UNIT 8 BIODIVERSITY PROSPECTING AND INDIGENOUS KNOWLEDGE SYSTEM

Structure

8.1 INTRODUCTION

Biological diversity is increasingly becoming recognised as important beyond its purely scientific interest. Social and economic values of biodiversity are assuming greater significance as a range of different groups; including Indigenous peoples assert their claims and interests. A diverse environment provides an important storehouse for the raw materials used in a range of products and processes, such as in agriculture, medicine, and cosmetics (Pushpangadan and Nair, 2005). The pharmaceutical industry is arguably the largest commercial user of plant genetic species, and the development of these products can create significant opportunities for economic growth for this industry sector. The diverse range of interests in biodiversity raises questions about how to reconcile what may sometimes be competing interests and values in the natural environment. Among the diverse interests in the natural environment are those

of Indigenous peoples. There are many aspects to Indigenous peoples' claims and interests in the natural environment and biological diversity. Indigenous peoples seek recognition and protection of their distinct rights in knowledge of, and practices relating to the management, use and conservation of biological diversity. They also seek the introduction of measures to prevent exploitation of their knowledge, and compensation or financial benefits from the uses of their knowledge, innovations and practices. It is important to recognise that there is the same diversity of views among Indigenous peoples as there is in the wider community (Myer el al. 2000).

Key Facts

Biodiversity provides many goods and services essential to life on earth. The management of natural resources can determine the baseline health status of a community. Environmental stewardship can contribute to secure livelihoods and improve the resilience of communities. The loss of these resources can create the conditions responsible for morbidity or mortality.

Biodiversity supports human and societal needs, including food and nutrition security, energy, development of medicines and pharmaceuticals and freshwater, which together underpin good health. It also supports economic opportunities, and leisure activities that contribute to overall wellbeing.

Land use change, pollution, poor water quality, chemical and waste contamination, climate change and other causes of ecosystem degradation all contribute to biodiversity loss and, can pose considerable threats to human health.

Human health and well-being are influenced by the health of local plant and animal communities, and the integrity of the local ecosystems that they form.

Infectious diseases cause over one billion human infections per year, with millions of deaths each year globally. Approximately two thirds of known human infectious diseases are shared with animals, and the majority of recently emerging diseases are associated with wildlife (Pushpangadan, 2017).

8.2 OBJECTIVES

After studying this unit, you should be able to:

- Define Bioprospecting, Indigenous Knowledge systems, Biodiversity and Traditional Health Systems.
- Describe Ethno-biology and Ethno-pharmacology.
- Explain opportunities for collaboration between biomedical and conservation communities.
- Describe Bio piracy in details.
- Describe IPRS and ownership of traditional knowledge, Traditional knowledge rights

- Explain Community forest management and Community biodiversity registers

Some Indigenous people may wish to preserve biodiversity related knowledge as their collective heritage; while others may see potential economic benefits to be gained by allowing the use by the wider community of their biodiversity related knowledge and practices. Some of these issues become apparent when considering the use of biological diversity for pharmaceutical and other products-an activity known as bioprospecting. (Nayar, 1996)

8.2 BIOPROSPECTING

Bioprospecting is the investigation of biodiversity for commercially valuable biological and genetic resources. The term specifically refers to the exploration of biological resources for new commercial uses.

- The emerging area of biotechnological application on biodiversity is known as bioprospecting, which includes "systematic search for genes, natural compounds, designs and whole organisms in wild life with a potential for product development by biological observations and biophysical, biochemical and genetic methods without disruption to nature".
- Bioprospecting is defined as a methodical and structured search for useful products derived from bio resources including plants, microorganisms, animals, etc., that can be establish further for commercialization and inclusive benefits of the society.

Activities of commercial sectors are based on bioprospecting, such as the pharmaceutical, biotechnology, seed and crop, horticulture, cosmetics and food sectors. (Figure 1).

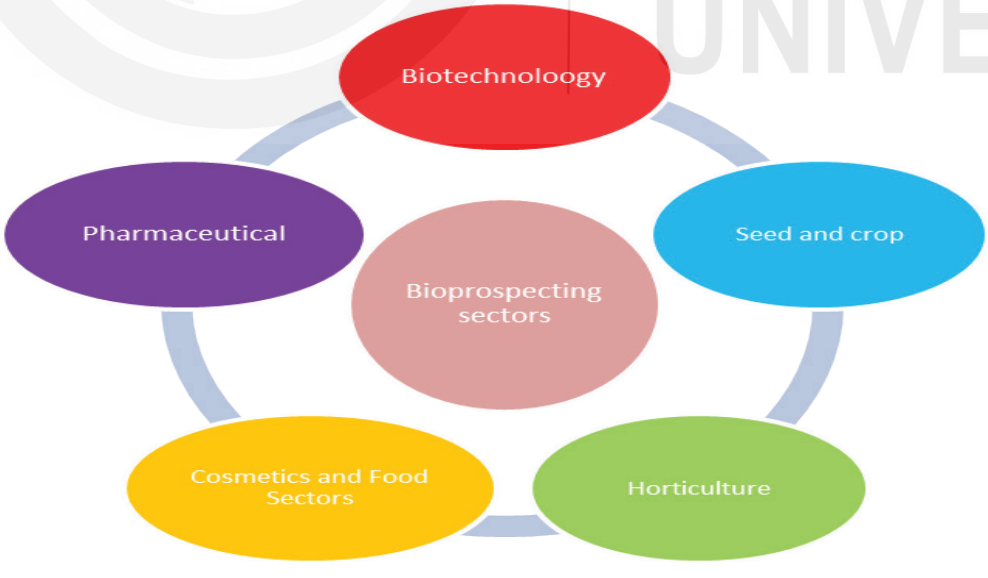

Figure 1: Bioprospecting Sectors (modified from Arora and Pandey, 1996).

Bio prospectors source their material in two ways

1. Biological resources,

2. Commercially lucrative traditional knowledge.

In a major global study in 1985, a total of 122 plant-derived pure compounds were recognized as being in use as drugs around the world. The medical use of 80% of these compounds linked with traditional medical use. It was also revealed that these compounds were derived from only 94 species of plants (Arora and Pandey, 1996).

Given that roughly 250,000 higher plant species occur, it is likely that there are many more medical uses of plants enduring to be revealed. It is assumed by many scientists that the most efficient way to do so would be to monitor and select plants on the basis of traditional medical use. Strength and weakness of bioprospecting have been mentioned in Table 1

Strengths	Weaknesses
Bioprospecting-derived small molecules are more structurally complex than synthetic chemicals, and therefore show greater specificity towards biological targets.	Although some potentially very useful microorganisms are known to exist in nature (eg. lignocellulose-metabolizing microbes), difficulties have been encountered cultivating these in a laboratory setting. This problem may be resolvable by genetically manipulating easier-to-culture organisms such as *Escherichia coli* or *Streptomyces coelicolor* to express the gene cluster responsible for the desired activity.
Natural products are also more amenable to membrane transport than synthetic compounds. This is advantageous when developing antibacterial drugs, which may need to traverse both an outer membrane and plasma membrane to reach their target.	Isolating and identifying the compound(s) responsible for a biological extract's activity can be difficult. Also, subsequent elucidation of the mechanism of action of the isolated compound can be time-consuming. Technological advancements in liquid chromatography, mass spectrometry and other techniques are helping to overcome these challenges.

