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RESEARCH TRENDS IN LIFE SCIENCE
VOLUME I

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PREFACE

The realm of life sciences encompasses an extraordinary array of disciplines, from molecular biology to ecology, genetics to neuroscience, and microbiology to environmental science. It is a dynamic and ever-evolving field, where researchers continually push the boundaries of knowledge and innovation. This book is a testament to the remarkable progress made in recent years and the exciting future that lies ahead. In this volume, we have gathered insights from leading experts, scholars, and practitioners who have dedicated their careers to advancing our understanding of the natural world and the living organisms that inhabit it. Their contributions span a wide spectrum of topics, from fundamental research that uncovers the intricacies of cellular processes to applied studies that address critical global challenges such as climate change, infectious diseases, and biodiversity conservation.

The chapters in this book delve into key research trends, methodologies, and breakthroughs that are shaping the life sciences landscape. From the revolutionary advances in genomics and gene editing technologies to the exploration of complex ecosystems and the impacts of human activities on biodiversity, these chapters provide a glimpse into the frontiers of life sciences research.

Furthermore, this book serves as a valuable resource for students, educators, and anyone with an interest in the fascinating world of life sciences. It offers a wealth of knowledge and insights that can inspire and inform future generations of scientists and researchers. We hope that this compilation of chapters will spark curiosity, foster collaboration, and encourage innovative thinking within the field.

As we embark on this journey through the intricate tapestry of life sciences, we invite you to explore the diverse and captivating topics presented in this volume. Whether you are a seasoned researcher, a student just beginning your academic journey, or simply a curious reader, we trust that you will find this book to be a valuable resource and a source of inspiration for your own exploration of the life sciences.

We extend our gratitude to all the authors who have generously shared their expertise and knowledge in these pages. Their dedication to advancing the frontiers of life sciences research is commendable, and we are honored to feature their contributions in this book.

Editors

TABLE OF CONTENT

ROLE OF TRADITIONAL HEALERS IN IMPROVING THE HEALTH OF PRIMITIVE TRIBES OF CENTRAL INDIA THROUGH THE USE OF MEDICINAL PLANTS

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Abstract:

In tribal societies, reliance on traditional healers is pervasive. There are still people who live alone in unpolluted surroundings remote from society, preserving their traditional values, customs, beliefs, and myths, despite notable global advancements in the fields of diagnostics and curative and preventive health. Baiga inhabitants have the worst health conditions of all the primitive tribes since they lead mostly solitary and secluded lives. The importance of traditional healers operating in the hard-to-reach regions of Madhya Pradesh's Mandla district has largely gone unnoticed. They are the source of traditional knowledge on how to treat different diseases with various medicinal plants found in the nearby natural woodlands. They are also experts in identifying nearby medicinal plants, when and how to pick them, and how much medicine should be administered to treat illnesses.

Current research includes an extensive list of medicinal plants used by the Baigas tribe to treat stomach problems, asthma, diabetes, blood pressure, fever, and more. About 30 medicines administered by 22 practitioners have been documented for various human ailments. Several rare medicinal plants have been documented for use in treating ailments. The study also includes many herbs used as general health-promoting agents. This study emphasized the need for adequate scientific training for traditional healers in basic medicine.

Keywords: Baiga, Traditional, Indigenous, Medicinal, Healers, Diseases.

Introduction:

People from tribes are ecosystems because they coexist peacefully with nature and uphold a strong connection between the two. Plants are essential to human livelihoods and the foundation of life on earth. Tribal people's way of life, traditions, and culture have

essentially not changed over the last several hundreds of years. They passed on their knowledge of the abilities of medicinal plants to treat a variety of diseases and ailments orally from one generation to the next after collecting it through extensive observation. More and more people are recognising the importance of incorporating local indigenous knowledge into the management and conservation of natural resources (Posey, 1992).

The earlier study on the ethnobotany in Madhya Pradesh on traditional health care by numerous ethno- botanists such as Bhalla *et al.* (1992); Jain (1963, 1991, 1992); Jain and Tarafdar (1963); Maheshwari (1989 and 1996); Prasad *et al.* (1990); Rai *et al.* (1996, 2002, 2003, 2004), Rai *et al.* (2001); Rai and Nath (2005a and 2005b); Rai and Nath (2000 and 2005); Saxena and Shukla (1971); Saxena (1988); Saxena and Kushwaha (2004) and Tewari (1984). A large number of traditional herbal healers in tahsil Multai district Betul, exist belonging to the tribal community and are utilizing local plants in ethno-medicinal practices prevalent in the area and resulted in the documentation of 47 medicinal plant species belonging to 29 families and 45 genera (Dahare and Jain, 2010).

Later, Mishra and Debnath (2016) reported on the uncommon and endangered medicinal plants used by baigas in the Dindori district. Asthma, blood pressure, renal, arthritis, fertility, fever, and at least 30 other medicinal plants were reported to be treated by at least 16 different traditional healers. They underlined the importance of having the right scientific training to provide basic healthcare. They noticed that the old practise of having separate healers identify herbs and create different formulations for direct patient administration has fallen off quickly. Furthermore, the Baiga tribes in the Baigachak area in the Dindori district considered local healers to be largely beneficial in improving their health conditions. Similar to this, Soni and Pradhan (2016) found that Dhurwa tribes in Bastar, Chhatisgarh, still practise traditional medicine and healing. At least 15 medicinal plants and their application techniques were described. They reported that younger generation is losing interest in tradtional methodsdue to impact of modernaization, urbanization, deforestation etc. They recommmed that correct, collaborative and effective implementation of traditional medicinal pratcices alongwith proper coordination with the modern medicinal practices can provide more fruitful results.

Study area

Mandla: Mandla District is situated in Satpura hills in the state of Madhya Pradesh of India. Mandla is surrounded by river Narmada on three sides and Narmada River passing through north-west side of Mandla. The Mandla district lies in the Southeast part of the state of

Madhya Pradesh spanning over an area of about 7544 km^2. Mandla district is situated in the south eastern part of Madhya Pradesh and cover an area of 7544 sq km. It is bounded by Jabalpur on the north west, Dindori and Seoni district in southwest and Kawardha district and Chhatisgarh state on the south east. Mandla is well connectedwith all parts of country by Rail and roads. It lies on Jabalpur-Balaghat narrow gauge railwayline. One State highway SH 37 (Jabalpur – Raipur) passes through Mandla town.

The most fertile part of the District falls in the valley of Banjr river which is an feeder river of Narmada, this fertile part of District is called 'Haveli'. The hilly terrain on the southern part of 'Haveli' is covered with dense forests. Paddy, wheat and oil seeds are the majorly produced in the valleys of rivers. The production of lac, timber cutting, paan cultivation, animal husbandry, production mat and ropes are the people's main employments. For Administrative purpose Mandla District is subdivided into 6 Tehsils and 9 Development Blocks. There are three major Agricultural Markets- Mandla, Nainpur and Bichhiya in Mandla District.

Material and Methods:

The present study was undertaken to identify healers, their medicine prepartions and utilization of rare medicinal plants in curing various diseases. Information on ethno-medicinal plants used by Baigas, for the various ailments and disorders recorded during field trips. Medicine man, traditional helares were also consulted during the survey. At present the local vaidya use them to make herbal remedies, some of which are well known for their potency. The Survey of vaidyas/Gunias was conducted for two consecutive years (2021-2022) in all seasons, in villages of 4 Blocks in Mandla District. The information's about the uses of various locally available yams and tubers in the natural forests was obtained from the local inhabitants (Baigas), local medicine men, Vaidyas and forest officials. The study was carried out in the 04 blocks i. e. Bichiya, Mawai, Mohgaon, Nainpur, in five villages of each block/Tahsil. A Total of 30 respondents were randomly interviewed using structured and open ended questionnaire. Most of them were involved in occupations such as agriculture and other casual labours, collection of forest produce etc. While collecting information on ethno medicinal plants special attention was paid to record information from local Vaidya, gunias and traditional herbal healers. The information was documented involving field study by contacting and interviewing traditional healers, ojhas, gunias etc for plants used to cure various types of diseases.

Results and Discussion:

Around 30 rare species (including wild yams, medicinal plants) being used by the 16 traditional healers/Baiga's have been documented from Mandla district (Table-1). The study recorded a total of 30 medicinal plants belonging to 10 families including 15 herbs, 03 shrubs, 02 trees and 10 climber species are climbers which are used as medicine.

Table 1: Habit wise number of rare plants used as medicine in the study area

Trees	Herbs	Shrubs	Climber	Total no.
02	15	03	10	30

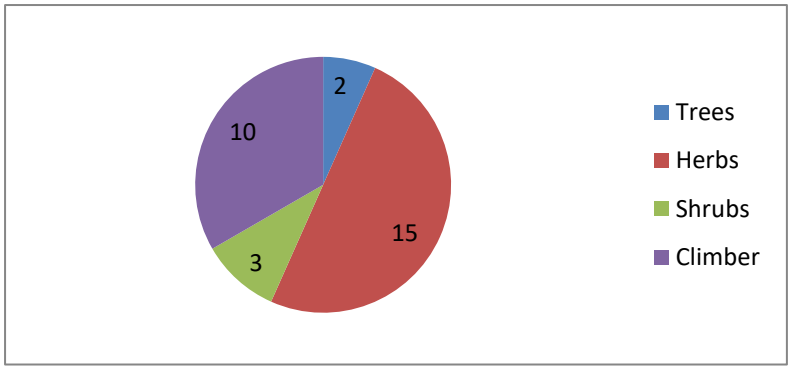

Figure 1: Showing habit wise distribution of medicinal plants

Table 2: Different categories of traditional healers enumerated in the study area

Gunias/Baiga's/Traditional Healers	Male
Generalists	10
Specialists for poisonous bites	03
Traditional bone setters	02
Fever/Asthma/Skin	05
Individual organ related/specific diseases	02
Total	**22**

Based on primary information during survey it was observed that there were twenty two traditional healers serving in the *Mandla* district (Table-2). Out of 22 most are generalists (10 no. s) followed by fever/asthama specialists (5 no. s). There were only two bone setter and individual organ specialist.

