope etc.
7.	Regional Agriculturral Research station, Lumle, Kaski/ 1964	1 – M. Sc. Ag. – Molecular biology and biotechnology 1- M. Sc. Ag. – Plant breeding	<ul style="list-style-type: none"> • Biotechnology laboratory with 3 rooms • PCR machine, gel electrophoresis, gel doc system, ice maker, distillation plant, oven autoclave etc.
8.	Seed Quality Control Centre (SQCC), Department of Agriculture, Harihar Bhawan	1- M. Sc. Ag – Plant Breeding – Nepal	<ul style="list-style-type: none"> • A separate building for molecular laboratory with GMO testing facility. • PCR machine, spectrophotometer, gel electrophoresis unit, Bio doc analyzer and other associated facilities.
9.	Plant Protection Directorate, Harihar Bhawan	1 – M. Sc. Ag. In IPM, seed pathology 2 – B. Sc. Ag. In Seed science and Extension	<ul style="list-style-type: none"> • One central lab with GC and simple lab equipment • 5- Regional plant protection labs with simple lab equipments • 11-plant quarantine labs with simple lab equipment

10.	DPR, Thapathali	4 – M. Sc. In Botany – abroad and Nepal	<ul style="list-style-type: none"> • Plant tissue culture laboratory and associated facilities available
11.	National Herbarium and plant research laboratory Godawari	2 – Ph. D. Plant Science – Abroad 4 – M. Sc. Botany, PGR, tissue culture – Abroad and Nepal	<ul style="list-style-type: none"> • Tissue culture laboratory, growth room and associated facilities (Glass house) available • Library and books available
12.	GREAT, Baneswor	2 – Ph. D. Plant physiology and Botany – Abroad 3 – M. Sc. – microbiology, biochemistry and Botany – Nepal 2 – B. Sc. – Biochemistry – Nepal	<ul style="list-style-type: none"> • Media kitchen with distillation plants, refrigerators, incubator, oven, etc. • Disease testing laboratory with ELISA reader, stereo-microscope etc. • Walk in growth chamber • Media preparation room
13.	Green Energy Mission, Nepal	1 – Ph. D. in <i>Cordiceps</i> Biology and Taxonomy 1 – Ph. D. in bacterial genetics and Biotechnology	-
14.	RECAST	24- technical employees	<ul style="list-style-type: none"> • Plant Tissue culture lab and associated facilities such as autoclave, analytical balance, laminar airflow, horizontal gel eletrophoresis, UV-Vis spectrophotometer etc. • Laboratory for bioassay based research.

Table 4.1.B. Current Biotechnological Programs and Projects/Activities of key Institutions in Plant Biotechnology Sector of Nepal.

S. N.	NAME OF THE INSTITUTION	CURRENT BIOTECHNOLOGICAL ACTIVITIES/ PROGRAMS AND PROJECTS	GOOD LABORATORY PRACTICE (GLP)
1.	Biotechnology Laboratory, Nepal Academy of Science and Technology,	<ul style="list-style-type: none"> • Diagnosis of citrus Huanglongbing (HLB) Disease using PCR technique – collaborative with France • Molecular characterization of Cry genes in Nepalese <i>Bacillus thuringiensis</i> Isolates – in house • Molecular characterization of genetic diversity in <i>Swertia chirayita</i> using RAPD – PCR technique – in house 	GLP followed

		<ul style="list-style-type: none"> • Molecular characterization of diversity in Tea cultivars of Dhankuta district using RAPD and SSR markers – in house • Biofertilizer – previously collaborative, currently in house • Biological Control –in house • Biodiversity conservation – collaborative • GMO project –in house • Study of mushroom and their antimicrobial activity – in house • Influence of organic matter in Vesicular Arbuscular Mycorrhiza (VAM) of eroded area of Nepal – collaborative with Sweden • Biopesticide – Collaborative • Study of mushroom diversity in Himalayan regions of Nepal – Italian collaborative • High altitude medicinal plants – Italian Collaborative 	
2.	Biotechnology, Unit, NARC, Khumaltar	<ul style="list-style-type: none"> • Diversity analysis of Rice and maize inbred lines – in house • Wide hybridization of rice species – in house • Screening of aromatic rice – in house • Haploid production of wheat and rice – in house • Marker assisted selection in rice – in house • Cold tolerance in rice – Collaborative 	GLP followed
3.	Agriculture Botany Division, NARC, Khumaltar	<ul style="list-style-type: none"> • Developing genetic database of local Rice bean – Collaborative FOSRIN project with CAZS- UR Wales, Kiel University, Germany, Norway, India • Genetic Resources Policy Initiative (GRPI) – Collaborative with IPGRI • Genetic Study of Rice – in house 	GLP followed
4.	National Potato Research Program, NARC, Khumaltar	<ul style="list-style-type: none"> • Pre-basic Seed (PBS) Potato production through tissue culture – in house • Sustainability studies for PBS production – in house • Utilization therapies for virus 	GLP followed

		elimination – in house	
5.	Plant pathology Division, NARC	<ul style="list-style-type: none"> • management of root knot nematode • Survey and Surveillance of wheat diseases • management of yellow rust or wheat • Biological control of diseases • Study on cultivation technique of mushroom 	GLP followed
6.	National Citrus Research Program, Dahnkuta	<ul style="list-style-type: none"> • Production of disease free citrus plants through micro-grafting • In vitro propagation of large cardamom –collaborative 	-
7.	Regional Agriculture research station, Lumle, Kaski	<ul style="list-style-type: none"> • Tissue culture related projects – in house 	GLP followed
8.	SQCC, Harihar Bhawan	<ul style="list-style-type: none"> • PCR-based GMO detection in imported soybean is being planned • Ex situ conservation of released varieties at -20°C. 	GLP followed
9.	Plant Protection Directorate, Hariharbhawan	<ul style="list-style-type: none"> • Plant pest and disease diagnosis of agricultural crops 	GLP followed
10.	DPR, Thapathali	<ul style="list-style-type: none"> • To develop protocol for mass production of lokta through tissue culture – collaborative 	GLP followed
11.	National Herbarium and Plant Research Laboratories, Godawari	<ul style="list-style-type: none"> • Micro-propagation of medicinal plants • Micro-propagation of ornamental plants • Micro-propagation of endangered species • In vitro conservation 	GLP followed
12.	GREAT, Nepal	<ul style="list-style-type: none"> • Post harvest and marketing of citrus fruit – in house 	GLP followed
13.	Green Energy Mission, Nepal	-	-
14.	RECAST	<ul style="list-style-type: none"> • Survey of medicinal plants used against cancer • Screening of Nepalese medicinal plants for antibacterial, antifungal and antiviral activities: isolation and characterization of bioactive compounds. • Product development of Sea buckthorn for commercial use. • Improved technology generation 	-

		for utilization of buckwheat, wild patol and wild persimmon. <ul style="list-style-type: none"> Utilization of the Himalayan nettle for natural fiber production 	
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(-): data not available.

B. Animal Biotechnology Sector

Status of HR, infrastructure, and current projects and activities of Identified Key Biotechnological institutions in Animal Biotechnology sector of Nepal are presented in following section (4.1 C & D).

Table 4.1.C. Human resources and Infrastructure Facility of key Institutions in Animal Biotechnology Sector of Nepal.

S. N.	NAME AND ADDRESS OF THE INSTITUTION	BIOTECHNOLOGY RELATED HR	INFRASTRUCTURE RESOURCES/ INFORMATION RESOURCES
1.	Animal Breeding Division, NARC, Khumaltar	2- Ph. D. – quantitative genetics and Genetics 1- M. Sc. – genetics 1 – B.V. SC. & AH 2 – B.Sc. Ag.	-
2.	Animal Health Research Division, NARC, Khumaltar	1- Ph. D. in Biomaterials 1 Ph. D. in Vet. Pathology – Abroad 1- Ph. D. in Animal Reproduction - Abroad 1- M. Sc. In public health – Abroad	<ul style="list-style-type: none"> Virology laboratory Bacteriology laboratory Pathology laboratory Theriogenology laboratory Parasitology laboratory Biosafety cabinet, ELISA reader, Lyophilizer
3.	Animal Nutrition Division, NARC, Khumaltar	1- Ph. D. – Ruminant 1 - M. Sc. – Ruminant 1 – M. Sc. – Non-ruminant	<ul style="list-style-type: none"> Facility for proximate analysis of feeds Calorimeter Library, Journals, periodicals
4.	Fisheries Research Division, NARC/ 1993	1 –Ph. D. – Aquaculture – abroad 2 – M. Sc. – Aquaculture – Abroad	<ul style="list-style-type: none"> Molecular laboratory and facilities being shared with Biotechnology lab of NARC
5.	Entomology Division, NARC/ 1991	1 – Ph. D. Pest management 4 – M. Sc. – Pest management and taxonomy	<ul style="list-style-type: none"> Microbial (NPV) extraction laboratory and associated facilities
6.	Central Veterinary Laboratory, Tripureswor/ 2052 B.S.	6 – M.Sc., B. V. Sc & A. H. Molecular Biology, Serology, Microbiology, Parasitology, Public Health – Abroad 2- Vet. Science – India	<ul style="list-style-type: none"> PCR laboratory with associated facilities and -20 °C and -80 °C deep fridge Walk in cold room Cryo – Microtome Storage facilities for

			biological <ul style="list-style-type: none"> • Internet, books and journal facilities available
7.	Rabies Vaccine Production Laboratory	6 – B. V. Sc. Vet - Animal Tissue Culture technology – Abroad	<ul style="list-style-type: none"> • TCARV production lab and associated facility available • - 80 °C deep fridge, Lyophilizer Inverted microscope, Ultracentrifuge etc.
8.	Department of biotechnology, KU	As mentioned in Plant biotechnology section.	<ul style="list-style-type: none"> • As mentioned in Plant biotechnology section.

Table 4.1.D. Current Biotechnological Programs and Projects/ Activities/ of key Institutions in Animal Biotechnology Sector of Nepal.

S. N.	NAME OF THE INSTITUTION	CURRENT BIOTECHNOLOGICAL ACTIVITIES/ PROGRAMS AND PROJECTS	GLP PRACTICE
1.	Animal Breeding Division, NARC, Khumaltar	<ul style="list-style-type: none"> • Semen production and artificial insemination in cattle– in house • Elite herd (ET) – in house • Characterization of buff (karyotyping) – in house 	GLP followed
2.	Animal Health Research Division, NARC, Khumaltar	<ul style="list-style-type: none"> • Salmonella antigen production – in house • Use of nettle as immuno-modulator in house 	GLP followed
3.	Animal Nutrition Division, NARC, Khumaltar	<ul style="list-style-type: none"> • Deal with crop plant, wild plant and livestock • Evaluation of Feed Resources using lab analytical methods • Digestibility of Fodder • Development of feeding package for rabbit • Sheep Feeding study in Karnali region • Feeding Urea Molasses Mineral Block • Dairy production 	GLP followed
4.	Fisheries Research Division, NARC	<ul style="list-style-type: none"> • Assessment of genetic variation and prospect of genetic improvement of Sahar (<i>Tor putitora</i>) for conservation and aquaculture • mono-sex population production of tilapia, <i>Oreochromis niloticus</i> by hormone administration (Sex manipulation) 	GLP followed
5.	Entomology Division, NARC	<ul style="list-style-type: none"> • Production and testing of microbial (nuclear poly-hydrosis virus and Bt) • Use, production and testing of microbial (NPV) as entomo-pathogenic substance for pest management. • Biological control 	GLP followed

6.	Central Veterinary Laboratory, Tripureshwor	<ul style="list-style-type: none"> • Regular animal Disease investigation • Regular Bird flu investigation • Regular Japanese Encephalitis Investigation • Regular field disease outbreak investigation • Regular PPR investigation • Regular PCR Bird flu investigation • Other microbiological, serological and animal cell culture activities for virus isolation 	GLP followed
7.	Rabies Vaccine Production Laboratory, Tripureswor	<ul style="list-style-type: none"> • TCARV production for animals and human use JICA- Nepal Collaboration. • Animal tissue culture 	GLP followed
8.	Department Biotechnology, KU	<ul style="list-style-type: none"> • Study of genetic variation in cattle by RAPD PCR technique – in house 	GLP followed

4.2 Medical Biotechnology Sector

Status of Human Resources (HR), infrastructure and Biotechnological activities of key institutions of Medical Sector are presented in the following section (Table 4.2 A and B).

Table 4.2.A. HR and Infrastructure facility of key medical Biotechnological Institutions of Nepal.

S. N.	NAME AND ADDRESS OF THE INSTITUTION	BIOTECHNOLOGY RELATED HR	INFRASTRUCTURE RESOURCES/ INFORMATION RESOURCES
1.	IoM, TUTH, Maahrajgunj	1-M. Sc. Medical biotechnology – AIMS 8-microbiology – Local	<ul style="list-style-type: none"> • Pathology lab, Molecular lab, • PCR machine, micro-centrifuge, deep fridge, autoclave, safety cabinets, microscope, incubators/ good facility of books, journals and Internet
2.	NPHL, Teku	2- MD Pathology 2-DCP pathology 2- M. Sc. Microbiology 3- B. Sc. Technology 10- Lab Technician	<ul style="list-style-type: none"> • units available for microbiology, virology, immunology, mycology, parasitology, clinical chemistry, clinical hematology, histopathology/cytology, training unit and QC unit. • BD caliber, ELISA readers, Biosafety cabinets I, II, III, deep freezer (-70° C), (-20° C), Automatic tissue processor, PCR (BIORAD)
3.	Leprosy mission,	1-Ph. D Microbiology-	<ul style="list-style-type: none"> • Molecular lab, microbiology

	Nepal, Tika Bhairab, Lele	Abroad 1- M. Sc. Microbiology – Nepal	lab and other related facilities <ul style="list-style-type: none"> • Thermal cycler, ELISA reader and washer, electrophoresis unit, gel doc system, class 2 biosafety hood, hybridizer, refrigerated centrifuge, DNA calculator, UV spectrophotometer etc.
4.	SPPL, Dillibazar	1- MD Pathology – Abroad 2 – microbiologists – Local	<ul style="list-style-type: none"> • Dade Dimension expand Fully automated biochemistry analyzer • Stat Fax 330 semi automated chemistry analyzer • - Flame photometer, fully automated ELISA analyzer, Fully automated HBA1C analyzer, Immunochemistry analyzer, Hematology analyzer, sperm analyzer, urine analyzer, HB and Protein electrophoresis unit and densitometer and other associated facilities.
5.	Everest Biotech Pvt. Ltd., Maharajgunj	1-Ph. D. Toxicology – Abroad 1- MS-DVD – Vet Medicine – Abroad 1- MS – Biochemistry – Abroad 2- M. Sc. – Microbiology TU, Nepal 2- M. Tech. – Biotech – India 1 – B. Sc. – Medical Education – TU, Nepal 1 – B. Sc. Micro – India 1- B. M. L. T. – Lab technology, TU, Nepal	<ul style="list-style-type: none"> • Infrastructure for cell culture, Nuclear protein, cell/tissue storage, product separation, quality control, data management, protein storage, power back up • cell culture hood, Incubator, Sonicator, Centrifuges, Nitrogen tan, Affinity chromatography, ELISA reader, Western Blot facility, -20°C freezer and Refrigerators, Generators and Batteries. • Intra/Internet facilities and Computers
6.	Department of Biotechnology, KU	2- Ph. D. Molecular Biology- Abroad 1-Ph. D. Immunology – Abroad 5 – M. Sc. – Microbiology, Molecular Biology, Biotechnology – Abroad and Nepal	<ul style="list-style-type: none"> • Molecular laboratory, Immunology laboratory • Hybridizer, PCR machine, HPLC, UV, GC, ELISA, SDS-PAGE • -20° C, -80 ° C Deep fridges, Centrifuges, Oven, etc.