For some biotechnological innovations to work, it is important to have enzymes that function at unusually high or low temperatures. An example of this is the polymerase chain reaction (PCR), which is dependent on a DNA polymerase that can operate at 60°C and above.	The underlying aim of bio prospecting is to find new resources and products from nature that can be used by humans.
With the Convention on Biological Diversity (CBD) now ratified by most countries, bioprospecting has the potential to bring biodiversity-rich and technologically advanced nations together, and benefit them both educationally and economically.	Implementing and enforcing bioprospecting-related treaties and legislation is not always easy. Drug development is an inherently expensive and time-consuming process with low success rates, and this makes it difficult to quantify the value of potential products when drafting bioprospecting agreements.
For useful molecules identified through microbial bioprospecting, scale up of production is feasible at reasonable cost because the producing microorganism can be cultured in a bioreactor.	Whilst the structural complexity of natural products is generally advantageous in drug discovery, it can make the subsequent manufacture of drug candidates difficult. This problem is sometimes resolvable by identifying the part of the natural product structure responsible for activity and developing a simplified synthetic analogue.

Table 1: Strength and Weakness of Bioprospecting (modified from Arora and Pandey, 1996)

Need for Bio prospecting

- Improving human health, through both medicine and better nutrition are the key focal areas.

It plays a dominant role in discovering leads for drug development, since current/ known compounds for developing drugs for human use are inadequate (Pushpangadan, 2005)

Process of bioprospecting has been described in figure 2

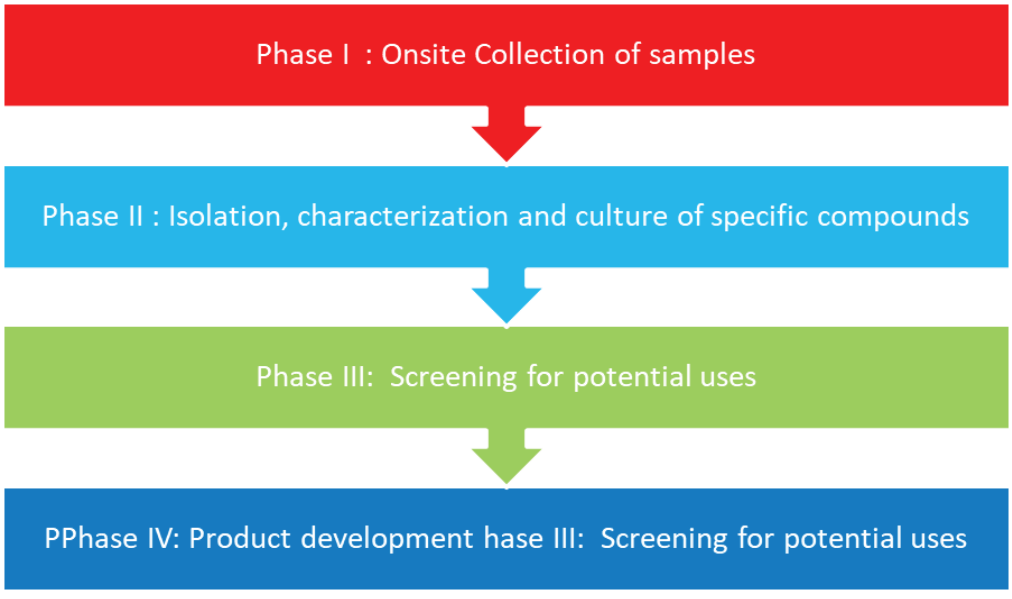

Figure 2 Process of Bioprospecting (modified from Pushpangadan, 2005)

Bioprospecting has thus three facets like "chemical prospecting, gene prospecting and bionic prospecting.

Chemical prospecting

Recent high-throughput chemical selection and automated bioassay programmes including the activity-guided screening for identifying, isolating, characterizing novel bioactive compounds from wild bio resources (higher plants, broyophytes, pteridophytes, fungi and microorganisms etc.) animals (insects and other wild invertebrates) have opened up new vistas in natural product research in general, drug and pharmaceuticals in specific (figure 2). Chemical prospecting of wild plant resources is becoming increasingly applicable in agro chemistry (bio pesticides), drugs and pharmaceuticals, cosmetics, proteins, enzymes, food additives and other industrially valuable chemical products.

Prospecting for phytomedicines

Prospecting of new potential pharmaceuticals from sources such as natural products which are traditional in nature or derived from little known or unknown forests sources has also become an important part of the pharmaceutical industry. With the initiation of chemistry, genomics research, new molecular biological tools for developing bioassays, cell based assays, high-throughput screening (HTS) and computer aided automation including robotics has incredibly speeded up the screening, isolation, structural elucidation, semi or full synthesis of natural molecules or its derivatives etc. have further dramatized the novel drug development. A large number of plant derived natural products are continued to be developed based on traditional or experiential local medicine practices.

Gene prospecting

DNA Fingerprinting techniques are finding wider applications in molecular systematics that aims at identification and characterization of potential genetic variants in a species or population at the DNA level. Such an approach is

now gaining considerable attention and is becoming increasingly important in establishing the sovereignty IPRs of the gene-rich but biotechnology poor countries of the Third world over their own biodiversity resources.

Bionic prospecting

Bionic prospecting is a new area by which new designs, patterns, models and techniques are evolved based on natural biodiversity. New sensor technologies, architecture, bio-engineering and bio-modelling are some of the interesting fields in bionic prospecting.

Check your Progress 1

1. What do you understand by the term Bioprospecting?

   .....

   .....

   .....

   .....

2. What is the need of Bioprospecting?

   .....

   .....

   .....

   .....

3. What is Chemical Prospecting?

   .....

   .....

   .....

   .....

8.3 INDIGENOUS KNOWLEDGE SYSTEMS (IKS)

Indigenous knowledge systems (IKS) involve knowledge systems that have developed within various societies' independent of, and prior to, the advent of the modern scientific knowledge system. IKS from various cultures evolved into broad and comprehensive knowledge systems, such as those from ancient countries like India, China and Africa, that addressed societal and traditional knowledge issues in various fields important to human survival and the quality of life, including agriculture, health and water, amongst others. The evaluation reveals that many technologies classified as 'appropriate' for developing communities to address basic needs of water, sanitation and agriculture have their roots in indigenous knowledge systems that have survived in some form, albeit at a much diminished level. The extensive history of IKS and practices provide a rich resource and a history of engagement, success and failure that

could beneficially inform communities in their search for improved quality of life.