The information depicted (Table-3) shows various species of yams and tubers used in curing various ailments by the traditional healers. Yams and tubers are very important source of food for survival in the Mandla region. Most of the Yams like Kanihakanda (*D. bulbifera*), Baichandi kanda (*D. hispida*), besides edible purposes, these were also used for

curing various diseases after some modification and processing i. e. *D. bulbifera* is used for cutting umbilical cord, *D. hispida* is used in curing Jaundice, Stomach ache, Malaria, Fever etc.

Table 3: Medicinal plants utilized by the traditional healers/Baiga tribes of Mandla **district, Madhya Pradesh**

Sr. No.	Local name of Yams/ tuber species	Medicinal uses by Traditional healers/Baigas
1	Kanihakanda, Khus or Donchikanda (*Dioscorea bulbifera*)	After burning and powdering used for disinfecting and cutting of newly born child Baby Nal (umbilical cord).
2	Kadugeethkanda (*Dioscorea pentaphylla*)	Paste of the leaves made with mustard oil is rubbed into affected areas for the treatment of rheumatism. General weakness worms, leprosy etc.
3	Baichandi kanda (*Dioscorea hispida*)	Jaundice, Stomach ache, Malaria, Fever etc. Leaf paste made with oil is rubbed into affected areas for the treatment of swellings.
4	Lodangikanda (*Disocorea spp*.)	Used in Stones in the urinary tract, bladder, kidney
5	Saidukanda, Badainkanda (*Disocorea spp*.)	Used in curing wounds, tumors, boils, sunburn, cut. Also used in injury and carbuncle
6	Vidarikand or Birarkanda or Bhui kumhda (*Prureria tuberosa*)	Diarrhea, bleeding, swelling in body, potency etc.
7	Tikhur kanda (*Curcuma angustifolia*)	Maste of rhizome given to patients facing Heat stroke, Decoctio also given for Weakness, Sexual strength etc
8	Rabikanda/Dhursi kanda	Paste of wet tuber given for Scorpion bite, poisonous insect bite
9	Jangli Suran (*Amorphophallus sylvaticus*)	Paste of wet tubers given for wound healing, also given during Asthma attack and for liver disorders

Table 4: List of endangered and rare medicinal plants used by the traditional healers of Mandla

Sr. No	Name of species	Plant habit	Plant Part used	Name of disease/ part affected	Method of application
1	Gulbakawli (*Hedychium coronarium*)	Climber	Flower	Eye related diseases, Cataract	Flowers were kept in water until decomposed, extract is separated and few drops were poured in eyes to treat cataract and improving eye sight and vision
2	Bhanvarmal (*Hymenodictyon excelsum*)	Tree	Roots	Tooth ache, snake bite	Dried roots kept beneath teeth. Chirchita is mixed with this species equally and paste were applied to infected part, some time decoction is given
3	Paras peepal (*Thespesia populnea*)	Tree	Seeds, Bark	Whooping cough, Asthma, Skin, Burn	Seeds were roasted in fire and eaten with Pan leaf. Ground up bark is used to treat skin diseases
4	White Bach (*Acorus calamus*)	Herb	Rhizome	Children's growth	Fresh roots were rubbed on surface and paste given with Honey
5	Vanhaldi (*Curcuma amada)*	Herb	Flower, Rhizome	Jaundice	Dry flowers were powdered, also in liquid form with water
6	Nagbala (*Grewia hirsuta*)	Shrub	Root, Fruit	Scar, boil	Dried bark powdered and spread on boil, scars etc
7	Hadjudi (*Cissus quadrangularis)*	Climber	Stem	Broken bone, abscess	Stem pasted with warm oil and tighten around broken bone. Paste of stem pasted in abscess part
8	Banjhita (*Rubia cordifolia)*	Climber	Seed, leaf	Malaria, Fever	Crushed, powdered seeds along with Jaggery, 2 leaf were crushed, sieved and given to patients

9	Baibidanga (*Embelia ribes*)	Shrub	Fruit	Fever, worm	Fruits were powdered and given for de-worming. Powder also boiled and liquid given to cure fever
10	Bajoor Ganth (*Lea indica)*	Large Shrub	Roots	Arthritis gastric, heart pain	Equal quantity of satawar, rohila, bajorganth in boiled water given as liquid paste. During chest pain, paste is applied by imbibing on its paste and rubbing of cloth on chest of patients.
11	Safed musli (*Chlorophytum spp.*)	Herb	Roots	In Fertility, Health tonic	Dried root power with milk. Chewing wet roots. For weak patients given as laddoos, for women after delivery. It is also often fried in ghee (clarified butter) and one wed to relieve sore throats and mouth ulcers
12	Tejraj (*Peucedanum nagpurense*)	Perennial herb	Roots, Leaves	General weakness	Chewing directly. Sometimes crushed leaves paste along with water.
13	Bhojraj (*Peucedanum dhana)*	Perennial Herb	Roots	General weakness	Chewing directly. Tuberous root pasted given 2 ts to enhance vigor and vitality of men.
14	Kali haldi (*Curcuma caesia)*	Herb	Tuber	Cough, Cold, headache	Rubbing fresh roots on stone plate, paste given to patients. Chewed directly. Dry powder with milk given to cough and cold affect patients
15	Kalihari (*Gloriosa superba)*	Climber	Rhizome	Stomach ache, snake bite	Cut pieces were used after drying. Powdered roots are chewed mixing with Jaggery (making tablets). Crushed and sieved extract drink mixing with water for snake bite
16	Bidari kanda (*Dioscorea bulbifera*)	Climber	Tuber	Scabies, Stomach ache, White liquid	Dried and Powdered roots with water. Immature root chewed for stomach ache.

The tubers like Vidarikand (*P. tuberosa*) which is used as raw for making vegetable is also used medicinally for curing diarrhea, bleeding, swelling in body, potency etc. Tikhur kanda (*C. angustifolia*) is an economically important tuberous herb. Its tubers were also used as general health tonic and helpful in heat stroke, general weakness, sexual strength etc. The plants and its parts being used by the traditional herbal healers against the diseases prevailing among tribal/local peoples of the area have been documented. Similarly, Suran (*A. sylvaticus*) tubers paste is given for wound healing and given during asthmatic attack, liver disorders etc.

Traditional healers also use endangered medicinal plants utilized for curing various human ailments (Table-4). Out to total 16 plants documented, some of the critically endangered plants are- Kali Haldi (*C. caesia*) largely used in cough and colds related symptoms, whereas kalihari (*G. superba*) is given in powder form, crushed and sieved extract for stomach ache and snake bite. Simalry, root powder of Safed musli (*C. borivilianum) is given* with milk. for weak patients and also given as laddoos, for women after delivery. Gulbakawali flowers were used in treating eyes, vision etc, and were kept in water until decomposed, extract is separated and few drops were poured in eyes to treat cataract and improving eye sight.

Banjitha (*R. cordifolia*) is given to patients affected by fever and malaria. Its seeds were powdered and mix with Jaggery and also two leaves were crushed, sieved and given to patients of fever. Bajoor ganth is given after mixing of satawar, rohila roots in boiled water given as liquid paste. Baibidang (*E. ribes*) fruits were powdered and given for de-worming and its powder is boiled and liquid given to cure fever. Hadjudi is a common climber of Mandla area and widely used in treating bones, fractures etc. by applying its stem paste.

Discussion:

In the present study, data collected through ethno-botanical survey included rare and critically endangered plant species with their vernacular names, use and mode of preparation. The tribal people of Mandla district are using 30 rare plant species. Among them 02 are trees, 03 are shrubs, 10 are climbers, 15 are herbs. Traditional medicine had minimal adverse effects with exception of vomiting and inflammations, since the dosages are not fixed (in most cases unknown) (Gidey, 2009). Singh, and Deewan (2018) reported diagnosis of disease among the Baiga tribe based on both traditional and modern methods of determination of the health problems. The local conventional healers or Baiga tribes are experts in diagnosing the disease by calculating the pulse, by observing eye color, tongue, neck, etc. The Baiga tribes differentiate healthy person and ill person through their daily

routine and appearance and behavioral change. The Baiga tribes follow their customary laws for the treatment of the diseases. They use the forest-based products, and medicinal plants for treatment of sickness and they have deep knowledge about the medicine and forest. Mishra *et al.* (2012) and Mishra (2013) found that Baiga tribes of Dindori district acquire a distinctive understanding of wild plant based traditional knowledge and their know-how in coping extreme famine conditions. Wild yams (*Dioscoreas*) tubers are processed and were used by the tribes at the time of crop failure and famine. Sandya and Sandya (2015) surveyed Ethno-Medico plants of District Dindori with co-operation of tribes. They highlighted 30 Ethno-Medico plants have been identified for the treatment of various diseas and contains information pertaining to botanical name, local name, plants used, their dose and process of administration. Ahirwar (2017) and Ahirwar (2021) documented traditional medicinal plants used by the Baiga tribes of Amarkantak and Mandla region (MP) in curing several diseases. They reported 78 plant species belonging to 35 genera and 28 families used used to cure skin diseases, diarrhoea, jaundice, cough, wounds, piles, urinarytroubles, asthma, tuberculosis, snakebite, gynaecological problems, heart diseases etc.