7.	WARUN, Kateshiwor	1- M.Sc. Biotechnology abroad	<ul style="list-style-type: none"> • Biosafety level I (PC I) molecular laboratory • Biosafety level II (PC II) molecular laboratory • ELISA and PCR Facility available
8.	NRL Pvt. Ltd. New Baneswor	12 – all medical laboratory technology graduates	-
9.	Om Nursing home Private Ltd., Chabahil	-	-
10.	Nepal Aushadhi Limited, Babarmahal, Kathmandu	1 – M. Sc. – Cellular and Molecular Biotechnology – Netherlands	<ul style="list-style-type: none"> • Office building and Laboratory • Incubator, Autoclave, Laminar Air Flow Hood, Spectrophotometer • Library books and Internet facility available.

(-): data not available.

Table 4.2 B. Current Biotechnological Programs and Projects/ Activities of key Medical Biotechnological Institutions/ Divisions of Nepal.

S. N.	NAME OF THE INSTITUTION	CURRENT BIOTECHNOLOGICAL ACTIVITIES/ PROGRAMS AND PROJECTS	GLP PRACTICE
1.	IoM, TU/TH, Maharajgunj/	<ul style="list-style-type: none"> • Provide analytical service of human bacterial, fungal and viral disease diagnosis using biochemical, ELISA, western blot, agglutination and precipitation techniques and PCR-based molecular techniques. • Also conducts epidemiological studies of various human diseases. 	GLP followed
2.	NHPL, Teku, Kathmandu	<ul style="list-style-type: none"> • JE, Polio, Measles • Antimicrobial Resistance surveillance (AMR) • ELISA, Western blot, protein and Hb electrophoresis, BD flowcytometer and drug testing facility available • CD4 cell count, Tumor marker, cancer marker • Provide routine diagnostic, special diagnostic facilities • Conducts training activities and provide QA and monitoring services 	GLP followed
3.	Leprosy Mission	<ul style="list-style-type: none"> • A post-genomic approach to improve 	GLP followed

	Nepal, Lele	<p>immuno-diagnosis of <i>Mycobacterium leprae</i> infection.</p> <ul style="list-style-type: none"> • RFLP-typing of <i>Mycobacterium tuberculosis</i> by IS6110 probes. • Development of a novel PCR method for detecting mutations conferring Rifampicin resistance in <i>M. leprae</i> • Genetic susceptibility to leprosy and leprosy reactions. 	
4.	SPPL Dillibazar Kathmandu/	<ul style="list-style-type: none"> • Provide analytical service for the diagnosis of human bacterial (<i>E. coli</i>, Salmonella) and Viral (Hepatitis, HIV, HEV etc.). • Immunization for Typhoid, Hepatitis B, Influenza, MMR, Tetanus and Meningitis provided. • Epidemiological studies carried out for HIV, HEV • Sero-prevalence of antibodies to hepatitis C virus among injecting drug users from Kathmandu. • The explosive human immunodeficiency virus type 1 Epidemic among injecting drug users of Kathmandu, Nepal is caused by subtype C virus of restricted genetic diversity. • and many other research works carried out. 	GLP followed
5.	Everest Biotech Pvt. Ltd. Maharajgunj	<ul style="list-style-type: none"> • Antibody production – in house 	GLP followed
6.	Department of Biotechnology, Kathmandu University	<ul style="list-style-type: none"> • Cloning and expression of <i>Streptomyces</i> genes – in house • Study of genetic variation in cattle by RAPD PCR technique – in house 	GLP followed
7.	WARUN, Koteshwor	<ul style="list-style-type: none"> • Influenza surveillance using PCR based technique – collaborative 	GLP followed
8.	NRL New Baneswor	<ul style="list-style-type: none"> • Provide diagnostic service of human bacterial and viral diseases (HIV, HBV, HCV etc.) using biochemical (hematology, urology and pathology), ELISA, IC, PA, HA techniques and PCR-based molecular techniques. • Epidemiological studies carried out for chronic hepatitis, HIV, <i>Chlamydia trachomatis</i> (CT), <i>Neisseria gonorrhoeae</i> (NG) 	GLP followed
9.	Om Nursing home, Chabahil	<ul style="list-style-type: none"> • Human <i>in vitro</i> fertilization (IVF) 	GLP followed

10.	Nepal Aushadhi Limited, Babarmahal, Kathmandu	<ul style="list-style-type: none"> • Therapeutic packaging and sale 	GLP followed
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4.3 Food and Industrial Biotechnology Sector

Status of HR, infrastructure and current activities of key stakeholder institutions in key food and Industrial institutions are presented in the following section (Table 4.3 A, 4.3 B).

Table 4.3.A Human resources and Infrastructure Facility of key Institutions in Food and Industrial Biotechnology Sector of Nepal.

S. N.	NAME AND ADDRESS OF THE INSTITUTION	BIOTECHNOLOGY RELATED HR	INFRASTRUCTURE RESOURCES/ INFORMATION RESOURCES
1.	Department of Food Technology and Quality Control (DFTQC), Babarmahal	1 – Ph. D. Food Science – Abroad 2- M. Tech. M. Sc. – Food Sc. And Tech., Microbiology – Abroad and Nepal 2- B. Tech, B. Sc. – Food Tech, microbiology – Nepal	<ul style="list-style-type: none"> • Microbiology laboratory and associated facilities • TLC, HPLC, GC, Refrigerated centrifuge, Lyophilizer, Co₂ incubator, phase contrast microscope, Spectrophotometer • Internet, library, books and journal facilities available
2.	Central Campus of Technology, IOST, Hattisar Dharan	1- Ph.D. – Food Tech. fruits and Veg. –Abroad 4 – M. Tech. M. Sc. – Food tech., Food Engineering, Microbiology, dairy technology – Abroad 10 – B. Tech. Diploma – Nepal	<ul style="list-style-type: none"> • 3 – microbiology labs • 2 – labs for biochemical Engineering and Industrial Microbiology • 2 labs for dairy technology and associated facilities all these labs • journals and books available
3.	Centre for Agricultural Technology (CAT), Gwarko	1 – Ph. D. – Botany – Abroad 1- Ph. D. – Agriculture – Soil microbiology 2 - M. Sc. – Botany, Entomology (IPM)	<ul style="list-style-type: none"> • 1200 sq.ft. laboratory space • Laminar Air flow, autoclave, incubators etc. • books and journals
4.	Nepal Dairy Private Ltd. Mahabouddha, Kathmandu	1- Ph. D. in Dairy Science – Abroad 2- M. Sc. – Microbiology and Environmental Science – Nepal 2 – B. Sc. – chemical Engineering and Food Technology – Abroad	<ul style="list-style-type: none"> • Microbiology laboratory and Associated facilities

5.	Nepal Biotech Nursery, Pvt. Ltd., Lalitpur Nepal	1- Biologist – Abroad	<ul style="list-style-type: none"> • 2500 sq. ft laboratory space and associated facilities for tissue culture • 1200 sq.ft. area for glass house • 16,500 sq. ft. area for shade house
6.	Department of Biotechnology, KU	1- Ph. D. – Neutraceuticals- Abroad	<ul style="list-style-type: none"> • As mentioned in Medical Biotechnology Section.

Table 4.3.B Current Biotechnological Activities/ Programs and Projects of key institutions in Food and Industrial Biotechnology Sector.

S. N.	NAME OF THE INSTITUTION	CURRENT BIOTECHNOLOGICAL ACTIVITIES/ PROGRAMS AND PROJECTS	GLP PRACTICE
1.	Department of Food Technology and Quality Control (DFTQC), Babarmahal	<ul style="list-style-type: none"> • Currently working in developing HR and infrastructure on GMO/ LMO/ GM-FFP detection • Screening of yeast strains for cider making • Development of lactic drink • Laboratory preparation of dahi starter and its viability tests • Laboratory preparation of pure murcha and its fermentation activities • Preparation of wine, cider, Perry and other alcoholic beverages using pure and mixed cultures • Preparation and quality evaluation of indigenous fermented foods (Mesu/ Chhurpi) • Preliminary studies on fermentation technology of soy sauce. 	GLP followed
2.	Central Campus of Technology, IOST, Hattisar Dharan	<ul style="list-style-type: none"> • Improving traditional kinnema (fermented soybean food) technology for commercialization – in house • Optimization of Jand (local alcoholic beverage) fermentation – in house • Besides, various food biotechnology related activities such as bakery production, brewing, fermented dairy production, confectionary industry based activity, fruit juice production, mushroom production, enzyme production from <i>Rhizopus</i> and <i>Aspergillus</i> spp. starter culture production, murcha or yeast production, 	GLP followed

		food nutritional quality assessment, food microbial quality assessment, food bacterial and fungal toxin (Aflatoxin) detection activities are being performed using local as well as imported organisms and raw materials.	
3.	Centre for Agricultural Technology (CAT), Gwarko	<ul style="list-style-type: none"> • Development of Shiitake mushroom cultivation technology • Spawn production for <i>Agaricus</i> and <i>Pleurotus</i> • Technology transfer to farmers • Annual production of 40, 000 bottles spawn production per year 	GLP followed
4.	Nepal Dairy Private Ltd. Mahabouddha, Kathmandu	<ul style="list-style-type: none"> • Pre-feasibility study of establishing a Yak cheese and butter factory at Gorkha district, Nepal • Feasibility study for buffalo milk cheese factory in Nepal • Feasibility study of Cheese and butter factories in the interior mid hills and high Himalayan region of Gorkha district • Feasibility study of establishing cheese factory at Ilam district. 	GLP followed
5.	Nepal Biotech Nursery, Pvt. Ltd., Lalitpur Nepal	<ul style="list-style-type: none"> • Participatory research on plantation, establishment of marketing channels and commercialization for high value cut flowers. • Conservation of endangered orchids and cultivation of hybrid orchids through participatory approach by community based women group and marketing of the orchids to enhance livelihood of local people • <i>In vitro</i> conservation of few endangered orchids of Nepal • <i>Ex situ</i> conservation of some high altitude medicinal plants (<i>Dactylorhiza hatagirea</i> and <i>Picrorhiza scrophulariiflora</i>) of Manang. 	GLP followed
6.	Department of Biotechnology, KU	<ul style="list-style-type: none"> • Assessment of herbal extracts as natural preservatives –Collaborative with IFS 	GLP followed

4.4 Environmental Biotechnology Sector

Current Status of HR, infrastructure and current Projects and activities of key stakeholder institutions of Environmental Biotechnology Sector are presented in the following section (Table 4.4 A, 4.4 B).

Table 4.4.A. Human resources and Infrastructure Facility of key Institutions in Environmental Biotechnology Sector of Nepal.

S. N.	NAME AND ADDRESS OF THE INSTITUTION	BIOTECHNOLOGY RELATED HR	INFRASTRUCTURE RESOURCES/ INFORMATION RESOURCES
1.	Department of Environmental Science, Kathmandu University, Dhulikhel/ 1991	1- Ph. D. – Air pollution – Abroad 2 – M. Sc. – Environmental biotechnology and Environmental engineering – Abroad	<ul style="list-style-type: none"> • Microbiological lab with associated facilities (hot air oven, incubator, BOD incubator, water bath/shaker, laminar air flow etc. • Pollution lab with GC, AAS, high volume air sampler, personal air sampler etc.
2.	Environment Laboratory, Nepal Academy of Science and Technology, Lalitpur	1- Ph. D. – Botany – Abroad 2- M. Sc. – Environmental Science, microbiology	<ul style="list-style-type: none"> • Environmental Laboratory with associated facilities
3.	Environment and Public Health Organization (ENPHO), New Baneswor/ 1990	2 – Ph. D. – Chemistry – Abroad 7- M. Sc. – Environmental Science, Env. Engineering, Env. Management, chemistry, botany, public health – Abroad and Nepal 1 – B. Sc. – Env. Engineering – Abroad	<ul style="list-style-type: none"> • Microbiological lab with associated facilities • Physico-chemical analytical lab with AAS and GC • Air quality monitoring facility with HVAS and OVS • Resource centre with internet, books, journals, articles and report facilities.
4.	RECAST	As mentioned in plant biotechnology section.	<ul style="list-style-type: none"> • Mentioned in plant biotechnology section.

Table 4.4.B. Current Biotechnological Programs and Projects/Activities/ of key Institutions in Environmental Biotechnology Sector of Nepal.

S. N.	NAME OF THE INSTITUTION	CURRENT BIOTECHNOLOGICAL ACTIVITIES/ PROGRAMS AND PROJECTS	GLP PRACTICE
1.	Department of Environmental Science, Kathmandu University, Dhulikhel/ 1991	<ul style="list-style-type: none"> • Microbiological study in arsenic water • Phyto-remediation filter for families 	GLP followed
2.	Environment Laboratory, Nepal Academy of Science and Technology,	<ul style="list-style-type: none"> • Water microbial quality evaluation and monitoring 	GLP followed

	Lalitpur		
3.	Environment and Public Health Organization (ENPHO), New Baneswor/ 1990	<ul style="list-style-type: none"> • Implementation of ECOSAN in Peri-urban areas – collaborative • Construction of wetlands – collaborative • Co-composting of ECOSAN – collaborative • Besides the institution is undertaking waste water management using reed-bed system, human waste management using ecological sanitation system and solid waste management using composting system. 	GLP followed
4.	RECAST	<ul style="list-style-type: none"> • An integrated approach for the utilization of municipal solid waste. 	-

(-): data not available.

4.5 Biotechnology Education Sector

Specific Biotechnology education (bachelors and Masters Degree) started only few years back in Nepal. Prior to this, different branches of biological sciences (Botany, Agriculture Science, and Zoology) have contributed in generating Biotechnology related human resources in the country. Current status of HR, infrastructure and ongoing activities in various key institutions of Biotechnology education Sector of Nepal is presented in the following section (Table 4.5 A, 4.5 B).

Table 4.5.A Human Resources and Infrastructure Facility of key Institutions in Biotechnology Education Sector of Nepal.