PROTECTION FOR IK IN INDIAN ACTS:

Some of India's new laws have implications for IK and bio-resources. The following are given below:

- The Geographical Indications of Goods - Registration and Protection Act, 1999.
- The Protection of Plant Varieties and Farmer's Rights Act, 2001.
- The Biological Diversity Act, 2002.
- The Patent (Second Amendment) Act, 2002.

8.4 BIODIVERSITY AND TRADITIONAL HEALTH SYSTEM

People depend on biodiversity in their daily lives, in ways that are not always apparent or appreciated. Human health ultimately depends upon ecosystem products and services (such as availability of fresh water, food and fuel sources) which are requisite for good human health and productive livelihoods. Biodiversity loss can have significant direct human health impacts if ecosystem services are no longer adequate to meet social needs. Indirectly, changes in ecosystem services affect livelihoods, income, local migration and, on occasion, may even cause or exacerbate political conflict (Pimm et al 1995).

Additionally, biological diversity of microorganisms, flora and fauna provides extensive benefits for biological, health, and pharmacological sciences. Significant medical and pharmacological discoveries are made through greater understanding of the earth's biodiversity. Loss in biodiversity may limit discovery of potential treatments for many diseases and health problems.

There is growing concern about the health consequences of biodiversity loss. Biodiversity changes affect ecosystem functioning and significant disruptions of ecosystems can result in life sustaining ecosystem goods and services. Biodiversity loss also means that we are losing, before discovery, many of nature's chemicals and genes, of the kind that have already provided humankind with enormous health benefits.

Biodiversity plays a crucial role in human nutrition through its influence on world food production, as it ensures the sustainable productivity of soils and provides the genetic resources for all crops, livestock, and marine species harvested for food. Access to a sufficiency of a nutritious variety of food is a fundamental determinant of health.

Traditional medicine continues to play an essential role in health care, especially in primary health care. Traditional medicines are estimated to be used by 60% of the world's population and in some countries are extensively incorporated into the public health system. Medicinal plant use is the most common medication tool in traditional medicine and complementary medicine worldwide. Medicinal

plants are supplied through collection from wild populations and cultivation. Many communities rely on natural products collected from ecosystems for medicinal and cultural purposes, in addition to food.

Although synthetic medicines are available for many purposes, the global need and demand for natural products persists for use as medicinal products and biomedical research that relies on plants, animals and microbes to understand human physiology and to understand and treat human diseases.

INTERNATIONAL TRADE OF MEDICINAL PLANTS

- Annual International trade in Medicinal and aromatic plant material is 400,000 to value at 1.1 to 1.3 billion US dollars in 1997. This figure is an increase of one third compared to 1995. Now this would have increased concededly.
- China is the leading country with an export of botanical drugs around 140,000 t/year.
- India ranks second in export in terms of volume around 35,700 t/year but only in sixth position in terms of value of around 5, 16,110,000 US dollars.

INTERNATIONAL MARKET FOR HERBAL MEDICINES

Annual global sales of medicinal products derived from the genetic resources is around 700 billion US dollars the global market for herbal medicine alone has reached 43 8 billion US dollars with an annual growth rate between 5 and 15%. It is expected to reach 5 trillion US dollars by 2002. China, the leader in the field generated an income of about 5 billion US dollars in 1999 from the International market and the global exports are around 10 billion US dollars which means China could snatch 50% global exports. Accordingly to WHO estimates, the European market in 1999 was calculated to be 11.9 billion US dollars in which Germany accounts for 38%, France for 21% and UK for 12%. The world wide Fund for Nature statistics have shown that the European Union imported over 100,000 tonnes of plant material in 1990, of which 12% were from India.

8.5 INDIGENOUS PEOPLE AND CONSERVATION

According to the United Nations Permanent Forum on Indigenous Issues, indigenous peoples have “historical continuity or association with a given region or part of a given region prior to colonization or annexation; identify themselves as indigenous and be accepted as members by their community; have strong links to territories, surrounding natural resources and ecosystems; maintain at least in part, distinct social, economic and political systems; maintain, at least in part, distinct languages, cultures, beliefs and knowledge systems; are resolved to maintain and further develop their identity and distinct social, economic, cultural and political institutions as distinct peoples and communities; and often form non-dominant sectors of society.”

When land is owned, managed or occupied in a traditional way, the word "traditional" refers to a knowledge that stems from centuries-old observation and interaction with nature. This knowledge is often embedded in a cosmology that reveres the *one-ness* of life, considers nature as sacred and acknowledges humanity as a part of it. And it encompasses practical ways to ensure the balance of the environment in which they live, so it may continue to provide services such as water, fertile soil, food, shelter and medicines.

Due to their subsistence economies and spiritual connection to lands and territories, most indigenous peoples suffer disproportionately from loss of biological diversity and environmental degradation. Their lives, survival, development chances, knowledge, environment and health conditions are threatened by environmental degradation, large scale industrial activities, toxic waste, conflicts and forced migration, as well as by land-use and land-cover changes (such as deforestation for agriculture and extractives for example). These challenges are further exacerbated by climate change.

Rather than helping, some mitigation measures can increase the threat to indigenous peoples' territories and coping strategies–as in the case of biofuel initiatives. While biofuel initiatives are meant to reduce greenhouse gas emissions, they may affect the ecosystems; water supply and landscape on which indigenous peoples depend, ultimately leading to an increase in monoculture crops and plantations and a consequent decline in biodiversity, food and water security.

On the other hand, when the rights of indigenous peoples are protected–and particularly their rights to land, territories and resources–their culture thrives and nature thrives.

Indigenous peoples' contributions are essential in designing and implementing solutions for ecosystems. Traditional knowledge and heritage can contribute to environmental assessments and sustainable ecosystem management. For example, the sustainable production and consumption of indigenous and traditional food has invaluable benefits for natural resources and ecosystems, contributes to a sustainable and healthier diet, and helps mitigate climate change. UNEP will further promote the use of traditional crops and pastoralism.

More broadly, UNEP is also working with the UN Permanent Forum on Indigenous Issues to publish work on traditional knowledge for ecosystems restoration and resilience, to be introduced in the fifth meeting of the UN Environment Assembly and mark the start of the UN Decade for Ecosystems Restoration (2021-2030).

The UN Declaration on the Rights of Indigenous Peoples requires that free, prior and informed consent of indigenous peoples be obtained in matters of fundamental importance for their rights, survival, dignity, and well-being. Moreover, consultations to obtain this consent must respect local governance and decision-making processes and structures; must occur in indigenous languages and on indigenous peoples' time frames; and be free of coercion or threat.