Bhandari *et al.* (2015) while working on balod, Chattisgarh reported total 56 plant species to be used by tribals and healers individually and in combination (mixture form) against various diseases. They also reported 37 herbal plants and 19 food plants which are used by the tribals and traditional healers of 15 village of Balod district in their daily life for the treatment of various ailments. Sharma *et al.* (2021) explored ethno-medicines, use of wild edible plants for dietary purpose and associated traditional knowledge of Baiga of Vindhyan highlands. They also assessed anthropogenic threats faced by valued species through overall threat impact. They recommend that health benefits derived from ethnic recipes may lead to the promotion of wild edibles not only enhancing dietary diversity locally but also on a global scale.

Traditional healers should be encouraged to transfer their knowledge to interested persons in their communities. As most of the medicinal plants are wild and harvested for their roots to prepare remedies, the healers in consultation with government officials should take care not to eradicate the medicinal plant species altogether. Awareness creation among the traditional healers and community at large is important in order to preserve the indigenous medicinal plant species. Conservation measures such area closure whereby a ban is placed on farming, grazing, tree felling will help minimize environmental degradation and the attendant global warming (Endashaw, 2007).

Unfortunately, there has been a rapid decline in the traditional practice of individual healers identifying plants and preparing various formulations for direct distribution to patients. With the increased availability and acceptance of conventional Western medicine and many of those who are familiar with the tenets and benefits of Ayurveda are not receiving the full respect. By documenting the herbal formulations prepared by traditional vaidyas, it may be possible to prevent unfortunate scenarios like the recent attempt by commercial interests in the United States to patent the traditional Ayurvedic medicinal plant and culinary spice turmeric (*Curcuma domestica* – Zingiberaceae) (Johnston and Webb, 1997).

Before the 1980s, the reputation of the respective traditional healers and the formulations developed by him were sufficient criteria for people to believe in its value. Today, the reduced number of knowledgeable and recognized traditional healers clearly reveals a major disruption in the ancient custom of carrying forward this traditional knowledge. Although the study on which this article reports succeeded in capturing substantial information about the traditional healers and their use and preparation of herbal formulations, additional studies are needed to complete the work. Moreover, the documented properties of the medicinal plants utilized by various traditional healers should be clinically evaluated to further strengthen their validity and to encourage the preparation of new formulations. The various formulations provided by traditional healers must be preserved to ensure the integrity of this time-honored knowledge of traditional healing (Kala 1998, Kala, 2005, Kala, 2006, Dikshit and Kala, 2014, Sandya and Sandya 2015).

Conclusion:

Traditional healers, or Baiga, are basically tribal healers who use specific parts of the plant and specific dosages to treat various ailments. Medicinal plants are consumed fresh or in decoction form, as infusions for oral treatment or as fresh pastes for external use. The parts of plants most commonly used for medicinal purposes are rhizomes, roots, stems, bark, leaves, flowers, and whole plants. Juice and paste are the main cooking methods. They mix several plants as ingredients to cure diseases instantly. Fresh plant parts are mainly used for the production of pharmaceuticals. Most often, fresh, dried medicinal plants are used as simple medicines, although some plants are used along with other parts of the plant. Local healers have traditionally inherited this practice from their ancestors since time immemorial. The locals' belief in traditional medicine and the lack of access to modern medicine have helped local healers to continue their treatments. In

addition, treatment with locally available medicines can also help improve the health of the Baiga people.

The information obtained from this study on the use of medicinal plants by the Baiga strain requires pharmaceutical studies, including alkaloid extraction and isolation, and some clinical studies. This will help create widespread awareness of the need to protect such plants and also help promote knowledge of local traditional medicine. Furthermore, it may help preserve and enrich these gene banks before these economically important species are lost forever. The people of the Mandra region rely on medicinal plants and rely on Ojas, Gunias or Bumkas for most of their ill health problems.

The study of traditional medicine is of great importance to the well-being of rural and tribal communities in the treatment of conventional diseases. As a result, health care costs can be high and inadequate in rural areas. Recognizing the importance of these economically important crops for the benefit of our future generations, and with the active support of the villagers to improve health care, in this promising area We still have a lot to do. In developing countries, traditional healers, or vidyas, are an important health resource and efforts have been made to integrate them into primary care programmes.

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A REVIEW ON RESEARCH WORK OF GENUS *AQUILARIA* WITH EMPHASIS ON ITS DISTRIBUTION, MEDICINAL AND ECOLOGICAL IMPORTANCE

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Abstract:

Aquilaria (Family: Thymelaeaceae) is a large evergreen tree distributed in Southeast Asia and the foothills of Northeast India. Only 21 species have been reported under this genus. Only three species of the genus are reported to be present in India, *A. malaccensis, A. khasiana,* and *A. macrophyla*; of these *Aquilaria malaccensis* is best known for the production of valuable resinous, fragrant, non-timber wood i. e. Agarwood. The oil produced from the Agarwood, prior to a fungal infection, has shown immense importance in the socioeconomic aspect. A lot of studies have been done on the wood extract. Sesquiterpene and other bioactive components have been reported, making it a potent essential oil with antimicrobial, anti-cancerous, antidiabetic effects. As the plant is rare and endangered, conservation is one of the critical issues. Micropropagation has been achieved for many species of *Aquilaria* by various researchers. Besides, marker based studies have been found a helpful tool for estimating population size and its conservation. The present review article may be useful to researchers to build preliminary knowledge on Aquilaria and will help do novel work exploring new research areas.

Keywords: *Aquilaria,* Agarwood, hydro distillation, GC-MS, seed viability, antimicrobial, anti-cancerous, DNA barcoding, SCAR marker, conservation, callus culture

Introduction:

Aquilaria, belonging to *the* family Thymelaeaceae is among the very few economic tree species of tropical and sub-tropical rain forest which has aromatic and medicinal values. This species is commonly known as Agarwood and has various local names such as Aloe wood, Eagle wood, Sashi, Gaharu, Agaru, etc. It is an evergreen tree found growing naturally in forests of North East India, mainly in lowland and on hillsides between altitudes of 100 m up to 1000 m under high, humid, subtropical climate with rainfall 1800-3500 mm per annum. It is a soft, medium-sized, shade tolerant tree that grows up to 15–25 m tall on average and can reach heights as much as up to 40 m, and 60 cm in diameter and

is adapted to live in various habitats. It regenerates through seeds and is found growing associated with varieties of herb, shrub and tree species in the forest. The plant is endemic to the Northeast region and has been used since a long time for extraction of the costliest essential oil of commerce known as agar oil. It has great demand in dye, perfume industry because of its unique, sweet and lustrous fragrance, which can not be compared with any other essential oil used in perfumery.

Distribution:

There are fifteen species in the genus *Aquilaria* of which eight are known to produce Agarwood (Ng, 1997). Two species, namely *A. malaccansis* Lam. and *A. khasiana* Hall. are available in the northeastern states of India and third species, *A. macrophylla*Miq., occurs in the Nicobar Islands (Tabin and Shrivastava, 2014). Others species like *A. yunnanensis* and *A. sinensis,* are common in China (Zhengyi *et al.,* 2007). *A. malaccensis* is the main species of commerce and chiefly distributed in 10 countries: Bangladesh, Bhutan, India, Indonesia, Iran, Malaysia, Myanmar, Philippines, Singapore and Thailand (Oldfield *et al.,* 1998). In India it is confined to the Northeast region of India and mostly distributed in the foot-hills of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and West Bengal (Asian Regional Workshop, 1997). Recently, natural population of the species has been reported to exist in pockets in Assam and Arunachal Pradesh (Saikia *et al.,* 2015). Earlier, this species was mainly reported from the hills and forests of Arunachal Pradesh, Nagaland, Manipur, Mizoram, and Tripura as well as in West Bengal (Palit, 1996). They are also widely distributed in Barak valley, Assam. The distribution patterns of the two prominent species in Assam are 95 % o f *A. agallocha* and 5% of *A. malaccensis (*Ahmed and Gogoi, 2000*)*. Another species *A. Khasiana* Hallier is found to grow in the khasi hills about 3000 ft. in Meghalaya. *A. beccariana* is found in the Kalimantan Sumatra in Indonesia and Malaysia. This species occurs in primary and secondary forests, sometimes in swamp forests upto an altitude of 800 m. *A. cummingiana* is asmall shrub or small tree of primary forests distributed in East Kalimantan, the Mollucas and the Philippines. *A. microcarpa* grows in lowland forests upto 200 m altitude in Indonesia and Singapore (Mukheiji, 1997). Figure 1 shows the distribution pattern of Agarwood in Asian countries (Sidik, 2008).