S. N.	NAME AND ADDRESS OF THE INSTITUTION	BIOTECHNOLOGY RELATED HR	INFRASTRUCTURE RESOURCES/ INFORMATION RESOURCES
1.	Central Department of Botany, TU	1 – Ph. D. – Plant tissue culture 1- Ph. D. – Plant physiology 1- Ph. D. – Bio-fertilizer 1 – Ph. D. – Molecular biology 1 – Ph. D. – Plant pathology 1 – Ph. D. – Mycology 2 – Ph. D. Plant systematics	<ul style="list-style-type: none"> • Plant tissue culture laboratory with associated facilities • Molecular biology laboratory with PCR machine and other associated facilities
2.	Central Department of Microbiology, TU	2- Ph. D. – Immunology – India 1 – Ph. D. – Enzymology – India 1 – Ph. D. – Biochemistry	<ul style="list-style-type: none"> • Animal cell culture laboratory with associated facilities • Plant tissue culture laboratory with associated

		<p>– Russia 5 – M. Sc. – Microbiology – Nepal</p>	<p>facilities</p> <ul style="list-style-type: none"> • Thermal cycler, Electrophoresis, gel doc system, amino acid analyzer, AAS, Fermentor etc.
3.	Central Department of Zoology, TU	<p>1-Ph. D. – parasitology-India 2- Ph. D. – Entomology-India 1-Ph. D. – Genetics & Ethnogenetics – Japan 4- Ph. D. – Zoology, Ecology, Environment</p>	-
4.	Department of biotechnology, KU, Dhulikhel	<ul style="list-style-type: none"> • As mentioned in medical Biotechnology section 	<ul style="list-style-type: none"> • Eight separate laboratories viz. one in immunology, one in microbiology, two in animal and plant tissue culture, two in bioinformatics, and two in molecular biology.
5.	Tri Chandra Multiple College	<p>2 – Ph. D. – Microbial Biotechnology – Abroad 8 – M. Sc. Microbiology – Nepal</p>	<ul style="list-style-type: none"> • Food and agricultural biotechnology lab with laminar air flow, water bath shaker, colony counter, spectrophotometer etc. • Environmental and medical biotechnology lab with TLC, water analysis kit, autoclave etc.
6.	National College, Lazimpat	<p>2 – Ph. D. – Biochemistry and Applied Microbiology – Abroad 7 – M. Tech/ M. Sc. – Food technology, microbiology and biochemistry</p>	<ul style="list-style-type: none"> • SDS –PAGE unit, Gel electrophoresis unit, TLC unit, distillation plant, conductivity meter, colorimeter, spectrophotometer, refractometer and other accessories of microbiological and biotechnological lab.
7.	Lord Buddha Education Foundation, Maitidevi/ 1998	<p>2 Ph. D. – Rice biotechnology and molecular biotechnology and molecular systematics 7 – M. Sc. – quantitative genetics, cell and molecular biology, cancer genetics, molecular</p>	<ul style="list-style-type: none"> • Plant tissue culture laboratory with associated facilities • Molecular biology lab with associated facilities • Growth chamber, Dark room • A good library facility

		genetics, cancer biology, microbial biotechnology	with e-journal access facility
8.	SANN International College, Kathmandu	3 – Ph. D. – Plant physiology, Molecular biology, agricultural microbiology, zoology, Analytical chemistry – Abroad 15 – M. Sc. – biochemistry, microbiology, botany, zoology, chemistry, physics – India and Nepal	<ul style="list-style-type: none"> • Biology, Chemistry, Physics, Microbiology, Molecular biology, Biochemistry and Biotechnology and Plant Tissue Culture laboratories • Laminar air flow, Walk in growth chamber, pH meter, Distillation plant, UV spectrophotometer etc. • Library with internet, books and journals
9.	IAAS, Rampur	-	-
10.	Hattisar Campus, Dharan	-	<ul style="list-style-type: none"> • Microbiology, biochemical engineering, industrial microbiology and dairy technology laboratories with associated facilities.
11.	Universal Science college, Maitidevi	-	<ul style="list-style-type: none"> • Biotechnology and biochemistry laboratories with associated facilities.
12.	HECAST	-	-

(-): data not available.

Table 4.5.B. Current Biotechnological Programs and Projects/ Activities/ of key Institutions of Biotechnology Education Sector of Nepal.

S. N.	NAME AND ADDRESS OF THE INSTITUTION	CURRENT BIOTECHNOLOGICAL ACTIVITIES/ PROGRAMS AND PROJECTS	GLP PRACTICE
1.	Central Department of Botany, TU, Kirtipur	<ul style="list-style-type: none"> • Ex-situ conservation of medicinal plants • Ex-situ conservation of mid-hill plants – in house and collaborative • bio-fertilizer – collaborative 	GLP followed
2.	Central Department of microbiology, TU, Kirtipur	<ul style="list-style-type: none"> • Study on sero- epidemiology of Japanese encephalitis in Nepal accomplished. • Study on genetic polymorphism among Bacillus thuringiensis isolates from Khumbu base camp of Everest region using RAPD has been carried out. • Study on prevalence of Malaria and Hepatitis B among Nepalese blood donors has been conducted. 	GLP followed

		<ul style="list-style-type: none"> • Study on delta endotoxin immunocross reactivity of <i>Bacillus thuringiensis</i> isolates from Khumbu base camp has been accomplished. • Study on prevalence of enteric fever and assessment of widal test in the diagnosis of typhoid fever has been accomplished. • Many previous Masters Research works carried out since 1994. 	
3.	Central Department of Zoology, TU	<ul style="list-style-type: none"> • Study of parasites • Study of Biofertilizers • Study of vermicompost 	GLP followed
4.	Department of biotechnology, KU, Dhulikhel	<ul style="list-style-type: none"> • Isolation of Streptomycetes • Assessment of herbal extracts as bio-preservatives 	GLP followed
5.	Microbiology Department, Trichandra Campus, Kathmandu	<ul style="list-style-type: none"> • Production of Biofertilizer in laboratory scale • Preparation of pre-fermenter culture of <i>S. cerevisiae</i> for fermentation of grapes. • Preparation of wine using pre-fermenter culture • Alcohol and acidity tests in milk • Enumeration of total and coli form organisms of different foods and food products 	GLP followed
6.	National College, Lazimpat	<ul style="list-style-type: none"> • Screening and characterization of antimicrobial substance producing actinomycetes from soil of different altitudes of Nepal. • Optimization of alcohol production using local available manna. • Assessment of antimicrobial property of medicinal plants. • Screening, characterization and optimization of lactic acid bacteria from indigenous DAHI- JUJU DHAU. • and many other biochemical, microbiological and biotechnological research thesis work carried out by graduates and post graduate students since 2001. 	GLP followed
7.	Lord Buddha Education Foundation, Maitidevi	<ul style="list-style-type: none"> • None at the moment only practical classes. 	GLP followed
8.	SANN International College, Kathmandu	<ul style="list-style-type: none"> • None at the moment only practical classes. 	GLP followed
9.	IAAS, Rampur	-	-
10.	Hattisar Campus	<ul style="list-style-type: none"> • As mentioned in food and industrial 	-

	Dahran	sector	
11.	Universal science college	-	-
12.	HECAST	-	-

(-): data not available.

4.6 Forensic Biotechnology Sector

Current Status of HR, infrastructure and current Projects and activities of key stakeholder institution of Forensic Biotechnology Sector are presented in the following section (Table 4.6 A, 4.6 B).

Table 4.6 A Human Resources and Infrastructure Facility of key Institutions in Forensic Biotechnology Sector of Nepal.

S. N.	NAME AND ADDRESS OF THE INSTITUTION	BIOTECHNOLOGY RELATED HR	INFRASTRUCTURE RESOURCES/ INFORMATION RESOURCES
1.	NAFOL	1- M. Sc. Forensic Science- Abroad 4- M. Sc. – Botany, Zoology, Microbiology - Nepal	<ul style="list-style-type: none"> • Molecular laboratory with ABI 310 DNA analyzer, gold plated PCR (ABI 9700) • Electrophoresis unit, centrifuge, ultra deep freeze (-80° C), biosafety cabinets etc. • Biological microscope, fluorescence microscope, polarized microscope etc • Few books, manuals, journals and Internet facility.

Table 4.6 B. Current Biotechnological Programs and Projects/ Activities/ of key Institutions of Biotechnology Forensic Sector of Nepal.

S. N.	NAME AND ADDRESS OF THE INSTITUTION	CURRENT BIOTECHNOLOGICAL ACTIVITIES/ PROGRAMS AND PROJECTS	GLP PRACTICE
1.	NAFOL	<ul style="list-style-type: none"> • DNA data basing of Nepalese population. • Detection of body fluid for crime investigation. • Use of immunological techniques for crime investigation and • PCR-based Short Tandem Repeats (STR) DNA profiling for human identification and biological relationship. 	GLP followed

5.0 GOVERNMENT POLICY/ LEGISLATION REGARDING APPLICATION OF BIOTECHNOLOGY

Recently, Nepal Government has ratified National Biotechnology Policy (NBP, 2006). Prior to this, Ministry of Forestry and Soil Conservation has published Biosafety Guidelines (2062) with regards to safe handling and use of modern biotechnology products (Biosafety guidelines, 2005/ 2062). Recently, MoFSC has developed National Biosafety Framework (NBF, 2007) comprising policy, legal, technical and administrative aspects of Biosafety to safeguard the biological diversity, human health and environment from the possible adverse effects of Genetically Modified Organism (GMOs) and their products as per CBD-CPB requirements.

Besides these, a number of national policy and legal documents exist in various disciplines and sub-sectors within various institution's mandate and objectives that are directly or indirectly related to biotechnology, biodiversity and biosafety. Following is the list of some of them (Table 5.1).

Table 5.1 Existing Policy/ Legislation concerning Biotechnology in various sectors.

S. N.	NAME OF THE POLICY/ LEGISLATION/ GUIDELINES	YEAR PUBLISHED
1.	Tenth Five Year Plan Perspectives	2002-2007 A. D.
2.	Nepal Agro-biodiversity Policy	2007 A. D.
3.	Agriculture Perspective Plan	1995 -2025 A. D.
4.	National Agricultural policy	2061 B. S.
5.	Food Act	2023 B. S.
6.	Amendment of Plant Protection Act	2029 B. S.
7.	Export import (control) Act	2033 B. S.
8.	Feed Products act	2033 B. S.
9.	Medicine/ Drug Act	2035 B. S.
10.	National Seed Act	2045 B. S.
11.	Livestock Health and Livestock Service Act,	2055 B. S.
12.	Animal Health and Animal Service Regulation	2056 B. S.
13.	Animal Feed Policy	-
14.	National Seed Policy	2056 B. S.
15.	National Seed Regulation	2054 B. S.
16.	Science and Technology Policy	2003 (2061 B. S.)
17.	Biosafety Guidelines	2004 (2062 B. S.)
18.	Biotechnology Policy	2006 (2063 B. S.)
19.	National Biosafety Framework (NBF) for Nepal	2006 (2063 B. S.)
20.	Nepal Biodiversity Strategy	2000 A. D.
21.	Forest Act	2049 B. S.
22.	The Environment Protection Act	1996 A. D.

In addition to, National Policy, legislations, strategies and guidelines, Nepal is a signatory country of a number of International legal instruments (Table 5.2) pertaining to conservation and sustainable utilization of biodiversity.

Table 5.2 Nepal's International Agreements

S. N.	INTERNATIONAL LEGAL INSTRUMENTS	DATE SIGNED
1.	Plant Protection Agreement for the South East Asia and Pacific Region	February 27, 1956
2.	Convention on Wetlands of International Importance Especially Waterfowl Habitat.	February 2, 1971
3.	Convention for the protection of the World Cultural and Natural Heritage	November 23, 1972
4.	Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES)	March 3, 1973
5.	World Conservation Strategy	1980
6.	World Charter for Nature	1982
7.	International Tropical Timber Agreement	November 18, 1983
8.	Agreement on Network of Aquaculture Centers in Asia and the Pacific	January 8, 1988
9.	Convention on Biological Diversity (CBD)	November 23, 1993
10.	Cartagena Protocol on Biosafety (CPB)	March 2, 2001 - signed
11.	World Trade Organization (WTO)	April 23, 2004

Source: Tuladhar, 2006

6.0 PRIORITY AREAS OF COOPERATION FOR NEPAL

Biotechnology has wide applications in almost all branches of biological science including medical, Agriculture, veterinary, food, environment and energy production. The emergence of new biotechnologies and evolution of older biotechnologies associated with availability of ocean of newly developed knowledge and techniques has made biotechnology, an arena possessing immense practical utility and tremendous economic potential in different sectors.

Due to various constraints, Nepal has lagged behind in Biotechnology and with the existing HR, infrastructure and budget allocation by Government in R & D in Biotechnology, Its very difficult for Nepal to keep pace with the rapidly evolving newer technological advancements in modern biotechnology. A strong national commitment is needed for the overall development of Biotechnology in various sectors for the economic enhancement of the nation as a whole. There are many areas in various Biotechnology sectors in which regional cooperation can be initiated. Priority Areas of Cooperation at regional level in various sectors will be presented in the following section.

6.1 Plant Biotechnology Sector

Use of biotechnological tools in Agriculture and forestry sector is very wide and aimed at generating improved agro forestry crops with enhanced yield, disease resistance, drought resistance, insect tolerant and many other important attributes. Besides, biotechnological tools such as molecular markers can be used to tag genes of interest; employed in marker assisted selection for accelerating breeding; fingerprinting cultivars, landraces and germ-plasm stocks; DNA based markers for diagnosis of diseases and pests of agronomic and forestry importance; assessment of biodiversity for conservation purposes etc. Furthermore, tissue culture technology offers *in vitro* mass multiplication technique of elite planting materials; production of disease free planting materials, somatic embryogenesis, protoplast

fusion, secondary metabolite production, ex situ conservation of germplasm and many other advantages. Priority areas of national, regional and International Cooperation in Plan biotechnology Sector for Nepal are:

- ✦ Human resource and infrastructure development in molecular biological, biotechnological/ modern biotechnological techniques (including rDNA technology) for sustainable utilization and conservation of agro-forestry and microbial resources; biosafety risk assessment and management; practical training for handling sophisticated equipments such as DNA sequencer, microarray, real-time PCR, HPLC-MS, MS, NMR etc..
- ✦ HR and infrastructure development in bioinformatics, molecular genetic characterization (using molecular markers such as SSRs, AFLP and DNA sequencing) of high value agricultural crops and medicinal plant species; molecular markers for plant breeding, marker assisted selection, molecular tagging of agriculturally important genes, use of QTL and gene pyramiding using molecular markers; use of biotechnological tools for IPR protection of agro-forest and microbial biodiversity by initiating National DNA bar-coding project.
- ✦ Establishment of National gene bank, seed bank, cryo-preservation facility, DNA bank and strengthening of ex-situ conservation sites (e.g. Botanical gardens) for conservation of high value Nepalese biodiversity (e.g. Medicinal plants).
- ✦ Assistance in strengthening plant quarantine services by upgrading modern biotechnological infrastructure and HR as per WTO requirement.
- ✦ Plant tissue culture techniques including virus-elimination, somatic hybridization, and secondary metabolite production, *in vitro* double haploid production etc.
- ✦ Exchange of efficient strains of microorganisms used in bio-fertilizer (both bacterial and mycorrhizal).
- ✦ Development and use of immunological and molecular diagnostics for agronomically important crop bacterial, fungal and viral diseases (e.g. citrus, potato etc.).
- ✦ Application of molecular tools for plant disease and pest management.

6.2 Animal Biotechnology Sector

Similarly, in animal biotechnology, a number of biotechnological tools can be employed aiming at enhanced production of healthy farm animals via marker assisted breeding, embryo transfer and artificial insemination, *in vitro* fertilization, disease diagnosis, therapeutic and vaccine production and use of transgenic animals as bioreactors for the production of economically important therapeutics and hormones as well as models for human medical research. Priority areas of cooperation in animal biotechnology sector from SAARC countries therefore are:

- ✦ Human resource and infrastructure development in molecular biological and biotechnological/ modern biotechnological fields of livestock and veterinary disciplines.
- ✦ Introduction of advanced technology for *in vivo* and *in vitro* embryo production, *in vitro* fertilization (sperm capacitation, oocytes maturation and fertilization), embryo micromanipulation (embryo sexing, embryo splitting, embryonic stem cell culture), sperm cell sexing through flow cytometry, Karyotyping, animal therapeutics, vaccines and diagnostics production, transgenic animals production (for the production of therapeutic agents, synthetic genes and peptides).
- ✦ Embryo transfer and artificial breeding of rare and endangered species of animals to increase their populations through biotechnological interventions.

- ✦ R & D & business in waste water treatment technologies, solid waste management and bioremediation technologies.
- ✦ Molecular genetic characterization of environmentally important microbes, plants and insects of Nepal and their IPR protection via DNA-barcoding.
- ✦ *Bacillus thuringiensis* based bio-pesticide production and application.
- ✦ Development of biotechnology-based renewable energy production technologies.

6.6 Biotechnology Education Sector

Biotechnology education sector is the most important sector to be addressed at present in Nepal, which has been realized past few years resulting into initiation of a number of educational institutes providing bachelors degree in Biotechnology. This is however, not sufficient and Nepal needs a good support from its helpful neighboring countries to enhance its educational standard of biotechnology education in various fields viz. plant biotechnology, animal biotechnology, medical biotechnology, industrial biotechnology, food and environmental biotechnology.