The UN Permanent Forum on Indigenous Issues and Expert Mechanism on the Rights of Indigenous People are important policy instruments for indigenous peoples to voice their concerns and advocate for policy change within the UN.

At national and local levels, however, indigenous peoples continue to be marginalized. In response, UNEP has established a policy to promote the protection of environmental defenders through which it will denounce attacks, torture, intimidation and murder of environmental defenders; advocate for better protection of environmental rights and the people standing up for them; support responsible management of natural resources; and request accountability for events in which environmental defenders have been affected.

With the Interfaith Rainforest Initiative, UNEP also engages with religious leaders and communities to work with indigenous peoples. A focus of our work is the mutual recognition of the sanctity of life and nature, and the equality among the beliefs of the world's religions and the traditional spiritualties of indigenous peoples. In doing so, we hope to contribute to the safeguarding traditional knowledge, while healing our planet by facilitating the reconciliation of historical conflicts between religions and indigenous peoples.

Conservation of plant diversity assumes greater importance at a time when the humanity is confronted with the problems of environmental degradation, including the unprecedented loss of biological diversity. It is estimated that about 60,000 out of the 2, 87,655 described plant species are facing threats of extinction due to various reasons. The situation has led to the development of several national and international initiatives, action plans, strategies, policies and legal frameworks aiming to halt the current continuing loss of plant genetic resources. The Global Strategy for Plant Conservation (GSPC) is one of such initiatives adopted by the conference of parties (COP) of CBD at its sixth meeting held in April 2002 in Hague. The GSPC initiative is aiming at practical conservation of threatened plant diversity through in-situ and ex-situ or a combination of these two methods plant conservation. In India, the National Biodiversity Strategy and Action plan identifies ex-situ conservation of plant diversity as a priority area of action and it suggests strengthening and enhancing the role of botanic gardens, home gardens and other ex-situ conservatory networks in India as important ways and means to achieve the above goals. The Ministry of Environment & Forests (MOEF) is implementing a special assistance programme to support selected botanic gardens in India to equip them with adequate infrastructure and other resources to support ex-situ conservation of plant diversity. Since 1992, MOEF has extended support to many botanic gardens for infrastructure development and plant conservation programmes (Pushpangadan, 2000).

India has a good network of Research & Development institutions supported by the Central Government Ministries / Departments. (eg. Ministry of Environment and Forest (MOEF), Department of science and Technology (DST) , Indian Council of agriculture research, Council of scientific and industrial research (CSIR) & The Indian Council of Forestry Research and Education (ICFRE), Statements, Universities, State Agricultural Universities and NGOs (eg. Foundation for Revitalization of Local Health Traditions (FRLHT), Kerala Forest Research Institute (KFRI), M S Swaminathan Research Foundation (MSSRF),

Tata Energy Resource Institute (TERI), Water environmental Federation (WEF) India).

8.6 ETHNOBIOLOGY AND ETHNO-PHARMACOLOGY

Ethnobiology is a multidisciplinary field of study that draws on approaches and methods from both the social and biological sciences. "Ethnobiology" has proven a rather difficult term to define since the scope of ethnobiological studies has changed considerably throughout history. One of its more recent definitions refers to the study of the reciprocal relationships between human cultures and the natural world. Reciprocal relationships here refer to the human perception of the biological environment, which will ultimately influence man's behaviour, while human behaviour in turn influences or shapes the biological environment. This broad definition of ethnobiology encompasses

Ethnotaxonomy: Study of the classification principles of animals, plants, soils, and ecosystems according to local peoples).

Ethnomedicine: Study of the cultural concepts of health, disease and illness, and of the nature of local healing systems,

Ethnoecology: Study of traditional environmental knowledge and of anthropogenic effects on the environment.

Ethnoagronomy: Study of subsistence economies and resource management, and material culture (study of biological resources used in art and technology).

Ethnobiology aims at investigating culturally-based biological and environmental knowledge, cultural perception and cognition of the natural world, and associated behaviours and practices.

Ethnomedicine is concerned with the cultural interpretations of health, disease and illness and also addresses the health care-seeking process and healing practices.

In both ethnobiology and Ethnomedicine, the documentation of the consequences of particular behaviours and practices is through cultural and biological expertise intrinsic to the fields of anthropology and biology/medicine.

Ethnobiology is primarily a field-based enterprise that has scholars and students 'on the ground' in diverse biological and cultural landscapes around the world. Ethnobiologists tend to travel frequently for fieldwork, often to remote and relatively isolated areas, interacting directly with local communities.

Much ethnobiology research is relevant to the conservation of biological and cultural diversity ('biocultural diversity'), and directly relates to sustainability; in fact, along with its sub-discipline of ethnobotany, ethnobiology has been called the 'science of survival'.

Regardless of geographical and/or research-specific priorities, there are recurrent themes that tie these reflections together:

- how the pandemic will impact local and indigenous communities, their traditional knowledge, livelihoods and use or management of natural resources;
- how this crisis should guide future interactions between researchers and local communities;
- what the new (conceptual and/or applied) priorities of the discipline should be. Inevitably, there exists some degree of overlap between these themes.

Ethnobiology aims at investigating culturally based biological and environmental knowledge, cultural perception and cognition of the natural world, and associated behaviours and practices. Ethnomedicine is concerned with the cultural interpretations of health, disease and illness and also addresses the health care seeking process and healing practices.

Genesis of the Subject Ethnopharmacology

Ethnopharmacology as a scientific term was first introduced at an international symposium held at San Francisco in 1967. This was used while discussing the theme 'Traditional Psychoactive drugs' in this Symposium. But later Rivier and Bruhn (1979) made an attempt to define Ethnopharmacology as "a multidisciplinary area of research concerned with observation, description and experimental investigation of indigenous drugs and their biological activities. It was later redefined by Bruhn and Holmstedt, (1981) as "The interdisciplinary scientific exploration of biologically active agents traditionally employed or observed by man". In its entirety, pharmacology embraces the knowledge of the history, source, chemical and physical properties, compounding, biochemical and physiological effects, mechanism of action, absorption, distribution, biotransformation, excretion and therapeutic and other uses of drugs. A drug is broadly defined as any substance (chemical agent) that affects life processes. Therefore, briefly, the main component of ethnopharmacology may be defined as pharmacology of drugs used in ethnomedicines (AICRPE, 1998). However, none of the above said definitions captures the true spirit of this interdisciplinary subject. Ethno- (Gr., culture or people) pharmacology (Gr., drug) is about the intersection of medical ethnography and the biology of therapeutic action, i.e., a transdisciplinary exploration that spans the biological and social sciences. This suggests that ethnopharmacologists are professionally cross-trained for example, in pharmacology and anthropology – or that ethnopharmacological research is the product of collaborations among individuals whose formal training includes two or more traditional disciplines. In fact, very little of what is published as ethnopharmacology meets these criteria.