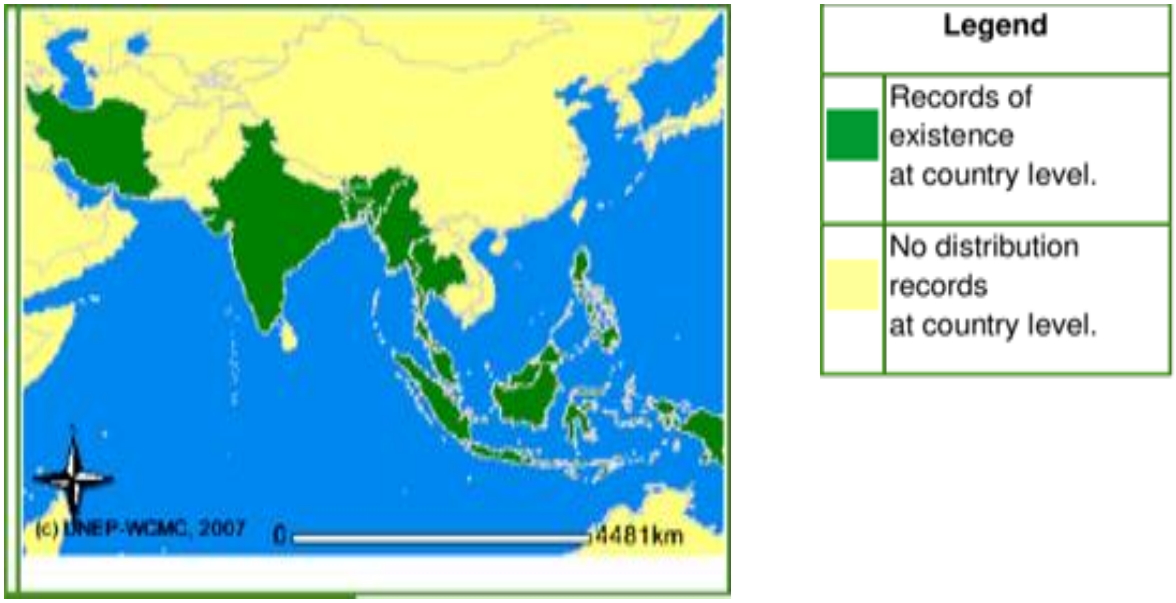

Figure 1: Distribution og Gaharu across Asian countires

Economical and medicinal importance

The tree is of great commercial and economical importance due to aromatic oil called 'agar oil' that accumulate in the wood. The term Agarwood specifically refers to the resinous heartwood from the *Aquilaria* tree. Generally agreed to the result of a pathological condition, this aromatic resin is produced as the tree sap thickens in response to injury and fungal infection. The wood is in high demand for yielding agar oil. The oil has immense value and importance as medicine, incense and perfume and has a huge market across Asia, Middle East and Europe. It has been used as a stimulant, cordial tonic and carminative and enters into several compound preparations. It is used as anti- asthmatic, aphrodisiac and astringent. It is also used in diarrhoea, dysentery, gout, rheumatism and paralysis. The oil is used in cosmetics and liniments for various skin diseases in some countries. When dusted on clothes and skin, agar wood acts as a preventive against fleas and lice.

Chemically agar oil is rich in sesquiterpene hydrocarbons. Many workers have isolated and characterized several chemical compounds of the oil. It has been seen that the chemical components of the oil vary depending upon the region on which the trees are grown, age of die plant and extent of disease lesions formed in the wood. Therefore, there is a lot of variations in the quality of agar oil originating from different countries as well as oil extracted from different agar plant materials. First-grade Agarwood is one of the most expensive natural raw materials in the world. In consumer countries, prices range from a few dollars kg-1 for low quality material to more than US$ 30,000 kg-1 for top quality wood. Similarly, agarwood oil fetches high prices (Agarwood "Wood of Gods" International

Conference, 2003). The non-infected part of the wood is used for carving and furniture purposes. Agarwood oil has also been a traditional medicinal source for Ayurvedic, Tibetan and East Asian Medicine and has been widely used for the treatment of Pleurisy (Maheshwari *et al.,* 1963). Agar is frequently found in young trees of about 20 years old, but the infestation takes time to mature and trees about 50 years old have shown the highest concentration (yield approximately 2 to 3 kg tree-1)(Varma *et al.,* 1965).

Ecological importance of the plant

The *Aquilaria malaccensis*, with its immense economic importance, still has limited natural distribution and is threatened due to its exploitation by humans. However, so far information on genetic diversity and structure of the native *Aquilaria* populations from India is still highly fragmentary and preliminary. The uncontrolled logging and unrestricted harvesting of *Aquilaria* for agarwood oil distillation has resulted in rapid erosion of the natural stands in India as well in other Southeast Asian countries and the species is rapidly vanishing from the wild (Barden *et al.,* 2000). *A. malaccensis* is 'vulnerable' globally, considered 'critically endangered' in India, and almost 'extinct in the wild' in Assam (IUCN, 2014). Of late, conservation of *A. malaccensis* has assumed more importance, particularly after being listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and incorporation in the IUCN Red List of Threatened Species (IUCN, 2007). However, with increasing efforts to conserve the species, it is turning into a home garden grown tree or homesteads in Northeast India (Kevles and Sciences, 1994; Saikia and Khan, 2013). Thus, there arises an urgent need to assess the genetic fitness of this economically important tree species, and to take up significant measures to protect the species before it loses its inherent diversity.

The occurrence of the tree itself does not guarantee the presence of the resin. Scientists estimate that only 10 percent of the *Aquilaria* trees in the natural forest contain Agarwood. Hence, there is a need for establishment of commercial plantations to achieve the maximum infection intensity in order to obtain higher yield to meet future demands. The success of any plantation program depends on the genetic resources coupled with precision silviculture technology. Previous studies on *A. malaccensis* have mainly focused on its morphology and anatomy (Chakrabarty *et al.,* 1994; Ng *et al.,* 1997), cytology (Debnath *et al.*, 1995), systematics (Eurlings *et al.,* 2005), reproductive biology (Kundu *et al.,* 2000); (Shankar, 2012). RAPD analysis for Sequence Characterized Amplified Region (SCAR) marker development (Tnah *et al.,* 2012), characterization of microsatellite markers

(Tnah *et al.,* 2012), and cultivation in homesteads (Saikiaand Khan, 2012 a, b). studies on its population genetics in the Assam region have been done, and such information is essential for formulating effective conservation strategies for this threatened species (Banu *et al.,* 2015).

Reporting of research work done on different species of *Aquilaria*

Lots of work has been done on different species of *Aquilaria*, though most of the works have been concentrated on *A. malaccensis* (synonym *A. agallocha*), *A. sinensis*, *A. crassana*. In India majority of the research work have been done on *A. malaccensis*. Work on Agarwood, extraction of oil from infected Agarwood, estimation of antioxidants, screening of antimicrobial activity against agarwood oil as well as leaf exract, study of genetic diversity by using different markers, DNA barcoding, micropropagation and some other tissue culture based works have been done in various time by different researchers. The roots of *A. malaccensis* were ideal in uptaking and storing Fe, while the stem of the *A. malaccensis* plant was ideal for the uptake and accumulation of Cd. The natural regeneration rate is reported to be quite fast (Troup, 1986) but the seed productions and seedling dispersion in the forest is limited(Soehartono and Newton, 2001), as it is produced once in a year during the monsoon season i. e. between June to August. The seeds have low reproductive potential as germination rate is variable, slow and short (Soehartono and Newton, 2001). The germination percentage in case of fresh seeds is high which sharply decreases for stored seeds (Ahmed and Gogoi, 2000). *Aquilaria* regenerates freely under the mother tree or sprouts from the stumps of harvested trees as seedlings in forests, however, mother trees are becoming scarce in many areas because of over-exploitation and harvesting for Agarwood (Soehartono and Newton, 2001). The germination potentiality is also influence by ecology and other reproductive factors (Soehartono and Newton, 2001). Variations among home garden populations of *A. malaccensis* and identification of three variants from different areas of Assam based on utility and utilitarian aspects of *A. malaccensis* in northeast India has been reported (Nath and Saikia, 2002). Another study by (Kundu *et al.,* 2000) on the desiccation sensitivity and recalcitrant behaviour of seeds demonstrated decrease in seed moisture content with time during different desiccation conditions. Agar formation is associated with mold and decaying fungi (Jalaluddin, 1977); (Venkataramanan *et al.,* 1985). The process of natural and artificial agarwood formation was reported by Jensen (2003).

Studies on oil of infected Agarwood were made by several workers (Bhuiyan, Begum, and Bhuiyan, 2009; Ishihara *et al.,* 1993). The agarwood oil is most frequently obtained by hydro-distillation because it is safe to operate and environmentally friendly (Liu *et al.,* 2008). The agarwood oil was hydro-distilled at various temperatures in order to study the distillation kinetics, quality of the oil, higher oil yield and better-quality oil were obtained at higher operating temperature (Pornpunyapat *et al.,* 2011). Identification of agarwood oil is impossible without the use of laboratory techniques (Barden *et al.,* 2000); however, agarwood oil grading has been traditionally performed by trained human graders (sensory panels) according to the basic specification, such as the oleoresin contents, color and the aroma/smell (Hidayat *et al.,* 2010). A human nose cannot tolerate a high number of samples and work in continuous production because it fatigues rapidly with increasing number of samples hence quality assessment of agar oil was done by using an 'electronic nose' (Keller, 1999). Secondary xylem of *A. agallocha* in relation to the formation of 'agar' has been studied (Rao and Dayal, 1992). The phytochemical and antimicrobial screening of *A. Agallocha* Roxb. extracts have proved the usefulness of agarwood tree for medicinal purposes (Dash *et al.,* 2008). Studies revealed that Agarwood has remarkable anticancer activity (Gunasekera *et al.,* 1981). Anti-inflammatory response of *A. agallocha* against carrageenan induced paw edema in rats have been studied (Rahman *et al.,* 2012). Agarofuran and agarospirol are considered as new promising nervous system drugs (Okugawa *et al.,* 1996) as benzene extractable compounds possess potent antidepression activities for central nervous system (Okugawa *et al.,* 1993).