Following priority areas of regional cooperation have been perceived in Biotechnology education sector of Nepal:

- ✦ Conducting regional collaborative R & D activities in subjects of interests to both the collaborating teaching and research institution parties from various fields.
- ✦ HR development by exchanging higher education scholars such as M. Sc., Ph. D. and Post Doctoral in various biotechnology disciplines.
- ✦ Documentation and conservation of Biotechnological resources.

6.7 Forensic Biotechnology sector

A number of biochemical, immunological, serological and DNA based technologies are routinely used in forensic laboratories through out the globe for various purposes such as crime investigation, human identification, paternity analysis, illegal trade of biological resources etc. Priority areas of national and regional cooperation of Forensic biotechnology sector of Nepal are:

- ✦ Human Resource development for personal identification from human remains.
- ✦ Infrastructure development for NAFOL in advanced molecular technologies in Forensic Science.

6.8 Bio-energy and Bioconversion Sector

In the present context of climate change, the importance of alternative energy such as bio-energy and bioconversion technologies is rapidly increasing. Priority areas of cooperation in this sector is exploration and sustainable exploitation of existing bio-energy and bioconversion resources of Nepal and of the region and sharing information and technology for the mutual benefit of collaborating national institutions as well as neighboring countries in the region.

6.9 Biotechnology Resources Information Sharing

Nepal is seeking biotechnology information retrieving and sharing facilities to enhance its research capabilities. Priority areas of cooperation are exchange of scientific databases and E-journals access facility.

7.0 AREAS OF EXPERTISE AVAILABLE FOR COOPERATION

Nepal has got ample skilled human resources in various medical, biological and chemical fields, which can be judiciously exploited by upgrading in different applied fields of biotechnology. However, Nepal has scarce human resources trained in different disciplines of modern biotechnology. Appropriate short term and long term training of existing HR in various disciplines can fulfill this gap. Expertise available for cooperation in various biotechnology sectors, their institution and contact details are indicated in following section.

7.1 Plant Biotechnology Sector

Expertise available for national/ regional cooperation in various plant biotechnology related institutions of Nepal is listed (Table 7.1).

Table 7.1 Expertise available in various plant biotechnology related institutions of Nepal.

S. N.	Available expertise/ Institution	Institutional address
1.	Biofertilizer, Organic farming, vermi-composting/ Nepal Academy of Science and Technology	Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur Nepal/ 977-1-5547714/ yamikd@yahoo.com
2.	Shoot Tip grafting in vitro of citrus for elimination of virus and virus-like diseases of citrus/ Nepal Academy of Science and Technology	Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur Nepal/ 977-1-5547714/ cregmi@hotmail.com , sangita7@hotmail.com
3.	Ectomycorrhiza/ Nepal Academy of Science and Technology	Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur Nepal/ 977-1-5547714/ geetashrestha1@hotmail.com
4.	<i>Bacillus thuringiensis</i> based biological pesticide	Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur Nepal/ 977-1-5547714/ jaya_sija@hotmail.com
5.	Molecular biology and molecular systematics (Random and specific PCR, Cloning, DNA sequencing, PCR-RFLP and other molecular tools in biodiversity assessment and diagnostic development)/ Nepal Academy of Science and Technology	Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur Nepal/ 977-1-5547714/ sangita7@hotmail.com
6.	Bioprospecting, bioinsecticide, biopesticide/ Nepal Academy of Science and Technology	Nepal Academy of Science and Technology/ 977-1-5547714/ ozone@ntc.net.np
7.	Molecular biology, wide hybridization, genetics, tissue culture/ Biotechnology unit NARC	Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur, Nepal/ 977-1-5539658 bimbhp49@gmail.com ,

		joshibalak@yahoo.com
8.	Plant Breeding, Molecular genetic diversity analysis/ Agrobotany Division NARC	Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur, Nepal/ 977-1-5521614, 977-1-5545485/ jwalabjch@enet.com.np
9.	Disease free pre-basic seed production of potato, micropropagation and microtuberization, potato virus testing and elimination, RT-PCR for virus diagnosis, cryopreservation/ National Potato Research Program NARC	Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur, Nepal/ 977-1-5522114/ bmsakha@gmail.com
10.	Plant disease management, Biological Control/ Plant Pathology Division NARC	Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur, Nepal/ 977-1-5523143/ ppd@narc.gr.np
11.	Plant rDNA technology/ Regional Agriculture Research Station, Lumle, Kaski, Nepal	Regional Agriculture Research Station, Lumle, Kaski, Nepal/ 061-622174 hkprasai_2006@yahoo.com
12.	Citrus horticulture/ National Citrus Research Programme, NARC, Paripatle Dhankuta	National Citrus Research Programme, NARC, Paripatle Dhankuta/ 026-520055/ citrus@ntc.net.np
13.	Integrated Pest Management, Department of Agriculture, Harihar Bhawan, Nepal	Department of Agriculture, Harihar Bhawan, Nepal/ 977-1-5521597/ ppd@ipmnet.wlink.com.np
14.	Plant tissue culture, Protoplast culture, Isozyme analyses/ Department of Plant Resources, Thapathali	Department of Plant Resources, Thapathali/ 977 - 1-4251160, 977-1-4251161/ dprdoc@ntc.np
15.	Plant tissue culture/ National Herbarium and Plant Research Laboratory, Godawari	National Herbarium and Plant Research Laboratory, Godawari/ 977-1-5560547, 977-1-5560549
16.	Plant disease diagnosis and virus elimination/ Plant tissue culture/ GREAT	Green Research and Technology (GREAT)/ 977-1-4473550/ great@info.com.np
17.	Bioprospecting of <i>Cordiceps</i> spp. of Nepal, their in vitro culture of fruiting bodies, extraction of active bioactive compounds, molecular diagnosis of crop diseases, rDNA technology, isolation of plant growth promoters from microorganisms, renewable plant oil energy development and mass propagation of potential oil bearing plants/ Green Energy Mission Nepal	Green Energy Mission Nepal/ 977-1-4248152/ rosemary-shrestha@hotmail.com
18.	Plant Biotechnology/ rDNA technology/ Amrit Science Campus	Amrit Science Campus, Lainchaur/ 977-1-4411637/ drtbb@mail.com.np

7.2 Animal Biotechnology Sector

Expertise available in various animal biotechnology related institutions of Nepal are listed (Table 7.2)

Table 7.2 Expertise available in various animal biotechnology related institutions of Nepal.

S. N.	Available expertise / Institution	institutional address
1.	TCARV production/ Rabies Vaccine Production Laboratory, Tripureshwor	Rabies Vaccine Production Laboratory, Tripureshwor/ 977-1-4251123 jrain@rabies.wlink.com.np
2.	PCR and different veterinary and microbiological and virological techniques/ Central Veterinary Laboratory, Tripureshwor	Central Veterinary Laboratory, Tripureshwor/ 977-14261938/ cvl@wlink.com.np
3.	Nutritionists/ Animal Nutrition Division, NARC	Animal Nutrition Division, NARC/ 977-1-5523039/ crupreti@yahoo.com
4.	Embryo transfer, artificial insemination, semen production, karyotyping / Animal Breeding Division, NARC	Animal Breeding Division, NARC 977-1-5523160/ spneopane04@yahoo.com

7.3 Medical Biotechnology Sector

Expertise available for national/ regional cooperation in various medical biotechnology related institutions of Nepal are listed (Table 7.3).

Table 7.3 Expertise available in various medical biotechnology related institutions of Nepal.

S. N.	Available expertise / Institution	Institutional address
1.	Medical biochemical tests, hormone assay, tumor marker assay, microbiology, Hematology and immunization/ Siddhi Poly Path Lab, Dilli Bazar.	Siddhi Poly Path Lab, Dillibazar Kathmandu/ 977-1-4410604/ ilshrestha@healthnet.org.np
2.	Pharmaco-genomics, molecular diagnostics, epigenetic biomarkers/ Everest Biotech Pvt. Ltd. Maharajgunj	Everest Biotech Pvt. Ltd. Maharajgunj/ 977-1-4437000/ 977-1-4433433
3.	Medical Biotechnology/ Department of Biotechnology, Kathmandu University (KU)	Department of Biotechnology, Kathmandu University (KU)/ ljanardan@ku.edu.np
4.	Medical Biotechnology/ Department of Microbiology, IoM, TUTH, Maharajgunj	Department of Microbiology, IoM, TUTH, Maharajgunj/ bmp268@hotmail.com
5.	Medical Microbiology and Biotechnology/ Central Department of Microbiology, TU	Central Department of Microbiology, TU/ 977-1-4331869/ microbiotu@wlink.com.np
6.	Medical biotechnology/ National College, Lazimpat Kathmandu	National College, Lazimpat Kathmandu/ 977- 1-4443090/ nacolnist@wlink.com.np

7.4 Food and Industrial Biotechnology Sector

Expertise available for national/ regional cooperation in various food and industrial biotechnology related institutions of Nepal are listed (Table 7.4).

Table 7.4 Expertise available in various food and industrial biotechnology related institutions of Nepal.

S. N.	Available expertise / Institution	Institutional address
1.	Prebiotics/ Probiotics/ antioxidants/ Enzyme/ Fermentation/ organic acids/ Dr. Megharaj Bhandari/ Department of Food Technology and Quality Control (DFTQC)	Department of Food Technology and Quality Control (DFTQC)/ 9841317484 mrjbhandari@yahoo.com
2.	Food Biotechnology/ Department of Food Technology and Quality Control (DFTQC)	Department of Food Technology and Quality Control (DFTQC)/ 977-1-4262369/ ukbhattarai@yahoo.com; dftqc@mail.com.np
3.	Food Biotechnology/ Central Campus of Technology Dharan	Central Campus of Technology Dharan/ 977-25-520228/ cdft@ntc.net.np gangapkharel@yahoo.com
4.	Food Biotechnology/ Nepal Academy of Science and Technology (NAST)	Nepal Academy of Science and Technology (NAST)/ 977 – 1-5547720/ dilipsubba@mail.com.np
5.	Food and Industrial Biotechnology, Microbial biotechnology/ National College, Kathmandu	National College, Kathmandu/ 977-1-4443090/ nacolnlist@wlink.com.np
6.	Food Biotechnology/ Tri Chandra Multiple college, Kathmandu	Tri Chandra Multiple college, Kathmandu/ 977-1-4230517/ shova_23@hotmail.com
7.	Probiotics/ Kathmandu University, Dhulikhel	Kathmandu University, Dhulikhel/ (011) 661399 ext. 133/ sameer_dixit@ku.edu.np
8.	Food science, chemical engineering, food technology/ Nepal Dairy Kathmandu	Nepal Dairy Kathmandu/ 977-1-4220674/ nd@mos.com.np
9.	Tissue culture technology transfer/ Nepal Biotech Nursery, Jawalakhel	Nepal biotech Nursery, Jawalakhel, Lalitpur/ 977-1-5591349/ nbn@mail.com.np

7.5 Environmental Biotechnology Sector

Expertise available for national/ regional cooperation in various environmental biotechnology related institutions of Nepal are listed (Table 7.5).

Table 7.5 Expertise available in various environmental biotechnology related institutions of Nepal.

S. N.	Available expertise / Institution	Institutional address
1.	Vermi-composting, water microbial quality evaluation, organic farming/ Nepal Academy of Science and Technology (NAST)	Nepal Academy of Science and Technology (NAST)/ 977-1-5547714/ kayodevi2003@yahoo.com
2.	<i>Bacillus thuringiensis</i> based biological pesticide/ Nepal Academy of Science and	Nepal Academy of Science and Technology (NAST)/ 977-1-

	Technology (NAST)	5547714/ jaya_sija@hotmail.com, sangita7@hotmail.com
3.	Air, water pollution and waste water treatment/ Dept. of Env. Science, KU, Dhulikhel	Dept. of Env. Science, KU, Dhulikhel/ 977-11-661399/ sanjay@ku.edu.np
4.	Waste Water Treatment, Vermi-composting/ Environment and Public Health Organization (ENPHO), New Baneshwor	Environment and Public Health Organization (ENPHO), New Baneshwor/ 977-1-4491416 nir_ita@hotmail.com

7.6 Biotechnology Education and Information Sector

Expertise available for national/ regional cooperation in various biotechnology education related institutions of Nepal are listed (Table 7.6).

Table 7.6 Expertise available in various biotechnology education related institutions of Nepal.

S. N.	Available expertise / Institution	Institutional address
1.	Plant tissue culture, molecular biology/ Central Department of botany, TU, Kirtipur	Central Department of botany, TU, Kirtipur/ 977-1-4331322/ bpant@wlink.com.np
2.	Microbiology and biotechnology/ Central Department of Microbiology, TU, Kirtipur	Central Department of Microbiology, TU, Kirtipur/ 977-1-4331869/ microbiotu@wlink.com.np
3.	Agricultural and Medical Biotechnology, Department of Biotechnology, KU, Dhulikhel	Department of Biotechnology, KU, Dhulikhel/ (011)-661399/ ljanardan@ku.edu.np
4.	Environmental Microbiology, medical microbiology and microbial biotechnology/ Trichandra Multiple Campus, Kathmandu	Trichandra Multiple Campus, Kathmandu/ 977-1-4230517/ shova_23@hotmail.com
5.	Food and Microbial biotechnology/ National College, Lazimpat	National College, Lazimpat/ 977-1-4443090/ nacolnlist@wlink.com.np
6.	Cell and Molecular biology, cancer genetics, molecular genetics, cancer biology/ Lord Buddha Education Foundation, Maitidevi	Lord buddha Education Foundation, Maitidevi/ 977-1-4411805/ biotechnepal@gmail.com
7.	Agricultural biotechnology and plant tissue culture/ SANN International College	SANN International College/ 977-1-4420509, 977-1-4430840
8.	Institute of Agriculture and Animal Science (IAAS), Rampur, Nepal	Institute of Agriculture and Animal Science (IAAS), Rampur, Nepal/ 056-581141/ dnaba@wlink.com.np
9.	Biotechnology Information Network for Asia (BINASIA)/ Research Centre for applied Science and Technology (RECAST), Kirtipur	Research Centre for applied Science and Technology (RECAST), Kirtipur/ 977-1-4330348, 4331303/ phoenix@wlink.com.np, turecast@mail.com.np

7.7 Forensic Biotechnology Sector

Expertise available for national/ regional cooperation in forensic biotechnology related institution of Nepal is listed (Table 7.7).

Table 7.7 Expertise available in forensic biotechnology related institution of Nepal.

S. N.	Available expertise / Institution	Institutional address
1.	Collaborative research in Forensic Biotechnology/ National forensic Laboratory, Khumaltar	National forensic Laboratory, Khumaltar/ 977-1-5526927/ forensic@mos.gov.np

8.0. RECENT BIOTECHNOLOGY PRODUCTS / PROCESSES DEVELOPED/ READY FOR TRANSFER

Biotechnology products/ processes ready for transfer in plant biotechnology sector are shown in the following section.

8.1. Plant Biotechnology Sector

Biotechnological products or processes already developed by different institutions and are ready to transfer at national or regional level are shown (Table 8.1).

Table 8.1. Plant biotechnology related Products or processes ready to transfer.