Hansen et al., 1995 has suggested that the objectives of Ethnopharmacology should focus on

- the basic research aiming at giving rational explanation to how a traditional medicine works,
- The applied research aiming at developing a traditional medicine into a modern medicine (Pharmacotherapy) or to develop its original usage by modern methods (Phytotherapy).

8.7 OPPORTUNITIES FOR COLLABORATION BETWEEN BIOMEDICAL AND CONSERVATION COMMUNITIES

Biomedical scientists are aware of biodiversity loss, but so far have failed to mobilise the full potential of their research skills and scientific influence to address the issue. There may be two reasons why some biomedical scientists might think this is a perfectly valid question. Firstly, biomedical scientists predominantly work with model organisms: species that are well suited to address a particular molecular, cellular, developmental or genetic issue, or that can be used to understand fundamental physiological or health-threatening processes that occur in humans and domesticated animals. Secondly, by working with model organisms in the lab, the research of many biomedical scientists is detached from nature. Few biomedical scientists investigate the organisms in their natural habitats, and this is important because working with a species in nature often makes transparent how badly an organism's habitat or its population is deteriorating. Without these first-hand experiences from wild populations, lab-based scientists are easily lured into the 'business as usual' attitude (Szekely et al.2010).

The ecological tradition is different: ecologists emphasise the diversity of their organisms, and many ecologists would argue that their organism is 'unique' because it exhibits adaptations to its environment. But conservation biologists are also to blame for failing to embrace biomedical research. Conservation biology focuses on ecological processes, and rarely brings in tools, approaches and results from the vast biomedical literature. Biodiversity can have immense impact on health, social life and finances of humans, and when research agencies need to justify their spending as being relevant to human well-being, the biomedical use of plants, microbes and animals is one of the underutilised justifications. Only a fraction of the Earth's species has been named, let alone studied in detail. The majority of the undescribed organisms comprise the bacteria, Achaea, Microeukaryotes (fungi, nematodes, algae and others) and arthropods, many of which could be of great practical importance for humans. At the present rate of discovery and description, however, many species will vanish before they are discovered. Therefore, biomedical scientists have an immense task of joining systematists, evolutionary biologists and ecologists discovering the processes underpinning the tree of life. Epidemiologists, mycologists and other biomedical scientists should join conservation biologists to combat the fungus. As well as the opportunity for a new research area, urgent efforts in this direction have a further importance for biomedical scientists: since amphibians harbour potential medicines and bioactive peptides and are frequently used in studies of embryonic development, the likely loss of tens of hundreds of amphibian species in the near future may hurt advances in biomedical science.

8.8 BIOPIRACY

Biopiracy is a violation of the rights of traditional communities over their biological resources and related knowledge. The implications of biopiracy are economic as well as ethical: Obtaining IPRs usually patents or Plant Breeders

Rights to gain monopoly control over biological resources, related traditional knowledge, or commercial products based on these resources or knowledge, without the consent of, or any benefits going to, the original holders of the resources/knowledge. The original holders of biological resources and related traditional knowledge do not get any share in the profits made from commercializing the products based on their resources/ knowledge. They also do not get any recognition for nurturing and developing the resources/ knowledge in the first place. Once an IPR is acquired by the bio pirate, the original holders of a biological resource or related traditional knowledge are barred from making any commercial use of the IPR-protected knowledge or resource. This could lead to a situation where, for example, a community is not allowed to sell an indigenous product that is covered by an IPR. The IPR-holder dictates the terms of use of the IPR protected resource/knowledge, which could mean that traditional communities who are the original holder could lose access to, or control over, their resource/knowledge. 5 The investigation of biological resources for new commercial uses has been an inherent part of global economic and social development. The problem arises when bioprospecting leads to biopiracy or environmentally unsustainable practices such as collecting huge quantities of samples from an area (Butchart et al 2010, Siddall et al, 2007)

Some examples of Biopiracy in the name of Bioprospecting in Asia Pacific Region are given in **Table 2**.

Country	Biological Resource	Biopirate Country	Notes
China	Bitter Melon (*Momordica charantia*)	US	US Patent No.5484889
China	Xi Shu/Happytrees (*Camptotheca lowreyana*)	US	US Patent No. PP 11959
Malaysia	Bintangor tree (*Calophyllum lanigerum*)	Singapore US	US Patents including Nos. 6420571, 6369241, 6160131 and 6277879
Pacific	Kava (*Piper mythesticum*)	US	US Patents including Nos. 6405948, 6277396 6080410, 6025363, 5977120, 5976550 and 5770207
Pacific	Nonu (Indian Mulberry *Morinda citrifolia*)	Europe US	In 1995 Nonu Samoa Enterprises began export of nonu, a tree with medicinal properties, to the US with US collaboration

Pakistan	Basmati Rice	US	US Patent Nos.6274183 and 5663484
PNG	Coral reef sponges	US	US Patent Nos. 6281196, 6153590, 5646138 and 5494893
Philippines	Soil microbes	US	The multinational company Eli Lily has earned billions of dollars from the erythromycin antibiotic, which was developed from a bacterium isolated from a soil sample that Filipino scientist Abelardo Aguilar collected in his home province of Lloilo. Neither Aguilar nor the Philippines received any royalties.
Philippines	Llang-IIang (*Cananga odorata*)	France	The use of the extracts from llang. Llangin the cosmetic industry is perhaps as old as perfume in France. There are several perfumeries in France that have used and continue to use it in their products.
Philippines	Banaba (*Lagerstroemia* sp.)	Japan, US	US Patent No. 5980904
Philippines	Nata de coco	Japan, US	US Patent Nos. 6280767, 6140105, 5962277 and 5795979
Philippines	Snails (Conus)	US	US Patent Nos. 6369193, 6344551, 6197535, 6153738, 6077934, 5633347, 5595972, 5589340 and 5514774

India	Basmati Rice	US	US Patent Nos. 5663484 and 4522838
India	Turmeric (*Curcuma longa*)	US	US Patent Nos.5401504, 5135796 and 5047100
India	Neem (*Azadirachta indica*)	US	Several US Patent including Nos. 5420318, 5391779 and 5371254; the US multinational company W.R Grace's EPO Patent No.0426257
India	Guggul (*Commiphora mukul*)	US	US Patent No.6113949 and US Patent Application 20020018757
Thailand	Jasmine Rice	US	A US plant geneticist has developed a strain of Jasmine Rice to be able to grow it in the US; he received the original seeds of the Thai Khao Dok Mail 105 (KDM 105) jasmine rice variety from the international Rice Researh Institute (IRR) in 1995.
Thailand	Plao-noi (*Croton sublyratus*)	Japan	In 1975 Sankyo of Japan extracted the active ingredient of the Thai local plant to produce the patented product Kelnac.
Samoa	Mamala tree (*Homalanthus nutans*)	US	US Patent No. 5599839
Sri Lanka	Kothala himbutu (*Salacia reticulata*)	Japan, US	Takama System, Ltd. (Yamaguchi, JP)'s US Patent No. 6376682