Pharmacognostical studies by researchers in Japan have confirmed variations in chemical composition of essential oils with nine major sesquiterpene compounds isolated from specimens of agarwood samples collected from different regions. Comparing the extracts of *A. agallocha* and *A. sinensis*, Japanese researchers have confirmed the variations in chemical composition between species and within species (Ishihara *et al.,* 1993b). The aqueous extract of *A. agallocha* stems had an immediate effect on hypersensitivity through the inhibition of histamine release from mast cells (Kim *et al.,* 1997). A cell suspension culture was established from fragrant wood producing *A. sinensis*. Methyl jasmonate was added to this culture in order to induce production of fragrant compounds. There is evidences of apoptosis and anti-metastatic activity on pancreatic cancer cells against essential oil of *A. crassana* (Saad S Dahham *et al.,* 2015). Extracts of *A. crassana* have revealed significant antioxidant and cytotoxic properties (Saad Sabbar Dahham *et al.,*

2014). Moreover, different parts of *A. crassana* have been studied and explored dynamic biological effects such as antioxidant, antibacterial and antifungal effects (Kamonwannasit *et al.,* 2011; Novriyanti *et al.,* 2010). The *A. malaccensis* leaf extract has antibacterial and antioxidant effect against both Gram positive and Gram-negative microbial strains (Uddin *et al.,* 2016). The study to identify the major phytochemical constituents in *Aquilaria malaccensis* (Thymelaeaceae) ethanolic leaf extract (ALEX-M) and elucidate their ability to suppress nitric oxide (NO) production from a murine macrophage-like cell line (RAW 264. 7) stimulated by lipopolysaccharide (LPS) and interferon-γ (IFN-γ). Dichloromethane (DCM) and ethyl acetate (EtOAc) fractions of ALEX-M were subjected to column chromatography (Eissa *et al.,* 2022).

Genetic variation and population studies of different species of *Aquilaria* from different parts of the world by using various markers have been done. Genetic variation and molecular authentication of *A. Malaccensis* and *A. hirta* from natural population of Malaysia, using RAPD and SCAR markers has been done (Lee *et al.,* 2011). In 2015 ISSR marker analysis of various population of *A. malaccensis* from Assam has been reported by (Banu *et al.,* 2015). These molecular studies have been proved very useful in building conservation strategies as these studies are very essential to know the population structure and genetic diversity.

Research work has been done based on the comparison of the traditional and scientific knowledge of the Penan Benalui and other forest products collectors of Indonesian Borneo (Donovan *et al.,* 2004). This study was concerned with the resin formation in the genus *Aquilaria*, a tropical forest tree of South and South-East Asia. The aromatic resin gaharu the product increasing under threat as the trees are overexploited and forest is cleaned. Although limited management of wildings failed to bring the resin producing species. Under cultivation, they found that the Penan recognize the complex ecology of resin formation involving two or may be three, living organism the tree, one or more fungi, and possibly an insect intermediary. Isolation of 128 endophytic fungi from *A. sinensis* and observation of their antimicrobial activity has been done (Gong and Guo, 2009). The active isolates were identified to 17 taxa. *Fusarium* spp. were the most dominant genera. Cui *et al.* (2011) have reported antimicrobial and antitumor activity of the endophytic fungi isolated from *Aquilaria sinensis*and results suggest that the endophytic fungi associated with Agarwood provide us with not only useful micro-ecological information, but also potential antimicrobial and antitumor agents. Cell

suspension and callus cultures may serve as an alternative solution to provide a fast-growing plant material to produce artificial Agarwood in a short period. Faizal *et al.* (2023) induced agarwood formation in callus cultures of *Aquilaria malaccensis* by application of crude mycelial extracts of *Fusarium solani* strains GSL1 or GSL2, or methyl jasmonate (MeJA).

Aquilaria spp are the principal source of Gaharu, a valuable resin, yet information about their reproductive ecology is very important because these informations are useful to evaluate the probability of reproduction occurring in *Aquilaria* spp. Six *Aquilaria* species were studied in Indonesia in this context (Soehartono *et al.,* 2000). There are many reports on biochemical changes in agarwood trees (Tamuli *et al.,* 2005). They found that during pathogenesis, changes occurred in sugar, ascorbic acid, phenol and protein contents of *A. malaccensis*. In healthy trees, the biochemical constituents increased. In infected trees, a decrease in the biochemical constituents was observed after inoculation with the fungi.

There are reports regarding DNA Barcoding and its application in species authentication (Tamuli *et al.,* 2005). The identification of *Aquilaria* species from their resinous non-wood product, the Agarwood, is challenging as conventional techniques alone are unable to ascertain the species origin. The DNA barcoding technique to generate barcode sequences for *Aquilaria* species and later applied the barcodes to identify the source species of Agarwood found in the market. Results indicated that all single barcodes can be easily amplified and sequenced with the selected primers. The combination of trnL-trnF+ITSandtrnL-trnF+ITS2 yielded the greatest species resolution using the least number of loci combination, while matK+trnL, trnF+ITS showed potential in detecting the geographical origins of *Aquilaria* species.

In-vitro culture techniques offer a viable system for rapid, true-to-type mass multiplication and germplasm conservation of endemic, rare, and endangered plants (Mallón *et al.,* 2010). A few studies indicate that successful micropropagation protocols were developed earlier (Shu-Yuan, 1995). The normal propagation of *A. malaccensis* by seed is difficult because the seeds' moisture content decreases rapidly during the first few hours/days, so the viability of seeds is lost very fast. Furthermore, insect pest infestation of the seeds often inhibits the growth of the tree (Yang *et al.,* 2008). This limitation may also be conquered by regenerating the plants through plant tissue culture technique. Agar tree is the one of the most important tree species of medicinal and commercial value for its production of impregnated resinous heart wood. By using tissue cultured Agarwood

plantlets, growers may obtain more oleoresin than if they grow from random seeds. The uniform growth with tissue culture plantlets may make the process of inducing oleoresin easier, and volume of oleoresin more predictable. Combinations of plant growth hormone such as 2, 4-D and Kinetin in the initiation of callus in some woody plant species was established earlier by several researchers (Faizal, 2023).

An investigation was undertaken with Pink cedar (*Aquilaria malaccensis* Lamk.) as the test tree species to standardize Integrated Nutrient Management (INM) techniques for improving the growth and quality of seedlings in the nursery and its impact under main field condition. Studies on the anatomical and mechanical properties of wood at different ages and the effect of different grades of infected and non-infected wood on Agarwood oil through GCMS were carried out. There are reports on integrated nutrient management and characterised wood of *Aquilaria malaccensis* (Jayachandran, 2013). Raising of quality seedlings of *Aquilaria malaccensis* through optimum nutrient management is an essential pre requisite for large scale plantations. Most of the nursery seedlings are raised in a potting mixture without assessing the nutrient requirements of the species. Nursery planting medium with sufficient nutrients induces resistance in the seedlings and enable them to withstand in adverse situations while outplanting (Srivastava and Behl, 2002). The prevailing scarcity and escalating price of chemical fertilizers combined with the availability and effectiveness of agro, industrial wastes, suitable bioinoculants and a concern for soil health warrants the practice of blending organic, inorganic and bio sources of plant nutrients in an appropriate manner for achieving higher productivity (Beniwal, 1989). Initial reduction in growth at the nursery level will reflect on the later stages of growth increment and biomass at the plantation level. Therefore, it is necessary to make nutrients available from organic, inorganic and biofertilizers along with adequate supply of water to augur the growth of seedlings at the early stages for better survival (Bhandari *et al.,* 1982). However, such nutritional studies, both at nursery and field conditions to augment the growth and development of *A. malaccensis* have not been attempted before. The variations in wood properties are attributed to the different distribution patterns of its microstructure, arrangement, size and dimension of component cells. In hardwood, the cells that make up the anatomical organization are the vessels, fibres and the wood rays. Fibres are the principal element that is responsible for the strength of the wood. The strength characteristics of wood are correlated to these anatomical properties. In turn, the amount and quality of fibres have a pronounced effect on wood strength and shrinkage.

This type of study helps to examine the variation in anatomical characteristics of plantation grown Agarwood of different age classes. Understanding the variation in the anatomical features provide a basis for improved wood utilization (Bhattacharyya *et al.,* 1952). Such information will also help to reduce the pressure on the utilization of trees from natural forest.

Future prospects

Aquilaria is a rare endangered plant with immense economical and ecological importance. Though many researches have been done in various field till date, in India the progress is less. There are many aspects which are unexplored. In India the plant is only confined to the hilly regions of Assam and Tripura and some parts of West Bengal. Studies on genetic diversity have been done only for the plants growing in parts of Assam but the plants of Tripura remain untouched. There are many reports on antioxidant, antimicrobial, antitumor and anti-inflammatory response against leaf extract of the plant but there are less or few reports on effects of oil extract, though many studies have been done to characterise the agarwood oil. In West Bengal the plant population is very less because of the climate, so various tissue culture techniques like micropropagation, seed culture etc. may establish a new horizon. this could be a very challenging as well as very exciting work to do. Besides these, we need to focus on conservation of this immensely valuable plant.