S. N.	Products/ Processes developed or adapted	Concerned Authority
1.	Microbial inoculants like legume inoculants, <i>Azotobacter</i> inoculants, phosphate solubilizing microbial inoculants	NAST
2.	Citrus shoot tip grafting <i>in vitro</i> technology for the elimination of citrus virus and virus-like diseases.	NAST
3.	Endophytes packets as bio-pesticides	NAST
4.	Tissue culture techniques in various crops	NARC
5.	Disease free potato prebasic seed (minituber) production technology Disease free microtuber production	NARC
6.	Disease resistant crops (seeds) and Mushroom varieties	NARC
7.	Tissue culture protocols for ornamental/ horticulture crops, medicinal plants, orchids and some tree species Sand rooting technique for transfer of <i>in vitro</i> plantlets	DPR
8.	Virus free pre-basic seeds of potato, Disease free grafted plants of mandarins, Virus free plants of large mandarins	GREAT
9.	Field transfer of tissue culture plants of endangered species	CDB, TU

8.2. Animal Biotechnology Sector

Biotechnological products or processes already developed by different institutions and are ready to transfer at national or regional level are shown (Table 8.2).

Table 8.2 Animal biotechnology related Products or processes ready to transfer.

S. N.	Products/ Processes developed or adapted	Concerned Authority
1.	PPR disease diagnosis pen side test	CVL
2.	Urea Molasses Mineral Block (UMMB)	NARC
3.	Semen collections of Cattle and Buffalo	NARC

8.3. Medical Biotechnology Sector

Due to the least investment of Government in medical R & D, no considerable achievements have been obtained in medical R & D in Nepal with regards to technology development and transfer. Medical biotechnological research activities are restricted to few hospitals, university departments and private pathology laboratories, where various biotechnological tools have been adapted for research and public service purposes. Many pharmaceutical companies exist which are only doing business activities of various medical items. The crude products such as antibiotics are imported from neighboring countries and formulations and packaging kind of activities are performed in Nepal.

Few laboratories such as NRL and WARUN have recently introduced PCR based diagnostics for providing analytical services and for epidemiological R & D activities. Therefore, there are no such organizations which have developed such biotechnological technology or product that are worth transferring in SAARC region.

8.4 Food and Industrial Biotechnology Sector

Various dairy, brewery, bakery and many other industries are adapting foreign technologies and most of the raw material requirements are also fulfilled from outside Nepal. Products and processes in Nepal are shown below. Few Biotechnology products/ processes developed by some food biotechnology related institutions and industries that are ready for transfer at national and regional level are shown (Table 8.4).

Table 8.4 Food and Industrial Biotechnology related products or processes ready to transfer.

S. N.	Products/ Processes developed or adapted	Concerned Authority
1.	Mushroom spawn and variety of mushrooms	CAT
2.	In vitro conservation of few endangered orchids of Nepal, Ex situ conservation of some high altitude medicinal plants using tissue culture.	NBN
3.	Whey beverages/ Bael (<i>Eagle marmelos</i>) wine/ curd powder/ murcha (yeast) culture Mushroom Spawn production	Central Campus of Technology Dharan
4.	Murcha or Yeast strains for cider making and other fermentations	DFTQC
5.	Lactic drink production technology	DFTQC
6.	Dahi (Yogurt) starter	DFTQC
7.	Preparation of wine cider, Perry and other alcoholic beverages using pure and mixed cultures.	DFTQC
8.	Preparation and quality evaluation of indigenous	DFTQC

	fermented foods (mesu/ chhurpi).	
9.	Biochemical, nutritional, toxicological and microbial quality evaluation of various food items	DFTQC

8.5. Environmental Biotechnology Sector

Nepal still being in infancy stage regarding Environmental Biotechnology/ modern biotechnology R & D activities, no significant achievement has been made so far (Table 8.5). Very nominal works have been conducted in Nepal with regards to environmental remediation using biotechnological tools.

Table 8.5 Environmental biotechnology related process ready to transfer.

S. N.	Products/ Processes developed or adapted	Concerned Person/ Authority
1.	ECOSAN toilet, Reed Bed Waste water treatment plants, vermi-composting	ENPHO

8.6 Biotechnology Education Sector

Various educational institutions conduct research in different biotechnological aspects. However, the students' dissertation works remain in paper only and many of their findings never get chance of application for the overall national benefit in Nepal. The only responded institution of the survey in this aspect was Central Department of Botany, TU (Table 8.6). This is a great misfortune for the country.

Table 8.6 Environmental biotechnology related process ready to transfer.

S. N.	Products/ Processes developed or adapted	Concerned Person/ Authority
1.	Germplasm of endangered and important plant species developed by tissue culture technology are available for transfer in the field or ex situ conservation.	CDB, TU

8.7 Bio-energy and bio-conversion Sector

Same situation prevails in this sector also. So far, *Jatropha* based bio-energy and biogas are two main biotechnologies currently in use in Nepal (Table 8.7). NAST has recently initiated a project in bio-ethanol.

Table 8.7 Bio-energy related technology ready to transfer.

S. N.	Products/ Processes developed or adapted	Concerned Person/ Authority
1.	Appropriate technology package based on <i>Jatropha curcas</i> oil; potential antibacterial, antiviral, antifungal and anticancer, plant extracts/ RECAST	RECAST
2.	Biogas technology/ over 40 private biogas construction companies.	Different private entrepreneurs

9.0 ISSUES AND CHALLENGES

It is well known that biotechnology has great potential to change present economic scenario of the world. There can be no single discipline where, biotechnology has no application. However, Biotechnology being rapidly evolving subject, its application in various disciplines may be highly challenging for one of the least developing countries like Nepal (with per capita income of US\$ 270). This is also reflected in the national investment in R & D related activities in the field of S & T (which ranged from 0.27 to 0.48% between the years 1990-1995).

In the meantime, any biotechnological development in Nepal or elsewhere in the world should be aimed at how to use biotechnological and modern biotechnological tools and techniques for the characterization, sustainable utilization and conservation of our valuable floral, faunal and microbial diversity to obtain maximum benefit from them for the rapid enhancement of economic status of Nepalese people.

In the present scenario of rapid globalization, Nepal's economic status and the present figure of Government investment in scientific R & D, a number of issues and challenges have been perceived, which are presented in the following section:

9.1 Issues

Following issues have been perceived for the development of Biotechnology in Nepal:

- ↓ Due to the lack of adequate knowledge and R & D awareness among the policy makers, the potentiality of Biotechnology in overall national development has not yet been perceived. As a result, it has not received due priority in national plans and programs. Also, due to lack of Government's commitment for promotion of Biotechnology based industries (such as soft loans, business subsidies etc.) private – public partnership in R & D and business is scarce in Nepal. Nepal also lacks horizontal integration between public-private institutions/ laboratories and appropriate policy to address private institutions working in biotechnology fields. Besides, prioritization of R & D areas in biotechnology at national level, accessibility and sharing of instruments, tools and machineries and research outcomes/ information among public-private sector institutions are lacking. Furthermore, provision of attractive scientific incentives for R & D through the establishment of competitive grant system at national and International level is also lacking. All these issues are leading to least investment of private sector in Biotechnological R & D in different sectors and thereby failing in producing competent biotechnology undergraduates who would be able to undertake thesis works during their internship and help solve pertinent problems being faced by biotech industries.
- ↓ Lack of coordination among concerned stakeholder ministries to address national and International issues pertinent to biotechnology and biodiversity. Nepal being a signatory country to CBD, CPB and WTO, it has been difficult for Nepal to be obliged to these International conventions and treaties with regards to IPR protection of Nepal's valuable agro-forest and microbial biodiversity for their sustainable utilization and conservation. Therefore, Nepal's national vision with regards to obligation towards these treaties should be clear in relevant National policies, which should be developed in line with its neighboring countries such as India and Sri Lanka.
- ↓ Role of Biotechnology to address IPR issues, access and benefit sharing issues of biodiversity and conservation and sustainable utilization of Biodiversity issues are not clear in national policies. Furthermore, indigenous traditional knowledge protection and

- information sharing issues are also not clear. Therefore, Nepal should also develop or amend its policies in the similar manner like its neighboring countries.
- ✚ Nepal being one of the least developed countries of the world, it can't lead in Biotechnological academic research in various fields. Adaptation of well proven mature technologies in various disciplines such as medicine, agriculture and environment is the need of today, but this is also not taking place in the current scenario. This reflects the lack of political will to popularize mature technologies.
 - ✚ In the education sector, masters' level teaching in biotechnology has not yet been initiated in the country. Biotechnology education in Nepal in various disciplines is being suffered by lack of practical education in Biotechnology/ modern biotechnology. Due to lack of national, regional and International linkages, Nepal still lacks academic institutions compatible to global standard education.
 - ✚ Modern biotechnology involving highly sophisticated technologies, demands high level of skill and commitment. However, the country is neither in a position to tap or employ young freshly graduated biotechnologists nor create working environment for already existing scientists in various disciplines. This is the main reason for ever increasing brain drain problem of Nepal.
 - ✚ Besides, provision of adequate budget for technology transfer, good coordination and cooperation among various institutions for technology transfer, laboratory accreditations, SoP implementation, GLP, equipment calibration are among other important issues to be addressed for the sound application of Biotechnology/ modern biotechnology in Nepal.

9.2 Challenges

Following challenges have been perceived for the overall development of biotechnology and modern biotechnology based R & D & business in Nepal:

- ✚ Lack of National commitment for S & T Research and Development is the main challenge for scientists working in various disciplines.
- ✚ For the sound application of modern biotechnology (recombinant DNA and other allied technologies) in the country, Nepal still lacks National Biosafety Framework (NBF), recombinant DNA safety guidelines, skilled HR and required infrastructure for conducting rDNA research in various fields, risk assessment and management of GMOs/ LMOs and their products as well as for regulating their import, safe handling and use as per CPB. Therefore, capacity building in modern biotechnology, biosafety risk assessment and management are vital for entering into the era of modern biotechnology. Capacity building in GMO detection techniques for unintentional transboundary movement of GMO and products (FFPs) (i. e. DNA and RNA based-PCR, Southern hybridization and PCR-RFLP; Protein-based – ELISA, Lateral Flow strips, Western Blots), development of rules for manufacture, use import/export and storage of hazardous microorganisms, GMOs or cells and development to technical rDNA safety guidelines are yet to take place.
- ✚ Greatest current challenge for Nepal is to retain qualified biotechnological HR in the country in the context of present globalization. Therefore, it's a big challenge for Nepal to develop skilled HR in teaching, training and conducting high quality R & D activities in various biotechnological fields.
- ✚ Due to lack of adequate funding for R & D in Biotechnology from government sector, scarce International funding opportunities in biotechnology and limited HR training opportunities, government institutions are badly suffering from lack of skilled HR and infrastructure to conduct advanced biotechnological research activities pertinent to

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industrial application. In this scenario, equipping laboratories with good equipments and acquire expensive molecular biological reagents and chemicals in good condition has become a big challenge for Nepal.

All these issues and challenges can be considered as major constraints for rational biotechnology development in different sectors and all these are leading to insignificant output in food, health and environmental security as well as safety for ever increasing human population in Nepal.

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Annex/ Questionnaire/ Agricultural-Forestry Biotechnology Sector

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- -----
- -----

2.6 Do you have action plans developed for any of your biotechnological projects?

Yes ----- or No -----

If yes, could you provide a copy of it for our reference?

2.7 Please mention Biotechnological activities being performed at your institution to address IPR protection, WTO, TRIPs, PBR protection issues (etc.) of Agro/Forest biodiversity of Nepal.

2.8 Please name relevant experts and expertise if any in the field of socio-economic impact assessment of Biotechnology/ modern biotechnology related projects in agriculture/ forestry sector.

- -----
- -----
- -----
- -----

III. Biotechnology/ Modern Biotechnology Infrastructure Facilities

3.1 Characterization of Institution: Please tick the appropriate option:

a) Biotechnology related works being performed in the organization:

- Microbial
- Crop plants
- Wild plants
- Livestock
- Veterinary science
- Forest plants
- Fisheries
- Aquatic
- Others if any
- Others if any
- Others if any

b) Kind of Biotechnology/ Modern Biotechnology related activities of the organization/ division

- Diagnostic (Plant diseases/ or pests, animal diseases/ pests)
- Molecular diagnostic (diseases, pests, animals, plants, GMOs, GM FFPs)
- Breeding (Conventional Plant breeding/ Conventional Animal breeding)
- Molecular Breeding (Plant or animal)
- Genetic diversity study (please specify organism)

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- Molecular genetic diversity study (please specify organism)
- Plant tissue culture (micro-propagation, virus-elimination, protoplast fusion etc.)
- Genetic Engineering or recombinant DNA technology (plants, animals, microbes)
- Risk assessment and management of LMOs/GMOs
- Bioprospecting (natural products, genes etc.)
- Biological Control
- Embryo transfer
- Artificial Insemination
- Enzyme production
- Vaccine production
- Animal cell culture
- Dairy production
- Any other

3.2 Specific Biotechnological techniques being employed in your Institution:

A. Diagnostics being developed/used in your Laboratory/ Institution (For Livestock, Veterinary and Pathology related Institutions/ Division)

S. N.	Biotechnological technique	Purpose	Source Local/ Imported	Demand/freq uency of use	Cost
1.	Biochemical techniques a. Hematology b. Urology/Pathology c. Histo-pathology d. Any other				
2.	Immunological techniques a. ELISA b. ----- c. ----- d. -----				
3.	Molecular diagnostic techniques a. Hybridization-based b. PCR - based c. Any other				

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B. Vaccines being produced/ used in your laboratory/ Institution

S. N.	Name of the vaccine	Purpose	Source Local/ Imported	Demand/frequency of use	Cost
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
10.					

C. Veterinary Biotechnological Therapeutic agents being produced/ used in your institution/ laboratory.

S. N.	Therapeutic agents	Purpose of use	Source Conventional/Recombinant	Demand	Cost
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

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D. Other Biotechnological products produced/ in use in your organization.

S. N.	Name of Biotechnological agents	Purpose of use	Source Import/ Export	Demand	Cost
1.	Monoclonal antibodies				
2.	Polyclonal antibodies				
3.	Taq polymerase				
4.	Restriction Endonucleases				
5.	Ligases				
6.	Reverse Transcriptase				
7.	PCR master mix				
8.	RT-PCR kit				
9.	TA Cloning kit				
10.	Sequence Terminator mix				
11.	Random and specific primers				
12.	DNTPs				
13.	Cloning Vectors				
14.	Competent cells				
15.	Any other				
16.	Any Other				

3.3 Please list the biotechnology related facilities in your laboratory.

S. No.	Infrastructure	Equipment (please mention the list)	Information/Library (Internet, books, journal facilities)

3.4 Is your laboratory undertaking any modern Biotechnology (Genetic Engineering or recombinant DNA technology) related projects?

Yes ----- or No -----

If yes please tick from following options.

- Genetically modified animals

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- Genetically modified microbes
- GM veterinary pharmaceuticals production (please specify)
- Others if any

3.5 Are you aware of Biosafety/ Cartagena Protocol on Biosafety with regards to safe handling, use and transfer of GMOs/ LMOs or their products?

Yes -----

No -----

3.6 Is your organization/ Division dealing with infectious bacterial, fungal or viral animal and plant diseases/ hazardous chemicals?

Yes ----- No -----

If yes, please specify from following options:

- Bacterial (please specify the origin) -----
- Fungal (please specify the origin) -----
- Viral (please specify the origin)-----
- Hazardous chemicals (Please specify)-----
- Epidemiological studies carried out by your institution (Please specify the field)-----
- Others if any -----

3.7 Are you incorporating Good Laboratory Practice (GLP) in your laboratory?

Yes ----- or No -----

3.8 What safety measures are being undertaken to deal with above-mentioned diseases or hazardous chemicals in your organization?