Table 2: Bioprospecting in Asia Pacific region (modified from Siddall et al, 2007)

Ironically, the very knowledge that forms much of the basis of modern scientific research and development is not regarded as a science. Scientists and industry share the profit and the traditional communities who provide the leads and raw materials gain nothing. The UN Convention on Biological Diversity (UN-CBD) signed by countries of the world in 1992 and which came to effect from 23rd December 1999 provide protection of traditional community's resources and their knowledge system Article 8 (j) and Article 15.7 recognize the need to respect the skills, practices etc. of indigenous and local communities and to ensure equitable benefit sharing of the benefits accrued from the sue of such bioresources and associated traditional knowledge. India has enacted two acts namely Protection of Plan Varieties and Farmers Act of 2001 and the Biodiversity Act of 2002. India is also the first in the world to experiment a benefit sharing experiment wherein the traditional knowledge of a forest dwelling community was subject to scientific study by scientists of Government owned national/regional laboratories and developed a value added, IPR covered and scientifically validated herbal drug which on commercialization shared the benefits(license fee and royalty) equally (1:1) by the research institute and the Kani tribe known as model/Pushpangadan model/JNTBGRI model of benefit sharing as now cited globally including the UN bodies particularly CPSD as the only model that implemented the Article 8(i) of 15.7 of CBD (Pushpangadan, 2000).

8.9 IPRS AND KNOWLEDGE OF TRADITIONAL SYSTEM

Traditional knowledge (TK) is knowledge, know-how, skills and practices that are developed, sustained and passed on from generation to generation within a community, often forming part of its cultural or spiritual identity.

Traditional knowledge can be found in a wide variety of contexts, including: agricultural, scientific, technical, ecological and medicinal knowledge as well as biodiversity-related knowledge.

The fundamental basics of Traditional Knowledge consist of:

- Construction of a new practice / process for fulfilling a need.
- Transmission of the process/ method through generations by the virtue of customs.
- Restricted to the group / community within a particular group / community by virtue of it values.

REASON FOR PROTECTION OF TRADITIONAL KNOWLEDGE

- Consideration of equity.
- Conservation questions.
- The maintenance of traditional customs and community.
- Prevention of appropriation of components of TK by unauthorized persons.

- Fostering its uses and its significance in development.

Intellectual property rights are intended to protect research and development (R&D) investment and to promote creativity by providing discoverer with motivation. But the way IPR are being interpreted and created, placed emphasis on changing the willingness of others to participate.

8.10 TRADITIONAL KNOWLEDGE RIGHTS

Through the intellectual property rights, private corporations exploit conventional knowledge and reap income from our natural wealth. Rural farmers and tribal people are made deprived of their natural resources and related skills due to bio piracy. As bio-pirating businesses placed high prices on these goods, conventional knowledge-based goods are too expensive for them. Bio-piracy leads to numerous disputes concerning the security of indigenous people's rights, sustainability of local flora and fauna and the global climate, and even the ability of the country to provide food security. TRIPS agreement of the World Trade Organization (WTO) stresses patent rights, but the rights of traditional information holders are ignored (Huber et al, 2007).

If it is possible to interpret and improve IPRs in an authentic and justified way, they can be used as a tool for TK security. There are still some fundamental points that can be used in either way, i.e. as a constructive security and/or defensive measure to preserve conventional information, despite many shortcomings in the new IPR regime. In order to protect the rights of indigenous peoples, their biological resources and related information, national IPR legislation and international conventions should be taken forward. A. Biological Diversity Act, 2002 being a signatory to the Convention on Biological Diversity (CBD), India considered it appropriate to give outcome to that convention. The Biological Diversity Act of 2002 was then approved by India to encourage the protection of biological diversity, the sustainable use of its elements, and the equal distribution of profits resulting from the use of natural assets.

8.11 COMMUNITY FOREST MANAGEMENT

Community forest management is the other main promising way to incentivize indigenous and tribal peoples to take good care of their forests and use forest resources to improve their welfare and standards of living. The low deforestation rates in community managed forests reflect that. To a large extent, the funds needed for these efforts can come from the forests themselves.

In the indigenous and tribal territories of Latin America and the Caribbean, community forestry principally takes places in four contexts:

i. pine production in the coniferous forests of Mexico and Central America;

ii. hardwood production in the tropical broadleaf forests;

iii. forest plantations and agroforestry plots throughout the continent; and

iv. Non-timber products and tourism services in diverse types of forests.

The indigenous territories of Mexico and Northern Central America have more than five million hectares of coniferous forests, especially in Oaxaca, Guerrero, Michoacán, Guatemala's highlands, and the Caribbean Coast of Honduras and Nicaragua (Chivian *et al.* 2008). Hundreds of communities generate income and employment from pine forests they manage sustainably, and many have progressed towards generating higher levels of value added (Keesing *et al.* 2010). Some of the most successful have diversified their activities to include production of resins and other non-timber products, rural tourism, and payment for environmental services. The region has a long tradition of indigenous and tribal production of coffee, cocoa, breadfruit, black pepper, plantains and bananas, and other crops grown in agroforestry systems with substantial tree cover. It also has great experience with community organization to process and market these products. The harvesting, processing, and sale of non-timber forest products, such as oils and essences, natural fibers (including vines), fruits, mushrooms, nuts, coconuts, ornamental and medicinal plants, resins, and spring water, provide major benefits to indigenous and forest communities. Women have a central (and often unnoticed) role in many of these activities (Groom 2006).

Community forestry could contribute much more to forest conservation and to community wellbeing than it has to date. The main barrier has been public policies that keep communities from being able to profitably harvest and process their wood and other forest products. The main regulatory and fiscal bottlenecks have been:

- lengthy and expensive bureaucratic procedures;
- corruption within the forest law enforcement agencies;
- forestry regulations that lack scientific basis;
- frequent policy changes; excessive taxes and administrative fees; and
- overemphasis on regulating community forestry enterprises compared to efforts to curtail deforestation for agriculture or illegal logging

If communities have large volumes of commercially valuable timber and government or international funds pay their advisors, community forestry enterprises generally do well. But they often find it difficult to sustain themselves if those resources disappear, largely due to high transactions costs (e.g. expensive studies required for permits, trips to resolve administrative problems, extensive paperwork, and administrative fees) (Slack, 2008)

8.12 BIODIVERSITY REGISTERS

One of the mandates of the Biodiversity Board is to prepare Peoples' Biodiversity Registers (PBR) involving the local communities. The register shall contain comprehensive information on availability and knowledge of local biological resources, their medicinal or any other use or any other traditional knowledge associated with them. PBR is not simply a register with names of species and their distribution in a given area but it is a comprehensive data base recording peoples' traditional knowledge and insight of the status, uses, history, ongoing changes and forces driving these changes on the biological diversity resources of their own localities. This will also provide

information on the current utilization patterns of biodiversity, its economic benefits to the local communities. The registers form a baseline data for future management strategies required for the sustainable utilization of biodiversity in a decentralized manner. Further, it helps equitable sharing of benefits arising out of commercial utilization of biodiversity resources and knowledge on their uses. The Biodiversity Register offers conservation, protection of IPR and the traditional knowledge (Peeters et al. 2002).