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NEUROPLASTICITY: HOW EXPERIENCE CHANGES THE BRAIN

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Abstract:

Neuroplasticity, a fundamental property of the brain, has garnered substantial attention within the field of neuroscience and beyond. This abstract explores the essence of neuroplasticity, shedding light on its significance in understanding brain function and the remarkable adaptability of the nervous system. Neuroplasticity encompasses the brain's ability to reorganize its structure and function in response to experiences, learning, injury, or environmental changes. This phenomenon is driven by complex cellular and molecular processes involving synaptic plasticity, neurogenesis, and changes in neural connectivity. Research in neuroplasticity extends its implications across diverse domains, including cognitive development, rehabilitation after brain injury, recovery from neurodegenerative diseases, and the optimization of learning and memory. Moreover, neuroplasticity serves as a foundation for novel therapeutic interventions, such as neurorehabilitation strategies and treatments for mental health disorders. This abstract underscore the ongoing relevance of neuroplasticity in unraveling the intricacies of brain plasticity, offering profound insights into human brain function, recovery, and the potential for enhancing neurological well-being.

Keywords: Brain, Neuroscience, Environmental, Neurorehabilitation, Nervous system

Introduction:

The concept of neuroplasticity has revolutionized our understanding of the human brain and its remarkable adaptability. For centuries, the brain was perceived as a static organ, its structure and function fixed in adulthood. However, in the latter half of the 20th century, pioneering research illuminated the brain's ability to rewire itself, adapt to changing circumstances, and recover from injury. This groundbreaking discovery opened new frontiers in neuroscience, psychology, and rehabilitation, fundamentally altering the way we view the potential of the nervous system [1].

Neuroplasticity, often referred to as brain plasticity, is the brain's innate capacity to undergo structural and functional changes in response to various stimuli, experiences, and environmental factors. These changes can occur throughout one's lifespan, from early development through adulthood and into old age. Neuroplasticity manifests in diverse forms, encompassing synaptic plasticity, cortical remapping, axonal sprouting, and even the generation of new neurons through neurogenesis. These dynamic processes enable the brain to adapt to learning, recover from injuries, compensate for deficits, and optimize its performance.

The exploration of neuroplasticity has transcended the confines of neuroscience, reaching into fields as varied as education, psychology, neurorehabilitation, and even artificial intelligence. Understanding the mechanisms and boundaries of neuroplasticity has significant implications for enhancing cognitive function, ameliorating the effects of neurological disorders, and designing innovative interventions for brain health. In this exploration of neuroplasticity, we delve into the fundamental principles, mechanisms, and real-world applications that underscore the pivotal role of brain plasticity in shaping our understanding of human cognition and neurological well-being. We unravel the intricate dance between nature and nurture, genes and environment, and the potential of the human brain to adapt, learn, and evolve throughout life [2].

Physiological processes

Neuroplasticity is a fascinating physiological process that underlies the brain's ability to adapt and change throughout life. It involves a range of cellular and molecular mechanisms that allow the brain to reorganize its structure and function in response to various stimuli, experiences, and environmental changes (Figure 1). Here's an overview of the physiological processes involved in neuroplasticity (Figure 2):

1. **Synaptic plasticity:**
    - **Long-Term Potentiation (LTP):** LTP is a crucial mechanism for learning and memory. It involves the strengthening of synapses (connections) between neurons. When two neurons are repeatedly activated together, the synapse between them becomes more efficient, leading to enhanced signal transmission.
    - **Long-Term Depression (LTD):** LTD is the opposite of LTP. It weakens synaptic connections when neurons are activated less frequently together. This process helps in fine-tuning synaptic strength and maintaining balance

in the neural network [3].

2. **Structural plasticity:**
    - **Dendritic spine remodeling:** Dendritic spines are tiny protrusions on the dendrites of neurons where synapses form. Structural plasticity involves the growth, elimination, and reshaping of dendritic spines in response to neural activity and learning.
    - **Axonal sprouting:** After brain injury, nearby neurons can send out new branches or axonal sprouts to form new connections, compensating for lost connections and enabling recovery.
3. **Neurogenesis:**
    - **Adult neurogenesis:** Contrary to the earlier belief that neurogenesis (the formation of new neurons) occurs only during development, recent research has shown that it also occurs in certain brain regions in adulthood, such as the hippocampus. This process contributes to learning, memory, and recovery from injury.
4. **Cross-modal plasticity:**
    - **Sensory cross-modal plasticity:** When one sensory modality is compromised (e. g., due to blindness or deafness), the brain can rewire itself to enhance other sensory modalities. This involves changes in the neural pathways responsible for processing sensory information.

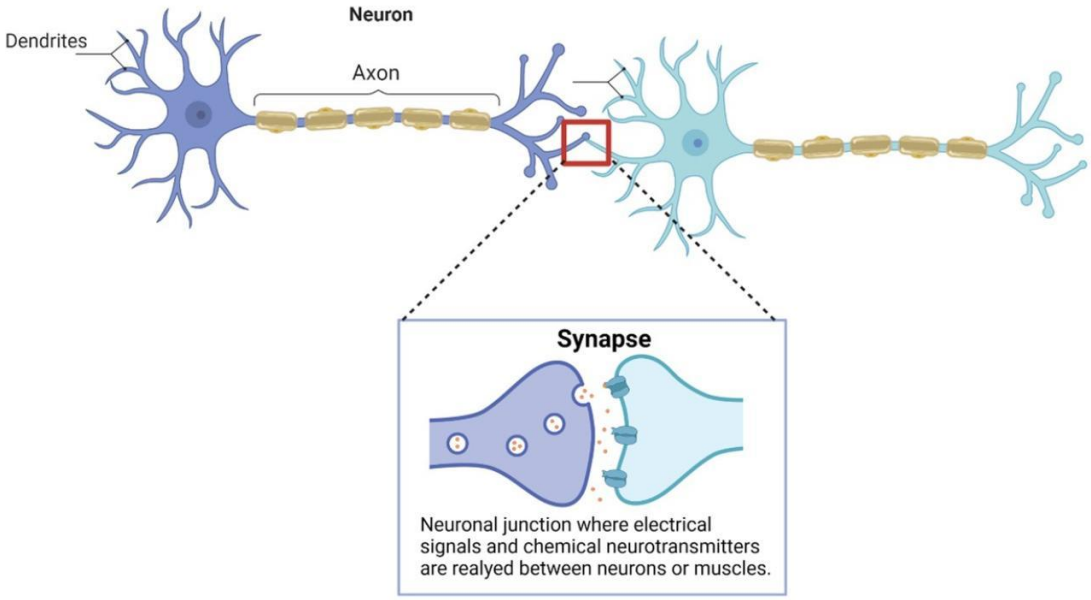

Figure 1: Illustrating structure of neuron and synapses

(Image created with Biorender.com)

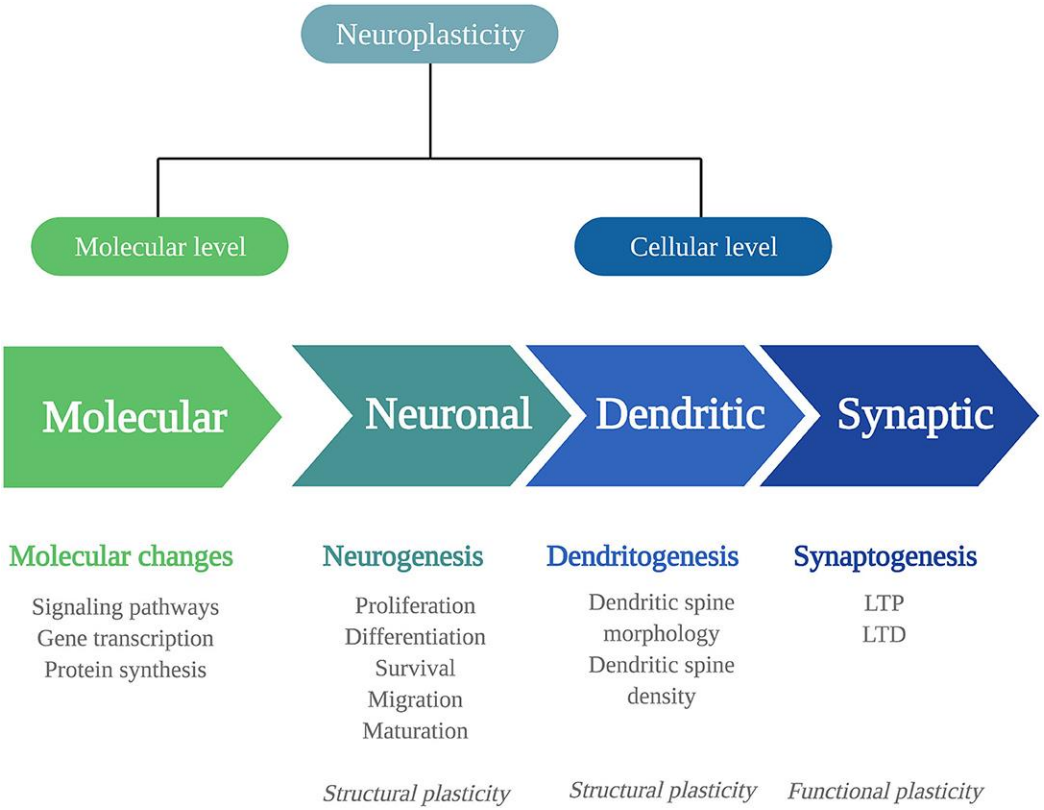

Figure 2: Illustrating the mechanisms of neuroplasticity. Schematic representation of the different mechanisms of neuroplasticity at a molecular and (sub)cellular level. Neuroplasticity at a molecular level affects intracellular signaling pathways, gene transcription, and protein synthesis. At a cellular level, neuroplasticity occurs at the subcellular levels of neurogenesis, dendritogenesis, and synaptogenesis. The neuronal changes of neurogenesis and dendritic changes alter the structural characteristics of the neuron: structural plasticity. Synaptogenesis involves functional changes: functional plasticity. LTP, long-term potentiation; LTD, long-term depression.