- Incineration
- Autoclaving
- Hazardous waste disposal
- Laboratory isolation
- Activities for human safety -----
- Activities for environmental safety -----
- Any other please specify -----
- Any other -----

IV. Existing Policy & Procedure/Measures governing Biotechnology/ Modern Biotechnology

4.1 Have your institution been involved in establishing any national policies in science and technology?

Yes ----- No -----

Annex/ Questionnaire/ Agricultural-Forestry Biotechnology Sector

If yes what are those?

4.2 Are you aware of Biotechnology Policy for Nepal 2063 published by MoEST?

Yes ----- No -----

If yes, do you have any comments on it? Please indicate.

4.3 Are you also aware of Biosafety Guidelines 2062 published by MoFSC?

Yes ----- No -----

If Yes, do you have any comments on it? Please indicate.

V. Priority Areas for Cooperation

5.1 In your opinion, what are the priority areas of cooperation in different sectors of agricultural/ forest biotechnology with national, regional and international agencies?

Please specify:

- a. Priority area of cooperation-----
- b. Expertise available for cooperation-----

VI. Biotechnology related Products and Processes ready for transfer

6.1 Please mention recent Agricultural/ Forest Biotechnology Products/Processes developed for transfer (at national, regional and International level):

VII. Issues and Challenges in the areas of Biotechnology/Modern Biotechnological R & D and Business?

7.1 In your opinion, what are the issues to be addressed for the development of Agricultural/ Forest Biotechnological R & D in your institution?

7.2 What challenges you are facing to move forward in Agricultural and Forest biotechnological R & D in your institution?

7.3 Could you suggest some national issues and challenges in this frontier area of S &T?

7.4 In your opinion, which factors are responsible for least development of biotechnology/modern biotechnology in Agriculture/ Forestry sector of Nepal? Please tick appropriate options.

- Lack of adequate funding in R & D
- Lack of skilled human resources
- Inadequate Government budget in Agriculture/ Forest Biotechnological R& D
- Lack of national commitment
- Lack of adequate training opportunities
- Biotechnology being ignored field in Nepal.
- Highly sophisticated and advanced technology but least paid human resources
- Lack of infrastructure
- Lack of information resources/ documentation system
- Lack of business investment
- Others if any -----

7.5 State the most relevant steps to be taken to address the concerns you described above.

- -----
- -----
- -----

7.6 What information regarding Biotechnology has your own institution developed?

- Publications,
- Website,
- Databases,
- Newsletters,
- Others

VIII. Other Important Aspects

8.1 Please name if there is foreign consultancy/AID regarding capacity building in biotechnology/ modern biotechnology in Agriculture/ Forestry sector in your institution.

- -----
- -----
- -----
- -----

Annex/ Questionnaire/ Agricultural-Forestry Biotechnology Sector

8.2 In your opinion, what are the priority programs and projects to be developed and implemented for the development of Agriculture/ Forest Biotechnology in Nepal?

- -----
- -----
- -----

8.3 Any other important things you like to mention

- -----
- -----
- -----

Thank you for your kind cooperation

Annex/ Questionnaire/ Medical-Forensic Biotechnology Sector

Key Informant Checklist/Questionnaire

**National Status on Use and Application of Biotechnology in the Context of Preparation of
National State - of - the -Art Report on Biotechnology**

Medical and Forensic Sector

Date:

I. Organizational Information of the Respondent Institution

1.1 Name of the Institution:

.....

1.2 Name of Respondent:

.....

1.3 Designation:

.....

1.4 Contact Address:

.....

▪ Telephone/Fax number:

.....

▪ E-mail address:

.....

1.5 Type of Institution:

- Government
- Semi-government
- Private
- Others please specify:

1.6 Level of Operation of the Organization: (Please specify affiliation to TU, KU, PU or others)

- Local
- National
- International-Regional
- International-Global

1.7 Type of Service of the Organization:

- Education
- Education and Research
- Private institution
- Others please specify

1.8 Established year-----

Annex/ Questionnaire/ Medical-Forensic Biotechnology Sector

II. Existing Biotechnology- related Experts/Expertise

- 2.1 Total number of Employees (Technical)-----
- 2.2 Number of expertise in medical biotechnological fields: (Please further specify subject qualification and expertise).

S. No.	Degree (Ph. D, M. Sc., B. Sc. Others)	Field	Specialization	Expertise	Degree (Local or Abroad)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

(Note: Please add sheet if space is not enough)

- 2.3 Current/On- going research projects in the field of Medical Biotechnology.

S. No.	Name of the project	In house project/ Collaborative	Duration of the project	Incharge /supervisor	Technology developed for transfer
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

(Note: Please add sheet if space is not enough)

- 2.4 Have you developed any action plan for development of medical Biotechnology in Nepal/ action plan for any of your project on medical biotechnology?

Yes ----- or No -----

If yes, could you kindly provide a copy for our reference?

Annex/ Questionnaire/ Medical-Forensic Biotechnology Sector

Please provide the list of past research projects of your institutions:

2.5 Please name relevant experts and expertise if any in the field of socio-economic impact assessment of Biotechnology/ modern biotechnology related projects in medical sector.

- -----
- -----
- -----
- -----

III. Biotechnology/ Modern Biotechnology Infrastructure Facilities

3.1 Characterization of Institution: Please tick the appropriate option:

- Biotechnological R & D
- Diagnostic service
- Diagnostic production
- Therapeutic production
- Vaccine service
- Vaccine production
- Molecular genetic diversity analysis
- IVF
- Others if any

3.2 Biotechnological techniques being employed in your Institution:

A. Diagnostics being developed/used in your Laboratory/ Institution

S. N.	Biotechnological technique	Purpose	Source Local/ Imported	Demand/freq uency of use	Cost
1.	Biochemical techniques e. Hematology f. Urology/Pathology g. Histo-pathology h. Any other				
2.	Immunological techniques e. ELISA f. ----- g. ----- h. -----				
3.	Molecular diagnostic				

Annex/ Questionnaire/ Medical-Forensic Biotechnology Sector

techniques					
d. Hybridization-based					
e. PCR - based					
f. Prenatal genetic disorder					
g. Other genetic disorders					
h. Any other					

B. Vaccines being produced/ used in your laboratory/ Institution

S. N.	Name of the vaccine	Purpose	Source Local/ Imported	Demand/frequency of use	Cost
1.	Typhoid				
2.	Hepatitis B				
3.	Influenza				
4.	MMR				
5.	BCG				
6.	Tetanus				
7.	Meningitis				
8.	Encephalitis				
9.	Polio				
10.	Cholera				
10.	Any other				

C. Biotechnological Therapeutic agents being produced/ used in your institution.

S. N.	Therapeutics	Purpose of use	Source Conventional/ Recombinant	Demand	Cost
1.	Antibiotics				
2.	Digestive enzymes				
3.	Insulin				
4.	Interferon				
5.	Blood clotting factor VIII				
6.	Any other				
7.	Any other				

Annex/ Questionnaire/ Medical-Forensic Biotechnology Sector

8.	Any other				
9.	Any other				
10.	Any other				

D. Other Biotechnological products produced/ in use in your organization.

S. N.	Name of Biotechnological agents	Purpose of use	Source Import/ Export	Demand	Cost
1.	Monoclonal antibodies				
2.	Polyclonal antibodies				
3.	Taq polymerase				
4.	Restriction Endonucleases				
5.	Ligases				
6.	Reverse Transcriptase				
7.	PCR master mix				
8.	RT-PCR kit				
9.	TA Cloning kit				
10.	Sequence Terminator mix				
11.	Random and specific primers				
12.	DNTPs				
13.	Cloning Vectors				
14.	Competent cells				
15.	Any other				
16.	Any Other				

3.3 Please list the biotechnology related facilities in your laboratory.

S. No.	Infrastructure	Equipment (please mention the list)	Information/Library (Internet, books, journal facilities)

Annex/ Questionnaire/ Medical-Forensic Biotechnology Sector

3.4 Is your laboratory undertaking any modern Biotechnology (Genetic Engineering or recombinant DNA technology) related projects?

Yes ----- or No -----

If yes please tick from following options.

- Genetically modified animals
- Genetically modified microbes
- GM pharmaceuticals (Insulins, Interferons etc.)
- Others if any

3.5 Are you aware of Biosafety/ Cartagena Protocol on Biosafety with regards to safe handling, use and transfer of GMOs/ LMOs or their products?

Yes -----

No -----

3.6 Is your organization/ Division dealing with infectious bacterial, fungal or viral human diseases/ hazardous chemicals?

Yes ----- No -----

If yes, please specify from following options:

- Bacterial (please specify the origin) -----
- Fungal (please specify the origin) -----
- Viral (please specify the origin)-----
- Hazardous chemicals (Please specify)-----
- Epidemiological studies carried out by your institution (Please specify the field)
- -----
- Others if any -----

3.7 Are you incorporating Good Laboratory Practice (GLP) in your laboratory?

3.8 What safety measures are being undertaken to deal with above-mentioned diseases or hazardous chemicals in your organization?

- Incineration
- Autoclaving
- Hazardous waste disposal
- Laboratory isolation
- Activities for human safety -----
- Activities for environmental safety -----
- Any other please specify -----
- Any other -----

IV. Existing Policy & Procedure/Measures governing Biotechnology/ Modern Biotechnology

4.1 Have your institution been involved in establishing any national policies in science and technology?

Yes ----- No -----

If yes what are those?

4.2 Are you aware of Biotechnology Policy for Nepal 2063 published by MoEST?

Yes ----- No -----

If yes, do you have any comments on it? Please indicate.

4.3 Are you also aware of Biosafety Guidelines 2062 published by MoFSC?

Yes ----- No -----

If Yes, do you have any comments on it? Please indicate.

V. Priority Areas for Cooperation

5.1 In your opinion, what are the priority areas of cooperation in different sectors of medical biotechnology with national, regional and international agencies?

Please specify:

- c. Priority area of cooperation-----
- d. Expertise available for cooperation-----

VI. Biotechnology related Products and Processes ready for transfer

6.1 Please mention recent medical Biotechnology Products/Processes developed for transfer (at national, regional and International level):

VII. Issues and Challenges in the areas of Biotechnology/Modern Biotechnological R & D and Business?

7.1 In your opinion, what are the issues to be addressed for the development of Medical Biotechnological R & D in your institution?

7.2 What challenges you are facing to move forward in Medical biotechnological R & D in your institution?

7.3 Could you suggest some national issues and challenges in this frontier area of S & T?

7.4 In your opinion, which factors are responsible for least development of biotechnology/modern biotechnology in medical sector of Nepal? (Please tick appropriate options)

- Lack of adequate funding in R & D
- Lack of skilled human resources
- Inadequate Government budget in Medical Biotechnological R& D
- Lack of national commitment
- Lack of adequate training opportunities
- Biotechnology being ignored field in Nepal.
- Highly sophisticated and advanced technology but least paid human resources
- Lack of infrastructure
- Lack of Information resources/ Documentation
- Lack of business investment
- Others if any -----

7.5 State the most relevant steps to be taken to address the concerns you described above.

- -----
- -----
- -----

7.6 What information regarding Biotechnology has your own institution developed?

- Publications,
- Website,
- Databases,
- Newsletters,
- Others

VIII. Other Important Aspects

8.1 Please name if there is foreign consultancy/AID regarding capacity building in modern biotechnology in medical sector in your institution.

- -----
- -----

Annex/ Questionnaire/ Medical-Forensic Biotechnology Sector

- -----
- -----

8.2 In your opinion, what are the priority programs and projects to be developed and implemented for the development of Medical Biotechnology in Nepal?

- -----
- -----
- -----

8.3 Any other important things you would like to mention.

- -----
- -----
- -----

Thank you for your kind cooperation

Key Informant Checklist/Questionnaire

**National Status on Use and Application of Biotechnology in the Context of Preparation of
National State - of - the - Art Report on Biotechnology**

Food and Industrial Biotechnology Sector

Date:

- I. Organizational Information of the Respondent Institution**
- 1.1 Name of the Institution:
.....
- 1.2 Name of Respondent:
.....
- 1.3 Designation:
.....
- 1.4 Contact Address:
.....
- Telephone/Fax number:
.....
 - E-mail address:
.....
- 1.5 Type of Institution:
- Government
 - Semi-government
 - Private
 - Others please specify:
- 1.6 Level of Operation of the Organization: (Please specify affiliation to TU, KU, PU or others)
- Local
 - National
 - International-Regional
 - International-Global
- 1.7 Type of Service of the Organization:
- Research and Development
 - Education
 - Education and Research
 - Production and Business
 - Others please specify

Annex/ Questionnaire/ Food-Industrial Biotechnology Sector

1.8 Established year-----

II. Existing Biotechnology- related Experts/Expertise

2.1 Total number of Employees (Technical)-----

2.2 Number of expertise in food / industrial biotechnological fields: (Please further specify subject qualification and expertise).

A. Human Resource (HR) available in the Institute/ Industry

S. No.	Degree (Ph. D, M. Sc., B. Sc. Others)	Field	Specialization	Expertise	Degree (Local or Abroad)
1.					
2.					
3.					
4.					
5.					

(Note: Please add sheet if space is not enough)

2.3 Is your Institution/ Industry currently conducting/ providing funds for various Research projects?

Yes ----- or No -----

If yes please provide details:

A. Current/On- going research projects in the field of Food/ Industrial Biotechnology.

S. No.	Name of the project	In house project/ Collaborative	Duration of the project	Incharge /supervisor	Technology developed for transfer
1.					
2.					
3.					
4.					
5.					

Annex/ Questionnaire/ Food-Industrial Biotechnology Sector

(Note: Please add sheet if space is not enough)

2.4 Please provide the list of past research projects of your institutions:

2.5 Do you have action plans developed for any of your biotechnological projects/ or action plans developed at national level?

Yes ----- or No -----

If yes, could you provide a copy of it for our reference?

2.6 Please name relevant experts and expertise if any in the field of socio-economic impact assessment of Biotechnology/ modern biotechnology related projects in Food/ Industrial sector.

- -----
- -----
- -----
- -----

III. Biotechnology/ Modern Biotechnology Infrastructure Facilities

3.1 Characterization of Institution: Please tick the appropriate option:

- Food Biotechnological R & D
- Modern Food Biotechnological R & D (Genetic Engineering, molecular diagnostics, Genomics, Proteomics, Bioinformatics)
- Food biotechnological business
- GMO/ LMO/ GM-FFP detection
- Industrial Biotechnological R & D
- Modern Industrial Biotechnological R & D (eg. production of recombinant enzymes for various factories eg. textiles, paper, leather industries etc.)
- Industrial Biotechnological business
- Any other
- Any other

3.2 Biotechnological products being produced/ techniques/ products being used in your Institution:

A. Status of Biotechnological products of your Institution

S. N.	Biotechnological Industry	Types of products being developed	Annual production	Business Status (Annual transaction)
1.				

Annex/ Questionnaire/ Food-Industrial Biotechnology Sector

2.				
3.				
4.				
5.				