- **People's Biodiversity Register (PBR):** PBR should aim to document folk knowledge of status, uses, history, ongoing changes and forces driving changes in biodiversity resources, and people's perceptions of how these resources should be managed.

- PBRs can be useful to preserve the rights of farmers or communities over the traditional knowledge they may hold over a particular variety.
- Additionally, PBRs provide geographical identity to the bioresources and can be useful in providing a tool for clarification when disputes over biopiracy and intellectual property rights arise. (Stuart et al. 2004)

Check your progress II

1. Define Indigenous Knowledge system.

   .....
   .....
   .....
   .....
   .....
   .....

2. Explain Ethanobiology

   .....
   .....
   .....
   .....

3. What is Biodiversity registers?

   .....
   .....
   .....
   .....

4. What is Biopiracy?

.....

.....

.....

.....

Case Study

TRADITIONAL KNOWLEDGE AND BENEFIT SHARING

In India**,** there is an example of benefit-sharing in the case of Arogyapacha. During an ethno-botanical expedition in the tribal region of the Western Ghats in the state of Kerala, a team of scientists encountered the Kani practice of eating seeds of the wild plant Trichopus zeylanicus, and this gave them energy. The Kani tribe has used the plant, 12 locally called 'Arogyapacha', for several years to help them through periods of physical exertion. Arogyapacha was investigated and finally a standardized drug based on the Kani knowledge of Arogyapacha was developed. The drug called "Jeevani" was released for commercial production in 1995. While transferring the technology for the production of the drug to a pharmaceutical firm, the Tropical Botanic Garden and Research Institute (TBGRI) agreed to share the license fee on a 50:50 basis. In addition to this, 2 per cent of the royalties from sales is to go to the tribal community. The Kani's have since then been helped to register a trust. This trust is fully owned and managed by the Kani tribe. About 60 per cent of the 2,000 Kani families of Kerala are now members of this trust. According to the trust's rules, the license fee and royalties received on account of the drug "Jeevani" will be in the form of the fixed asset of the trust and only the interest accrued from this amount can be used by the Kanis for welfare activities. This model was developed over a period of about 12 years from 1987 to 1999 in consultation with the Kani tribe.

The Petcacab **Ejido*:* an example of good Mayan forest management in Quintana Roo, México**

For thirty years the Mayan indigenous community of Petcacab in Quintana Roo was left with no choice but to allow the Maderas Industrializadas de Quintana Roo (MIQRO) company to extract large volumes of mahogany with little benefit to local inhabitants. Even though the community formally owned the land, the government authorities of the period had given MIQRO a concession, which allowed it to harvest the timber, without the community's consent. That situation changed abruptly in 1983, when the government allowed the communities to directly manage and benefit from their own forest resources and began the Pilot Forestry Plan (Plan Piloto Forestal) to support community forestry enterprises.

Now, Petcacab has been sustainably harvesting its timber for almost forty years. It is a relatively prosperous community, with about 1 000 inhabitants, which sold USD 1 687 315 in forest products in 2016. It owns 51 176 hectares, of which it uses 81 percent for forestry, leaves 10 percent for strict conservation, and uses only 9 percent for agriculture and other purposes. Its forests are full of jaguars, deer, Guatemalan black howlers, tapirs, lowland pacas, pheasants, wild turkeys, and toucans. It sends 300 000 board feet of wood to Central Mexico

each year, directly generating 280 jobs. The Forest Stewardship Council (FSC) has certified the good management of its forests. It processes its own wood, as well as wood from four neighboring communities.

The forest provides much more than just sawn boards to Petcacab's Mayan inhabitants. A 2006 study found they used 197 plants and 66 animal species. Community members sell wood palings and guano palm leaves as construction materials, charcoal for barbecues, wood furniture and handicrafts, natural chicle gum, and honey. They hunt and fish for their own subsistence. Local indigenous women formed their own carpentry business, called Lol Koópte', which uses sawmill residues to make furniture. The community also uses part of its conservation area for ecotourism.

8.13 LET US SUM UP

We have studied in this unit about the importance of Bioprospecting in medicine. We have discussed in detail the potential impact of traditional knowledge on biodiversity conservation and health management.

8.14 KEYWORDS

Conservation: The management of human use of nature so that it may yield the greatest sustainable benefit to current generations while maintaining its potential to meet the needs and aspirations of future generations.

Conservation of Biodiversity: The management of human interactions with genes, species, and ecosystems so as to provide the maximum benefits to the present generation while maintaining their potential to meet the needs and aspirations of future generations; encompasses elements of saving, studying, and using biodiversity.

Taxonomy: The classification of animals and plants based upon natural relationships.

Wild species: Organisms captive or living in the wild that have not been subject to breeding to alter them from their native state

Wild life living: Non-domesticated animals. Some experts consider plants also as part of wildlife.

8.15 SUGGESTED FURTHER READING/ REFERENCES

1. Pushpangadan P (2017) Challenges and Emerging Dimensions of Plant Based Medicines, Invited talk Biosummit VIT, Velloore, Tamil nadu, India.
2. Nayar MP Hotspots of Endemic Plants of India, Nepal and Bhuttan, (1996) pp.254 Tropical Botanic Garden & Research Institute, Thiruvananthapuram, Kerala, India.
3. Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GA, Kent J (2000) Biodiverstiy hotspots for conservation Priorities. Nature 403: 853-858.

4. Nagar B, Hantschel O, Young MA, Scheffzek K, Veach D, et al. (2003) Structural basis for the autoinhibition of c-Abl tyrosine kinase. Cell 112: 859-871.

5. Arora RK, Pandey A (1996) Wild edible plants of India: diversity, conservation and use.

6. Pushpangadan P, Nair KN (2005) Value Addition and commercialization of Biodiversity and Associated Traditional Knowledge in the context of the Intellectual Property Regime. J Intellectual Property Rights 10: 441-453.

7. AICRPE (All India co-ordinated Project on Ethnobiology) Final Technical Report 1992-1998, Ministry of Environment & Forest, Govt. of India New Delhi.