5. **Homeostatic plasticity:**
    - **Maintaining balance:** To ensure the stability of neural networks, homeostatic plasticity mechanisms exist to regulate synaptic strength. If synapses become too strong (LTP) or too weak (LTD), homeostatic mechanisms can bring them back to a stable state.
6. **Experience-dependent plasticity:**
    - **Use-it-or-lose-it:** Neural circuits that are frequently used tend to become stronger, while those that are rarely used can weaken or even be pruned through a process called synaptic pruning. This is the brain's way of optimizing its resources.

These physiological processes collectively enable the brain to adapt to learning new skills, recovering from injuries, adjusting to sensory changes, and maintaining overall cognitive flexibility. Neuroplasticity is a dynamic and ongoing process that plays a vital role in shaping the brain's structure and function throughout an individual's life. Understanding these processes is essential not only for neuroscience but also for developing therapies for various neurological conditions and enhancing human cognitive abilities [4,5].

Benefits of neuroplasticity

Neuroplasticity, the brain's ability to adapt and reorganize itself, offers a wide range of benefits that have significant implications for various aspects of human life. Here are some of the key benefits of neuroplasticity:

1. **Learning and skill acquisition:**
    - Neuroplasticity allows individuals to learn new skills, acquire knowledge, and adapt to new environments throughout their lives. It forms the foundation of education and skill development.
2. **Memory enhancement:**
    - Neuroplasticity plays a crucial role in memory formation and retention. It enables the strengthening of synaptic connections associated with learning and memory, leading to improved recall and information retention.
3. **Recovery from brain injuries:**
    - Individuals who have suffered brain injuries, strokes, or trauma can benefit from neuroplasticity. The brain can often reorganize and compensate for damaged areas, facilitating recovery and the regaining of lost functions.
4. **Rehabilitation:**
    - Neurorehabilitation programs harness neuroplasticity to help individuals recover from neurological conditions or physical injuries. These programs aim to optimize neural pathways and improve functional outcomes.
5. **Enhanced cognitive function:**
    - Engaging in mentally stimulating activities and challenges can promote neuroplasticity, leading to improved cognitive functions such as problem-solving, creativity, and critical thinking.
6. **Adaptive changes in response to experience:**
    - The brain can adapt to changes in sensory input, enabling individuals to adjust to sensory impairments or heightened sensory experiences. This is particularly evident in cases of sensory deprivation.

7. **Cross-modal compensation:**
    - Neuroplasticity allows individuals with sensory deficits (e. g., blindness or deafness) to develop enhanced abilities in their remaining senses. For example, blind individuals often have heightened auditory and tactile perception.
8. **Enhanced recovery post-stroke:**
    - Stroke survivors can experience significant functional improvements through neuroplasticity-based therapies and exercises. The brain can reroute functions to undamaged areas, promoting motor and cognitive recovery.
9. **Pain management:**
    - Neuroplasticity-based interventions, such as cognitive-behavioral therapy, can help individuals manage chronic pain by reshaping the way the brain processes pain signals.
10. **Mental health and well-being:**
    - Engaging in activities that promote neuroplasticity, such as mindfulness meditation and cognitive therapy, can have positive effects on mental health, reducing symptoms of anxiety, depression, and stress.
11. **Aging and cognitive resilience:**
    - Encouraging neuroplasticity through lifelong learning and cognitive challenges can help maintain cognitive function as individuals age, potentially delaying the onset of age-related cognitive decline.
12. **Optimizing brain health:**
    - Neuroplasticity-based interventions and lifestyle choices, such as regular physical exercise, a balanced diet, and social engagement, can help optimize overall brain health and resilience.
13. **Customized rehabilitation:**
    - Neuroplasticity enables therapists and clinicians to tailor rehabilitation programs to individual needs, maximizing the effectiveness of interventions for conditions like traumatic brain injury or stroke.
14. **Innovative therapies:**
    - Researchers are developing novel therapies and interventions that leverage neuroplasticity to treat neurological disorders, such as Alzheimer's disease and Parkinson's disease.

Overall, the benefits of neuroplasticity highlight the brain's extraordinary capacity for adaptation and recovery. This characteristic not only enhances our ability to learn and grow but also offers hope and opportunities for individuals facing neurological challenges and cognitive changes throughout their lives [6,7].

Theories of neuroplasticity

Early theories of neuroplasticity represent the initial attempts to understand and describe the brain's ability to adapt and change its structure and function. These early theories laid the groundwork for our current understanding of neuroplasticity. Here are some prominent early theories of neuroplasticity [7,8,9].

1. **Hebbian plasticity (Hebb's rule):**
    - Proposed by Canadian psychologist Donald Hebb in 1949, Hebbian plasticity is one of the foundational concepts in the study of neuroplasticity. Hebb's Rule suggests that when one neuron repeatedly and consistently stimulates another neuron, the connection between them strengthens. This principle is often summarized as "cells that fire together, wire together. " Hebbian plasticity explains how associative learning occurs and provides a mechanistic explanation for memory formation.
2. **Behaviorism and learning theory:**
    - Behaviorist theories, particularly those of B. F. Skinner, emphasized the role of external stimuli and reinforcement in shaping behavior and learning. While these theories did not focus on the underlying neural mechanisms of neuroplasticity, they highlighted the importance of environmental factors and experience in modifying behavior and cognitive function.
3. **Sensory deprivation and enriched environments:**
    - Early experiments in sensory deprivation and enriched environments conducted in the mid-20th century provided insights into how sensory experiences and environmental conditions can influence brain structure and function. Researchers found that depriving animals of sensory input led to detrimental effects on the brain, while enriched environments with cognitive and sensory stimulation had a positive impact.
4. **Phantom limb phenomenon:**
    - Studies of the phantom limb phenomenon, where amputees experience sensations and pain in missing limbs, contributed to early understandings of

neuroplasticity. Researchers observed that the brain's representation of the missing limb could reorganize, with neighboring brain areas assuming control over the amputated limb's functions.

5. **Neurological rehabilitation:**
    - Observations from early neurological rehabilitation practices, such as those developed by neurologists and therapists working with stroke survivors and individuals with brain injuries, contributed to the understanding that the brain can rewire itself to compensate for damage. These observations laid the foundation for contemporary neurorehabilitation strategies.
6. **Penfield's homunculus:**
    - Canadian neurosurgeon Wilder Penfield's work on the cortical homunculus, a map of the body's representation in the brain, demonstrated that brain regions associated with specific body parts could adapt and reorganize following injury or surgical intervention. This work highlighted the plasticity of somatosensory and motor representations in the brain.

These early theories and observations paved the way for further research into neuroplasticity, including the exploration of synaptic plasticity, dendritic spine remodeling, and the molecular mechanisms that underlie adaptive changes in the brain. Contemporary neuroscience continues to build upon these early insights, leading to a deeper understanding of how neuroplasticity shapes cognition, behavior, and recovery from neurological condition [10,11].

Limitations of neuroplasticity

While neuroplasticity is a fascinating and essential concept in neuroscience, it also has its limitations and constraints. Understanding these limitations is crucial for appreciating the complexities of brain plasticity and its implications. Here are some key limitations of neuroplasticity:

1. **Age-related changes:**
    - One of the most significant limitations of neuroplasticity is that it tends to decline with age. While the brain retains some degree of plasticity throughout life, there are critical periods of heightened plasticity during development. As individuals age, the capacity for rapid learning and structural changes in the brain becomes more limited.

2. **Recovery after severe brain damage:**
    - While the brain can adapt and reorganize to some extent after brain injuries, the extent of recovery depends on various factors, including the type and severity of the injury. Severe and extensive brain damage may limit the brain's ability to compensate fully, leading to persistent deficits.
3. **Genetic constraints:**
    - Genetic factors can influence an individual's baseline level of neuroplasticity. Some people may have a genetic predisposition that makes it easier for them to learn new skills or recover from injuries, while others may face greater challenges in this regard.
4. **Neurological conditions:**
    - Certain neurological conditions, such as neurodegenerative diseases like Alzheimer's and Parkinson's, can impair neuroplasticity. The progressive loss of neurons and synaptic dysfunction in these conditions can limit the brain's ability to adapt and compensate for damage.
5. **diminished plasticity in specific brain areas:**
    - Not all brain regions exhibit the same degree of plasticity. Some areas, like the primary sensory and motor cortices, are more adaptable, while others, like the prefrontal cortex, are less plastic. The extent of plasticity can vary depending on the specific brain region.
6. **Stability of established neural circuits:**
    - Once neural circuits have been established during development and reinforced through learning, they can become relatively stable and resistant to change. This stability is essential for maintaining essential functions and knowledge but can make it challenging to modify established habits or behaviors.
7. **Maladaptive plasticity:**
    - In some cases, neuroplasticity can lead to maladaptive changes in the brain. For example, chronic pain conditions can involve the strengthening of neural pathways associated with pain, leading to persistent pain sensations even after the initial injury has healed.
8. **Ethical and safety considerations:**
    - Manipulating neuroplasticity for cognitive enhancement or therapeutic

purposes raises ethical and safety concerns. Interventions designed to enhance plasticity may have unintended consequences, and long-term effects may not be fully understood.