B. Biotechnological products being developed/ used in your Laboratory/ Institution.

S. N.	Biotechnological Technique being used	Organism being used/ Hormones/ Enzymes etc. being used	Source of cultures/ Enzymes (Local/ Imported)	Technology Local/ Foreign
1.	Bakery production			
2.	Brewing			
3.	Fermented Dairy production			
4.	Leather tanning industry			
5.	Dying Textiles			
6.	Paper Industry			
7.	Confectionary industry			
8.	Fruit Juice production			
9.	Pickles/ fermented foods			
10.	Mushroom production			
11.	Enzyme production			
12.	Starter culture production			
13.	Animal feeds production			
14.	Mushroom spawn production			
15.	Soy sauce production			
16.	Murcha or yeast production			
17.	Bio-fertilizer Industry			
18.	Medicinal plant propagation			
19.	Micro-propagation			
18.	Any other			

Annex/ Questionnaire/ Food-Industrial Biotechnology Sector

C. Biotechnological techniques being developed/used in your Laboratory/ Institution

S. N.	Biotechnological technique	Purpose	Name of organism/ biochemical enzymes used	Source of biochemical reagents used Local/ Imported
1.	Food nutritional quality detection 10. ----- b. ----- c. ----- d. -----			
2.	Food microbial quality detection i. ----- j. ----- k. ----- l. -----			
3.	Food bacterial or fungal toxin detection a. TLC b. ----- c. -----			
4.	Detection of Genetically modified Foods/ Feeds/ or for processing (FFPs) a. Strip test b. Hybridization-based technique c. PCR-based technique d. Any other e. Any other			

Annex/ Questionnaire/ Food-Industrial Biotechnology Sector

3.3 Please list the biotechnology related facilities in your laboratory.

S. No.	Infrastructure (Laboratory space, growth rooms, glass house etc.)	Equipment (please mention the list)	Information/Library (Internet, books, journal facilities)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

3.4 Is your laboratory undertaking any modern Biotechnology (Genetic Engineering or recombinant DNA technology) related projects?

Yes ----- or No -----

If yes please tick from following options.

- GM Foods detection
- GM Feeds detection
- GM enzymes production (Please specify)
- Others if any
- Others if any

A. Modern Biotechnological reagents/ products being produced/ in use in your organization

S. N.	Name of Biotechnological agents	Purpose of use	Source Local/ Import/ Export	Demand
1.	Taq polymerase			
2.	Restriction Endonucleases			
3.	PCR master mix			
4.	Primers			
5.	DNA probes			
6.	DNTPs			
7.	Monoclonal antibodies			
8.	Polyclonal antibodies			
9.	Diagnostic kit (Immunological)			
10.	Diagnostic kit (Molecular)			
11.	Plant growth regulators			
12.	Any Other			

Annex/ Questionnaire/ Food-Industrial Biotechnology Sector

3.5 Are you aware of Biosafety/ Cartagena Protocol on Biosafety with regards to safe handling, use and transfer of GMOs/ LMOs or their products?

Yes -----

No -----

3.6 Is your organization/ Division dealing with infectious bacterial, fungal or viral human diseases/ hazardous chemicals?

Yes ----- No -----

If yes, please specify from following options:

- Bacterial (please specify the origin) -----
- Fungal (please specify the origin) -----
- Viral (please specify the origin)-----
- Hazardous chemicals (Please specify)-----
- Epidemiological studies carried out by your institution (Please specify the field)-----
- Others if any -----

3.7 Are you incorporating Good Laboratory Practice (GLP) in your laboratory?

3.8 What safety measures are being undertaken to deal with above-mentioned diseases or hazardous chemicals in your organization?

- Incineration
- Autoclaving
- Hazardous waste disposal
- Laboratory isolation
- Activities for human safety -----
- Activities for environmental safety -----
- Any other (please specify) -----
- Any other (please specify) -----

IV. Existing Policy & Procedure/Measures governing Biotechnology/ Modern Biotechnology

4.1 Have your institution been involved in establishing any national policies in science and technology?

Yes ----- No -----

If yes what are those?

4.2 Are you aware of Biotechnology Policy for Nepal 2063 published by MoEST?

Yes ----- No -----

Annex/ Questionnaire/ Food-Industrial Biotechnology Sector

If yes, do you have any comments on it? Please indicate.

4.3 Are you also aware of Biosafety Guidelines 2062 published by MoFSC?

Yes ----- No -----

If Yes, do you have any comments on it? Please indicate.

4.4 Please list any other existing policy, which deals with biotechnology/ modern biotechnology in Food and Industrial sector.

- -----
- -----
- -----
- -----

V. Priority Areas for Cooperation

5.1 In your opinion, what are the priority areas of cooperation in different sectors of Food and Industrial biotechnology with national, regional and international agencies?

Please specify:

- a. Priority area of cooperation-----
- b. Expertise available for cooperation-----

VI. Biotechnology related Products and Processes ready for transfer

6.1 Please mention recent Food/ Industrial Biotechnology Products/Processes developed by your institution for transfer (at national, regional and International level):

VII. Issues and Challenges in the areas of Biotechnology/Modern Biotechnological R & D and Business?

7.1 In your opinion, what are the issues to be addressed for the development of Food/ Industrial Biotechnological R & D and business in your institution?

Annex/ Questionnaire/ Food-Industrial Biotechnology Sector

7.2 What challenges you are facing to move forward in Food/ Industrial biotechnological R & D in your institution?

7.3 Could you suggest some national issues and challenges in this frontier area of S & T?

7.4 In your opinion, which factors are responsible for least development of biotechnology/modern biotechnology in Food/ Industrial sector of Nepal? Please tick appropriate option from following:

- Lack of adequate funding in R & D
- Lack of skilled human resources
- Inadequate Government budget in Food and Industrial Biotechnological R& D
- Lack of national commitment
- Lack of adequate training opportunities
- Biotechnology being ignored field in Nepal.
- Highly sophisticated and advanced technology but least paid human resources.
- Lack of business investment
- Lack of physical infrastructure
- Lack of Information resources/ documentation system
- Others if any -----

7.5 State the most relevant steps to be taken to address the concerns you described above.

- -----
- -----
- -----

7.6 What information regarding Biotechnology has your own institution developed?

- Publications,
- Website,
- Databases,
- Newsletters,
- Others

VIII. Other Important Aspects

8.1 Please name if there is foreign consultancy/AID regarding capacity building in modern biotechnology in Food/ Industrial sector in your institution.

- -----
- -----
- -----
- -----

Annex/ Questionnaire/ Food-Industrial Biotechnology Sector

8.2 In your opinion, what are the priority programs and projects to be developed and implemented for the development of Agriculture/ Forest Biotechnology in Nepal?

- -----
- -----
- -----

8.3 Any other important things you like to mention

- -----
- -----
- -----

Thank you for your kind cooperation

Key Informant Checklist/Questionnaire

**National Status on Use and Application of Biotechnology in the Context of Preparation of
National State - of - the -Art Report on Biotechnology**

Environmental Biotechnology Sector

Date:

I. Organizational Information of the Respondent Institution

1.1 Name of the Institution:

.....

1.2 Name of Respondent:

.....

1.3 Designation:

.....

1.4 Contact Address:

.....

▪ Telephone/Fax number:

.....

▪ E-mail address:

.....

▪ Website:

.....

1.5 Type of Institution:

- Government
- Semi-government
- Private
- Others (specify):

1.6 Level of Operation of the Organization: (Please specify affiliation to TU, KU, PU or others)

- Local
- National
- International-Regional
- International-Global

1.7 Type of Service of the Organization:

- Education
- Education and Research
- Analytical service
- Others please specify

Annex/ Questionnaire/ Environmental Biotechnology Sector

1.8 Established year-----

1.9 Degree granted:

Degree granted	Field	Started year	Total number of graduates by 2006
Ph. D.			
M. Sc.			
B. Sc.			

II. Existing Environmental Biotechnology related Experts/Expertise

2.1 Total number of Employees (Technical)-----

2.2 Number of expertise in various environmental related biotechnological fields: (Please further specify subject qualification and expertise).

S. No.	Degree (Ph. D, M. Sc., B. Sc. Others)	Field	Specialization	Expertise	Degree (In house/ Abroad)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

(Note: Please add sheet if space is not enough)

2.3 Current/On- going research projects in the field of Environmental Biotechnology.

S. No.	Name of the project	In house project/ Collaborative	Duration of the project	In charge /supervisor	Technology developed for transfer
1.					
2.					
3.					
4.					
5.					

(Note: Please add sheet if space is not enough)

Annex/ Questionnaire/ Environmental Biotechnology Sector

2.4 Which Biotechnological methods are being employed in your institution for the environmental management?

- -----
- -----
- -----

2.5 Please provide the list of past research projects of your institutions:

- -----

2.6 Do you have action plans developed for any of your biotechnology related environmental projects/ or action plan developed for Environmental management in the context of Nepal?

Yes ----- or No -----

If yes, could you provide a copy of it for our reference?

2.7 Please name relevant experts and expertise if any in the field of socio-economic impact assessment of Biotechnology/ modern biotechnology in environmental sector.

- -----
- -----
- -----

III. Environmental Biotechnology/ Modern Biotechnology Infrastructure Facilities

3.1 Characterization of Institution:

a) Kind of Biotechnology/ Modern Biotechnology related activities of the Institutions:

- Bioprospecting
- Biological control
- Enzyme production related to environmental bioremediation
- Biofertilizer
- Solid waste management
- Waste water management
- Air pollution control
- Biosafety
- Education/training
- Curriculum development
- -----
- -----

3.2 Please list the Environmental biotechnology related facilities in your laboratory.

S. No.	Infrastructure	Equipment (please mention the list)	Information/Library (Internet, books, journal facilities)
1.			
2.			
3.			

Annex/ Questionnaire/ Environmental Biotechnology Sector

4.			
5.			
6.			
7.			
8.			
9.			
10.			

3.3 Is your laboratory undertaking any modern Biotechnology (Genetic Engineering) related projects relevant to environmental bioremediation?

Yes ----- No -----

If yes please specify-----

3.4 Are you aware of Biosafety/ Cartagena Protocol on Biosafety with regards to safe handling, use and transfer of GMOs/ LMOs or their products?

Yes -----

No -----

3.5 Is your organization/ Division dealing with noxious diseases/ pests/ hazardous chemicals?

Yes ----- No -----

If yes, please specify from following options:

- Bacterial (Human, animal or plant – please specify the origin)
- Fungal (Human, animal or plant – please specify the origin)
- Viral (Human, animal or plant – please specify the origin)
- Insects
- Hazardous chemicals (Please specify)
- Epidemiological studies (Please specify the field)
- Others if any

3.6 Are you incorporating Good Laboratory Practice (GLP) in your laboratory?

3.7 What safety measures are being undertaken to deal with above-mentioned diseases, pests or hazardous chemicals in your organization?

- Incineration
- Autoclaving
- Hazardous waste disposal
- Laboratory isolation
- Activities for human safety -----
- Activities for environmental safety -----
- Any other

IV. Existing Policy & Procedure/Measures governing Biotechnology/ Modern Biotechnology

4.1 Have your institution been involved in establishing any national policies in science and technology?

Yes ----- No -----

If yes what are those?

4.2 Are you aware of Biotechnology Policy for Nepal 2063 published by MoEST?

Yes ----- No -----

If yes, do you have any comments on it?

4.3 Are you also aware of Biosafety Guidelines 2062 published by MoFSC?

Yes ----- No -----

If Yes, do you have any comments on it?

V. Priority Areas for Cooperation

5.1 In your opinion, what are the priority areas of cooperation in different sectors of Environmental biotechnology with national, regional and international agencies?

Please specify:

- a. Priority area of cooperation-----
- b. Expertise available for cooperation-----

VI. Biotechnology related Products and Processes ready for transfer

Please mention recent Biotechnology Products/Processes developed for transfer (at national, regional and International level):

VII. Issues and Challenges in the areas of Biotechnology/Modern Biotechnological R & D and Business?

7.1 In your opinion, what are the issues to be addressed for the development of Environmental Biotechnological R & D in your institution?

7.2 What challenges you are facing to move forward in Environmental biotechnological R & D in your institution?

7.3 Could you suggest some national issues and challenges in this frontier area of S & T?

7.4 In your opinion, which factors are responsible for least development of biotechnology/modern biotechnology in environmental sector of Nepal? Please tick appropriate options.

- Lack of adequate funding in R & D
- Lack of skilled human resources
- Lack of national commitment
- Lack of adequate training opportunities
- Biotechnology being ignored field in Nepal.
- Highly sophisticated and advanced technology but least paid human resources
- Lack of infrastructure
- Lack of information resources/ documentation
- Lack of business investment
- Others if any -----

7.5 State the most relevant steps to be taken to address the concerns you described above.

- -----
- -----
- -----

Annex/ Questionnaire/ Environmental Biotechnology Sector

7.6 What information regarding Biotechnology has your own institution developed?

- Publications,
- Website,
- Databases,
- Newsletters,
- Memoranda,
- Others

VIII. Other Important Aspects

8.1 Please name if there is foreign consultancy/AID regarding capacity building in modern biotechnology and /or bio-safety/ environment.

- -----
- -----
- -----
- -----

8.3 In your opinion, what biotechnology related priority programs and projects are to be developed and implemented for the effective management of Nepalese environment?

- -----
- -----
- -----

8.2 Any other important things you like to mention

- -----
- -----
- -----

Thank you for your kind cooperation

Key Informant Checklist/Questionnaire

**National Status on Use and Application of Biotechnology in the Context of Preparation of
National State - of - the -Art Report on Biotechnology**

Biotechnology Education Sector

Date:

I. Organizational Information of the Respondent Institution

1.1 Name of the Institution:
.....

1.2 Name of Respondent:
.....

1.3 Designation:
.....

1.4 Contact Address:
.....

▪ Telephone/Fax number:
.....

▪ E-mail address:
.....

▪ Website:
.....

1.5 Type of Institution:

- Government
- Semi-government
- Private
- Others (specify):

1.6 Level of Operation of the Organization: (Please specify affiliation to TU, KU, PU or others)

- Local
- National
- International-Regional
- International-Global

1.7 Type of Service of the Organization:

- Education
- Education and Research
- Others please specify (Training, short term courses etc.)

1.8 Established year-----

1.9 Degree granted

Annex/ Questionnaire/ Biotechnology Education Sector

- Biotechnology
- If others please specify

Degree Subject	Started year	Total number of graduates by 2006
Ph. D.		
M. Sc.		
B. Sc.		

II. Existing Biotechnology- related Experts/Expertise

- 2.1 Total number of Employees (Technical)-----
- 2.2 Number of expertise in various biotechnological fields: (Please further specify subject qualification and expertise).

S. No.	Degree (Ph. D, M. Sc., B. Sc. Others)	Field	Specialization	Expertise	Degree (Local or Abroad)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

(Note: Please add sheet if space is not enough)

- 2.3 Current/On- going research projects in the field of Biotechnology.

S. No.	Name of the project	In house project/ Collaborative	Duration of the project	Incharge /supervisor	Technology developed for transfer
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Annex/ Questionnaire/ Biotechnology Education Sector

(Note: Please add sheet if space is not enough)

2.4 Have you developed action plans for any of your biotechnological project or Biotechnology Education?

Yes ----- or No -----

If yes, could you provide a copy of it for our reference?

2.5 Please provide the list of past research projects of your institutions:

2.6 Please name relevant experts and expertise if any in the field of socio-economic impact assessment of Biotechnology/ modern biotechnology.

- -----
- -----
- -----
- -----

III Biotechnology/ Modern Biotechnology Infrastructure Facilities

3.1 Characterization of Institution:

a) Biotechnology related works being performed in the institution (Please specify fields):

- Plant Biotechnology
- Animal Biotechnology
- Microbial Biotechnology
- Medical Biotechnology
- Industrial Biotechnology
- Environmental Biotechnology
- Food Biotechnology
- If others please specify-----
- If others please specify-----

b) Kind of Biotechnology/ Modern Biotechnology related activities of the Institutions:

- Diagnostic (Food microbial, GMOs detection, Veterinary-related, Plant-related please specify)
- Genetic study (Please specify)
- Tissue culture (Micro-propagation, virus-elimination, protoplast fusion etc. Please specify)
- Molecular characterization (Please specify)
- Genetic transformation (rDNA) or genetic manipulation (Please specify)
- Molecular breeding
- Molecular taxonomy
- Vaccine production

Annex/ Questionnaire/ Biotechnology Education Sector

- GMO/ FFPs testing
- Bioprospecting
- Biological control
- Embryo transfer
- Enzyme production (please specify)
- Dairy production
- Food adulteration analysis
- Bakery production
- Brewery production
- Animal cell culture
- Biofertilizer
- Mushroom production
- Solid waste management and pollution control
- Education/training
- Curriculum development
- -----
- -----
- -----
- -----

3.4 Please list the biotechnology related facilities in your laboratory.

S. No.	Infrastructure	Equipment (please mention the list)	Information/Library (Internet, books, journal facilities)

3.5 Is your laboratory undertaking any modern Biotechnology (Genetic Engineering) related projects?

Yes ----- or No -----

If yes please tick from following options.