8. Pushpangadan P, George V, Pradeep PRJ, Nair SB (Eds.) Dhishana 2008, Steamllining India's Traditional Knowledge: Towards Formulating a Sui generis Regime, Abstracts, AIHBPD, Thiruvananthapuram

9. Rivier J, Bruhn JG (1979) Editorial. J Ethnopharmacol 1:1.

10. *Bruhn* JG, *Holmstedt* B. Ethnopharmacology, Objectives, Principles and Perspectives 1981. *In* Beal J L., Reinhard, E. (eds.).Natural Products as Medicinal Agents. Hippokrates verlag. Pp: 405-430.

11. Hansen K, Nyman U, Smitt UW, Pushpangadan P, Adsersen A, et al. (1995) In-vitro Screening of Traditional Medicines for Anti-hypertensive effect based on Inhibition of the Angiotensin Converting Enzyme (ACE). J Ethnopharmacol 48: 43-51.

12. Pushpangadan P (2005) Knowledge Empowerment and bioresource–based industrial intervention for transforming UP villages to economic powers. Proceedings of the 4th seminar organized by the UP management Committee, Lucknow 237-251.

13. Pimm SL, Russell GJ, Gittleman JL, Brooks TM (1995) The future of biodiversity. Science 269: 347-350.

14. Pushpangadan P (2002) Biodiversity and Emerging Benefit Sharing Arrangements-Challenges and Opportunities for India. Proc Indian Natl Acad (PINSA) B 68: 297-314.

15. Butchart, S.H., Walpole, M., Collen, B., van Strien, A., Scharlemann, J.P., Almond, R.E., Baillie, J.E., Bomhard, B., Brown, C., Bruno, J., et al. (2010). Global biodiversity: indicators of recent declines. Science 328, 1164–1168.

16. Siddall, M.E., Trontelj, P., Utevsky, S.Y., Nkamany, M., and Macdonald, K.S. (2007). Diverse molecular data demonstrate that commercially available medicinal leeches are not Hirudo medicinalis. Proc. R. Soc. Lond. B 274, 1481–1487.

17. Chivian, E., and Bernstein, A. eds. (2008). Sustaining Life (Oxford: Oxford University Press).

18. Keesing, F., Belden, L.K., Daszak, P., Dobson, A., Harvell, C.D., Holt, R.D., Hudson, P., Jolles, A., Jones, K.E., Mitchell, C.E., et al. (2010).

Impacts of biodiversity on the emergence and transmission of infectious diseases. Nature 468, 647–652.

19. Groom, M.J., Meffe, G.K., and Carroll, C.R. (2006). Principles of Conservation Biology, 3rd Edition, (Sunderland, MA: Sinauer Associates).

20. Peeters, M., Courgnaud, V., Abela, B., Auzel, P., Pourrut, X., Bibollet-Ruche, F., Loul, S., Liegeois, F., Butel, C., Koulagna, D., et al. (2002). Risk to human health from a plethora of simian imunodeficiency viruses in bushmeat. Emerg. Infect. Dis. 8, 451–457.

21. Huber, J.A., Mark Welch, D.B., Morrison, H.G., Huse, S.M., Neal, P.R., Butterfield, D.A., and Sogin, M.L. (2007). Microbial population structures in the deep marine biosphere. Science 318, 97–100.

22. Slack, J.M. (2008). Origin of stem cells in organogenesis. Science 322, 1498–1501.

23. Stuart, S.N., Chanson, J.S., Cox, N.A., Young, B.E., Rodrigues, A.S.L., Fischman, D.L., and Waller, R.W. (2004). Status and trends of amphibian declines and extinctions worldwide. Science 306, 1783–1786.

24. Szekely, T., Moore, A.J., and Komdeur, J. eds. (2010). Social Behaviour: Genes, Ecology and Evolution.

8.16 CHECK YOUR PROGRESS 1

1. Bioprospecting is the investigation of biodiversity for commercially valuable biological and genetic resources. The term specifically refers to the exploration of biological resources for new commercial uses.

    - The emerging area of biotechnological application on biodiversity is known as bioprospecting, which includes "systematic search for genes, natural compounds, designs and whole organisms in wild life with a potential for product development by biological observations and biophysical, biochemical and genetic methods without disruption to nature".
    - Bioprospecting is defined as a methodical and structured search for useful products derived from bio resources including plants, microorganisms, animals, etc., that can be establish further for commercialization and inclusive benefits of the society.

2. **Need for Bio prospecting**

    - Improving human health, through both medicine and better nutrition are the key focal areas.
    - It plays a dominant role in discovering leads for drug development, since current/ known compounds for developing drugs for human use are inadequate.

3. Recent high-throughput chemical selection and automated bioassay programmes including the activity-guided screening for identifying, isolating, characterizing novel bioactive compounds from wild bio resources (higher plants, broyophytes, pteridophytes, fungi and microorganisms etc.) animals (insects and other wild invertebrates) have opened up new vistas

in natural product research in general, drug and pharmaceuticals in specific (figure 2). Chemical prospecting of wild plant resources is becoming increasingly applicable in agro chemistry (bio pesticides), drugs and pharmaceuticals, cosmetics, proteins, enzymes, food additives and other industrially valuable chemical products.

Check your Progress 2

1. Indigenous knowledge systems (IKS) involve knowledge systems that have developed within various societies' independent of, and prior to, the advent of the modern scientific knowledge system. IKS from various cultures evolved into broad and comprehensive knowledge systems, such as those from ancient countries like India, China and Africa, that addressed societal and traditional knowledge issues in various fields important to human survival and the quality of life, including agriculture, health and water, amongst others.

2. Ethnobiology is a multidisciplinary field of study that draws on approaches and methods from both the social and biological sciences. "Ethnobiology" has proven a rather difficult term to define since the scope of ethnobiological studies has changed considerably throughout history. One of its more recent definitions refers to the study of the reciprocal relationships between human cultures and the natural world. Reciprocal relationships here refer to the human perception of the biological environment, which will ultimately influence man's behaviour, while human behaviour in turn influences or shapes the biological environment

3. One of the mandates of the Biodiversity Board is to prepare Peoples' Biodiversity Registers (PBR) involving the local communities. The register shall contain comprehensive information on availability and knowledge of local biological resources, their medicinal or any other use or any other traditional knowledge associated with them. PBR is not simply a register with names of species and their distribution in a given area but it is a comprehensive data base recording peoples' traditional knowledge and insight of the status, uses, history, ongoing changes and forces driving these changes on the biological diversity resources of their own localities.

4. Biopiracy is a violation of the rights of traditional communities over their biological resources and related knowledge. The implications of biopiracy are economic as well as ethical: Obtaining IPRs usually patents or Plant Breeders Rights to gain monopoly control over biological resources, related traditional knowledge, or commercial products based on these resources or knowledge, without the consent of, or any benefits going to, the original holders of the resources/knowledge.