- Genetically modified plants
- Genetically modified animals
- Genetically modified microbes

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- Food containing GMOs
- Feeds containing GMOs
- GMOs as raw material for processing
- GM pharmaceuticals (Insulins, Interferons etc)
- Others if any

3.6 Are you aware of Biosafety/ Cartagena Protocol on Biosafety with regards to safe handling, use and transfer of GMOs/ LMOs or their products?

Yes -----
No -----

3.7 Is your organization/ Division dealing with noxious diseases/ pests/ hazardous chemicals?

Yes ----- No -----

If yes, please specify from following options:

- Bacterial (Human, animal or plant – please specify the origin)
- Fungal (Human, animal or plant – please specify the origin)
- Viral (Human, animal or plant – please specify the origin)
- Insects
- Hazardous chemicals (Please specify)
- Epidemiological studies (Please specify the field)
- Others if any
- Others if any

3.8 Are you incorporating Good Laboratory Practice (GLP) in your laboratory?

3.9 What safety measures are being undertaken to deal with above-mentioned diseases, pests or hazardous chemicals in your organization?

- Incineration
- Autoclaving
- Hazardous waste disposal
- Laboratory isolation
- Activities for human safety -----
- Activities for environmental safety -----
- Any other
- Any other

IV. Existing Policy & Procedure/Measures governing Biotechnology/ Modern Biotechnology

4.1 Have your institution been involved in establishing any national policies in science and technology?

Yes ----- No -----

If yes what are those?

4.2 Are you aware of Biotechnology Policy of Nepal 2063 published by MoEST?

Yes ----- No -----

If yes, do you have any comments on it?

4.3 Are you also aware of Biosafety Guidelines 2062 published by MoFSC?

Yes ----- No -----

If Yes, do you have any comments on it?

V. Priority Areas for Cooperation

5.1 In your opinion, what are the priority areas of cooperation in different sectors of biotechnology with national, regional and international agencies?

Please specify:

- a. Priority area of cooperation-----
- b. Expertise available for cooperation-----

VI. Biotechnology related Products and Processes ready for transfer

6.1 Please mention recent Biotechnology Products/Processes developed for transfer (at national, regional and International level):

VII. Issues and Challenges in the areas of Biotechnology/Modern Biotechnological R & D and Business?

7.1 In your opinion, what are the issues to be addressed for the development of Biotechnological R & D in your institution?

Annex/ Questionnaire/ Biotechnology Education Sector

7.2 What challenges you are facing to move forward in biotechnological R & D in your institution?

7.3 Could you suggest some national issues and challenges in this frontier area of S & T?

7.4 In your opinion, which factors are responsible for least development of biotechnology/modern biotechnology in Nepal? Please tick appropriate options.

- Lack of adequate funding in R & D
- Lack of skilled human resources
- Lack of national commitment
- Lack of adequate training opportunities
- Biotechnology being ignored field in Nepal.
- Highly sophisticated and advanced technology but least paid human resources
- Lack of infrastructure
- Lack of information resources / documentation
- Lack of business investment
- Others if any -----

7.5 State the most relevant steps to be taken to address the concerns you described above.

- -----
- -----

7.6 What information regarding Biotechnology has your own institution developed?

- Publications,
- Website,
- Databases,
- Newsletters,
- Memoranda,
- Others

VIII. Other Important Aspects

8.1 Please name if there is foreign consultancy/AID regarding capacity building in modern biotechnology and /or bio-safety.

- -----
- -----
- -----

Annex/ Questionnaire/ Biotechnology Education Sector

8.2 In your opinion, what are the priority programs and projects towards the development of Biotechnology Education in Nepal?

- -----
- -----
- -----

8.3 Any other important things you like to mention

- -----
- -----
- -----

Annex B

List of Key Informants

**LIST OF KEY INFORMANTS
AGRICULTURAL AND FORESTRY BIOTECHNOLOGY SECTOR**

S.N	Name of Respondent	Name of Institution	Address/ Contact
1.	Dr. Sarbajna Man Tuladhar	Research Centre for Applied Science and Technology (ReCAST)	Tribhuvan University, Kirtipur/ Tel. 4330348/ turecast@mail.com.np
2.	Mr. Hari Kumar Prasai	Regional Agricultural Research Station, NARC	Lumle, Kaski, P.O. Box: 1, Pokhara/ Tel. 061-622174/ hkprasai.2006@yahoo.com
3.	Dr. Tek Bahadur Gurung	Fisheries Research Division	Godavari, Lalipur/ Tel. 5560155
4.	Mr. Deepak Pandey	Seed Quality Control Center	Hariharbhawan, Lalitpur/ Tel. 5534258/ seed@sdqc.wlink.com.np
5.	Dr. Rosemary Shrestha	Green Energy Mission Nepal	Anamnagar, Kathmandu/ Tel. 4248152/ rosemary_shrestha@hotmail.com
6.	Dr. Tej Kumar Shrestha	Central Department of Zoology, TU	Kirtipur, Kathmandu/ Tel. 4331896
7.	Mr. N. K. Dangal	Institute of Agriculture and Animal Sciences (IAAS)	Rampur, Chitwan
8.	Dr. Rebati Man Shrestha	Central Veterinary Laboratory	Tripureshwor, Kathmandu/ Tel. 4212143, 4261938/ cvl@wlink.com.np
9.	Dr. Jagan Nath Rai	Rabies Vaccine Production Laboratory	Tripureshwor, Kathmandu/ Tel. 4251123/ jrain@rabies.wlink.com.np
10.	Dr. Kanti Shrestha	Nepal Academy of Science and Technology (NAST)	Khumaltar, Lalitpur/ Tel. 5547714
11.	Dr. Hari Bimb	Biotechnology Unit, NARC	Khumaltar, Lalitpur/ Tel. 5539658
12.	Dr. S. R. Baral	National Herbarium and Plant Laboratories	Godavari, Lalitpur/ Tel. 5560547
13.	Mr. Dilliram Sharma	Plant Protection Directorate, DOA	Hariharbhawan, Lalitpur/ Tel. 5521597/ ppd@ipmnet.wlink.com.np
14.	Dr. Krishna P. Paudyal	National Citrus Research Programme, NARC	Paripatle, Dhankuta/ Tel. 026-520055/ citrus@ntc.net.np
15.	Dr. Buddhi Ratna Khadgi	Plant Pathology Division, NARC	Khumaltar, Lalitpur/ P.O. Box: 1176/ Tel. 5523145/ ppd@narc.gov.np
16.	Entomology Division, NARC	Khumaltar, Lalitpur/ Tel. 5521141/ ento@narc.gov.np
17.	Dr. Chet Raj Upreti	Animal Nutrition	Khumaltar, Lalitpur/

Annex/List of Key Informants

		Division, NARC	Tel. 5523039/ crupreti@yahoo.com
18.	Dr. Shreeram P. Neupane	Animal Breeding Division, NARC	Khumaltar, Lalitpur/ Tel. 5523160/ umsvet@yahoo.com
19.	Dr. Upendra Man Singh	Animal Health Research Division, NARC	Khumaltar, Lalitpur/ Tel. 5551292
20.	Dr. Kayo Devi Yami	Nepal Academy of Science and Technology (NAST)	Khumaltar, Lalitpur/ Tel. 5547714
21.	Dr. Chiranjivi Regmi	Nepal Academy of Science and Technology (NAST)	Khumaltar, Lalitpur/ Tel. 5547714
22.	Dr. Sangita Shrestha	Nepal Academy of Science and Technology (NAST)	Khumaltar, Lalitpur/ Tel. 5547714
23.	Ms. Geeta Shrestha	Nepal Academy of Science and Technology (NAST)	Khumaltar, Lalitpur/ Tel. 5547714
24.	Dr. Bimal Kumar Baniya	Agriculture Botany Division, NARC	Khumaltar, Lalitpur/ Tel. 5521614
25.	Mr. Binesh Man Sakha	National Potato Research Program, NARC	Khumaltar, Lalitpur/ Tel. 5522114/ bmsakha@gmail.com
26.	Dr. Mukunda Ranjit	Green Research and Technolog (GREAT)	P.O.Box: 13897, Kthmandu/ Tel. 4473550/ great@info.com.np
27.		Biotechnology Section, Department of Plant Resources (DPR)	Thapathali, Kathmandu/ Tel. 4251160/ dprdoc@ntc.np
28.	Dr. K. C. Thakur	Veterinary Epidemiology Center	Tripureshwor, Kathmandu

(-): data not available.

Annex/List of Key Informants

**LIST OF KEY INFORMANTS
MEDICAL AND FORENSIC BIOTECHNOLOGY SECTOR**

S.N	Name of Respondent	Name of Institution	Address/ Contact
1.	Dr. Pramod Aryal	Everest Biotechnology	Maharajgunj, Kathmandu/ Tel. 4433433
2.	Dr. Sanjaya Kumar Shrestha	Walter Reed /AFRIMS Research Unit Nepal (WARUN)	P.O.Box: 295, Kathmanu/ Tel. 9851077359
3.	Mr. Chaman Ranjit	Anandaban Hospital, Leprosy Mission Nepal	Lele, Lalitpur/ P.O.Box: 51, Kathmandu/ Tel. 4290538
4.	Dr. Iswar Lal Shrestha	Siddhi Poly Pathology Laboratory	Dilibazar, Kathmandu/ Tel. 4410604/ lshrestha@healthnet.org.np
5.	Mr. Sushil Thapa	National Reference Laboratory Pvt. Ltd	New Baneshwor, Kathmandu/ Tel. 4784141/ nrl.netplus.com.np
6.	Prof. Dr. Sarala Malla	National Public Health Laboratory	Teku, Kathmandu/ Tel. 4240217/ nphl@wlink.com.np
7.	Mr. Achalaeshwar Dutta Shrestha	Nepal Aushadi Limited	Babarmahal, Kathmandu/ Tel. 4220635/ nal@mos.com.np
8.	Prof. Dr. Bharat Mani Pokhrel	Institute of Medicine (IOM), Tribhuvan University Teaching Hospital	Maharjgunj, Kathmandu/ Tel. 4418672/ bmp268@hotmail.com
9.	Mr. Santosh K. C.	Department of Drug Administration	Bijulibazar, Kathmandu/ Tel. 4780432/ drug@dda.gov.np
10.	Dr. Jiwan Rijal	National Forensic Science Laboratory	Khumaltar, Lalitpur, P.O.Box: 4540,Ktm/ Tel. 5526927/ forensic@most.gov.np

**IST OF KEY INFORMANTS
FOOD AND INDUSTRIAL BIOTECHNOLOGY SECTOR**

S.N	Name of Respondent	Name of Institution	Address/ Contact
1.	Dr. Ganga P. Kharel	Central Campus of Technology	Hattisar, Dhara, P.O. Box: 4/ Tel. 977-25-520228
2.	Mr. Brajesh Vaidya	Nepal Biotech. Nursery	Jawalakhel, Lalitpur/ Tel. 5591349/ nbn@mail.com.np
3.	Mr. Uttam Kumar Bhattarai	Department of Food Technology and Quality Control (DFTQC)	Babarmahal, Kathmandu/ Tel. 4262369/ dftqc@mail.com.np
4.	Dr. Keshari Laxmi Manandhar	Center for Agricultural Technology (CAT)	Imadol, Gwarko, Lalitpur Tel. 5202527/ pkm@ccsl.com.np
5.	Dr. Heramba Bdr. Rajbhandary	Nepal Dairy Pvt. Ltd	Mahaboudha, Kathmandu/ Tel. 4220674/ nd@mos.com.np
6.	Mr. Choodamani Bhandari	National Dairy Development	Hariharbhawan, Lalitpur/T el. 5525400/ chooda2002@gmail.com
7.	Mr. Pradeep Jung Pandey	Lomus Pharmaceuticals	Lazimpat, Kathmandu
8.	Dr. Keshar Man Bajracharya	Simca Laboratories Pvt. Ltd	Ganabahal, Kathmandu
9.	Mr. Sashi Agarwal	Curex Pharmaceuticals	Indrachowk, Kathmandu
10.	Mr. M. G. Khetan	Gorkha Brewery	Hattisar, Kathmandu

Annex/List of Key Informants

**LIST OF KEY INFORMANTS
ENVIRONMENTAL BIOTECHNOLOGY SECTOR**

S.N	Name of Respondent	Name of Institution	Address/ Contact
1.	Dr. Sanjay NTH Khanal	Department of Environment Science and Engineering, Kathmandu University	Dhulikhel, Kavre/ Tel. 011-661399/ sanjay@ku.edu.np
2.	Dr. Sarbajna M. Tuladhar	Research Center for Applied Science and Technology (ReCAST), TU	Kirtipur, Kathmandu/ Tel. 4330348/ turecast@mail.com.np
3.	Ms. Nirita Giri	Environment and Public Health Organization (ENPHO)	New Baneshwor, Kathmandu/ Tel. 4491416/ www.enpho.org
4.	Mr. Rajeeb M. Singh	Himalayan Whitehouse International College	New Baneshwor, Kathmandu/ Tel. 4487562/ whitehouse@mail.com.np

Annex/List of Key Informants

**LIST OF KEY INFORMANTS
BIOTECHNOLOGY EDUCATION SECTOR**

S.N	Name of Respondent	Name of Institution	Address/ Contact
1.	Dr. Bijaya Pant and Prof. S.D. Joshi	Central Department of Botany	Tribhuvan University, Kirtipur/ Tel. 4331322
2.	Mr. Rajeeb Kumar Singh	Himalayan Whitehouse International College	New Baneshwor/ Tel. 4487562/ whitehouse@mail.com.np
3.	Dr. Tika Bahadur Karki	National College	Lazimpat, Kathmandu/ Tel. 4443090/ nacolnist@wlink.com.np
4.	Ms. Shova Shrestha	Department of Microbiology, Tri-Chandra College	Ghantaghar, Kathmandu/ Tel. 4230517/ shova_23@hotmail.com
5.	Dr. Anjana Singh	Central Department of Microbiology, TU	Kirtipur, Kathmandu/ Tel. 4331869/ microbiotu@wlink.com.np
6.	Mr. Sameer M. Dixit	Department of Biotechnology, Kathmandu University	Dhulikhel, Kavre/ Tel. 011-661399/ sameer_dixit@ku.edu.np
7.	Dr. Mukunda Ranjit	SANN International College	Kathmandu/ Tel. 4420509
8.	Mr. Rajendra Bahadur Shahi	Lord Buddha Education Foundation, College of Professional Studies	Kathmandu, Tel. 4411805
9.	Dr. Janardan Lamichhane	Department of Biotechnology, Kathmandu University	Dhulikhel, Kavre/ Tel. 011-661399/ ljanardan@ku.edu.np
10.	Mr. Madan Shakya	Amrit Science Campus	Lainchaour, Kathmandu/ Tel. 4411637/ amritcampus@ntc.net.np
11.	Dr. Binayak Prasad Rajbhandari	Himalayan College of Agricultural Science (HICAST)	Bhaktapur
12.	Dr. Panna Thapa	Department of Pharmacy, Kathmandu University	Dhulikhel, Kavre