9. **Individual variability:**
    - There is considerable variability among individuals in terms of their capacity for neuroplasticity. What works for one person may not work as effectively for another, and responses to interventions or therapies can vary widely.

Understanding these limitations underscores the importance of conducting research and interventions in a thoughtful and evidence-based manner. While neuroplasticity offers considerable promise for rehabilitation, learning, and recovery, it is not a panacea and has constraints that need to be considered when exploring its potential applications [12].

Conclusion:

In conclusion, neuroplasticity stands as a captivating testament to the brain's remarkable ability to adapt, rewire, and redefine itself throughout an individual's life. This dynamic process challenges the traditional notion of the brain as a static organ, revealing its innate capacity for change in response to experiences, learning, and environmental influences. The principles of neuroplasticity, encompassing synaptic plasticity, structural adaptations, and even adult neurogenesis, have revolutionized our understanding of brain function and have profound implications across various domains. From the optimization of learning and memory to the rehabilitation of individuals with brain injuries, neuroplasticity offers a myriad of practical benefits. It allows us to harness the brain's inherent adaptability for cognitive enhancement, recovery from neurological conditions, and the development of innovative therapeutic interventions. Moreover, it underscores the importance of lifelong learning, physical activity, and mental engagement in maintaining brain health and cognitive resilience.

Nonetheless, neuroplasticity is not without its limitations, such as age-related declines in plasticity and the challenges of recovery from severe brain injuries. These limitations emphasize the need for a nuanced approach when applying neuroplasticity-based interventions and therapies. As neuroscience continues to advance, our comprehension of the intricacies of neuroplasticity deepens, opening new avenues for research and practical applications. The study of neuroplasticity not only sheds light on the brain's extraordinary adaptability but also reinforces the notion that the human brain, with all its complexities and potentials, remains one of the most fascinating frontiers of scientific

exploration. In embracing this evolving understanding, we embark on a journey of unlocking the brain's mysteries and harnessing its incredible capacity to adapt, learn, and thrive.

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CHARACTERIZATION OF BIOACTIVE COMPOUNDS AND ANTIMICROBIAL EFICACY IN *ELEPHANTOPUS SCABER* L.

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Abstract:

The *Elephantopus scaber* L. plant has a long history of use in human and animal medicine. Research work indicated that *E. scaber* extracts have antibacterial capabilities and identified their chemical components by cutting-edge technologies like HPLC and LC/MS-MS. Antibacterial activities were determined using disc diffusion. Extracts inhibited *Escherichia coli, Pseudomonas aeruginosa, Bacillus subtilis* and *Staphylococcus aureus* to varied degrees. Most of the compounds discovered in leaf, shoot, and root are phenolic derivatives and flavonoids. Leaf HPLC fingerprint exhibited 6 primary peaks, whereas shoot and root each showed 5 peaks. Since several chemical components have been extracted from leaves, shoots, and roots of *E. scaber*, these substances may have medicinal benefits for many ailments. Based on this study, leaves, branches, and roots may be considered as a source of natural antibacterial agents.

Keywords: *Elephantopus scaber* L., LC/MS-MS, HPLC, Antimicrobial activity

Introduction:

The studies claim that a substantial body of research has conclusively shown that phenolic compounds in plants are the primary antioxidant contributors in plant extracts. These compounds have several biological roles, including antimicrobial, anti-diabetic, and anti-inflammatory properties. Over 6 billion individuals, or 80–85 percent of the global population, utilize herbal medicine to cure different disorders. Over 80% of the population continues to utilize herbal remedies to treat a range of ailments. Approximately 35,000 to 70,000 plant species have been examined for possible bioactive compounds[1].

Herbal remedies are the most common, although animal and mineral resources have also been used. Ayurveda is an ancient Indian medical system dating back more than 5,000 years. Around 8000 plant species are used in traditional medicine in India, and around 25,000 effective plant-based medicines are utilized by rural and ethnic populations[2]. Unani is a blend of the ancient medical systems of Egypt, Syria, Iran, Iraq, China, India, and other east Asian nations. In the majority of developing countries, medicinal and aromatic plants serve as the core of traditional healthcare systems.

Opium derived from the *Papaver somniferum* plant, tobacco-derived from the *Micotia tabacum* plant, cocaine derived from the Erthroxylon plant, and other plant chemicals are extensively used as drugs. For several reasons, the conservation and sustainable usage of medicinal plants have gained significance. There are a variety of approaches and techniques that may be used to support the conservation and use of these plants. The Wayanadi Kalanadi tribe has not been included on the authorized list of scheduled tribes. They belong to the predominant Malayan caste in other regions of Kerala[3]. However, their cultural practices vary from those of the Malay. Biodiversity conservation could be aided by well-planned bioprospecting and non-destructive commercialization. Using herbs and plants found in their woods, they are also masters in the treatment of cattle and veterinary care. The Himalayas is home to the highest amount of native fossils, including 3,169 Dicotyledons. There are similarities between the summit vegetation of India's Nilgiri, Palni, and Cardamom hills and that of Ceylon's Adam's Peak. Comparing the projected distribution of endemic plants to their actual distribution demonstrates a considerable shift and narrowing of the distribution spectrum[4].

Biodiversity refers to the various plant and animal species that exist on Earth. The Western Ghats, also known as the undulating hills or Sahyadri, span around 16000 kilometers from Mumbai to Kanyakumari, the southernmost point of India. The region's woods and hills include over 700 species of medicinal plants, many of which are used in alternative and complementary medicine. Antioxidants are contained in several foods and are naturally created by the body. Antioxidants may neutralize or inactivate free radicals, preventing them from causing cellular harm [5-7].

There is a worldwide trend to use the natural compounds contained in medicinal and food plants as therapeutic antioxidants since many diseases have similar risk factors. Antioxidants are an important class of compounds to biochemists and pharmaceutical businesses. They are renowned for their capacity to mitigate the harm caused by reactive

species including oxygen, nitrogen, and even chlorine. It is essential for free radical innovation in a broad range of diseases, which adds to a fresh approach to healthcare systems. Ethyl gallate, for example, had the ability to increase antibiotic potency in methicillin-resistant strains of Staphylococcus aureus, which interacted synergistically with the alkyl gallates on the B- lactam[8].

Recent growth in plant-based medical knowledge is restricted to just the most widely utilized traditional treatments. Using both physical and physiological techniques, it is still necessary to explore the medical effectiveness of several other plants with unknown potential[9-10]. To ensure that the therapy is successful while causing as few side effects as possible, it is necessary to study the drug's therapeutic potential and conduct toxicity testing. In India, several plant species have been recognized as having the potential to be exploited as a source of medicine. Soxhlet extraction, often known as solid-liquid extraction, is a sample preparation technique involving leaching or lixiviation. This method is used to separate the individual compounds from a combination of high molecular weight fractions and inhibitory components that may block further extraction. Hence present work focused on the identification of bioactive compounds and checking the antibacterial capabilities of *Elephantopus scaber* L. [11-12].

Materials and Methods:

Study area

The Wayanad Plateau is located inside the Western Ghats area of Kerala in northern India which covers around 3000km^2. Idukki and Pathanamthitta are the districts with the most forest cover. There are 28 varieties of vegetation in the state, however, the existence of the majority is questionable. In 1983, the state government prohibited the clear-cutting of natural forests. Wayanad District has three Forest Divisions: North Forest, South Forest, and Wayanad Wildlife division. The district is classified into three taluks mainly Sultan Bathery taluk, Vythiri taluk, and Manandavady taluk. Sulthanbathery Taluk has 336. 30 square kilometers of forest land, followed by Mananthavady Taluk with 299. 90 square kilometers[13]. Sulthan Bathery taluk is situated in Kerala's Wayanad district (Fig. 1). Its elevation ranges from 700 to 2100 meters above sea level. The average maximum and lowest temperatures were 29^0 C and 18^0 C, respectively. Kerala, the southernmost state of India, is renowned for its natural reserve, cultural diversity, and high rate of literacy. The western Ghats Forest is populated by five major ethnic groups (tribes): Kurichia, Kuruma, Kattunaika, Adiyan, and Paniya. Based on their indigenous knowledge, these tribes use a

variety of medicinal plants for primary healthcare and other applications. Current research on the tribe's traditional knowledge of medicinal plant applications in Wayanad's forest promotes sustainable use and development[6, 7, 14]. The kalanaadi tribes mostly resided in the pulpally regions. The primary research is carried out in Pulpally, which is located inside Sulthan Bathery thaluk next to the Madaparampu road and located between 11°45'53. 9"N and 76°09'15. 9"E.

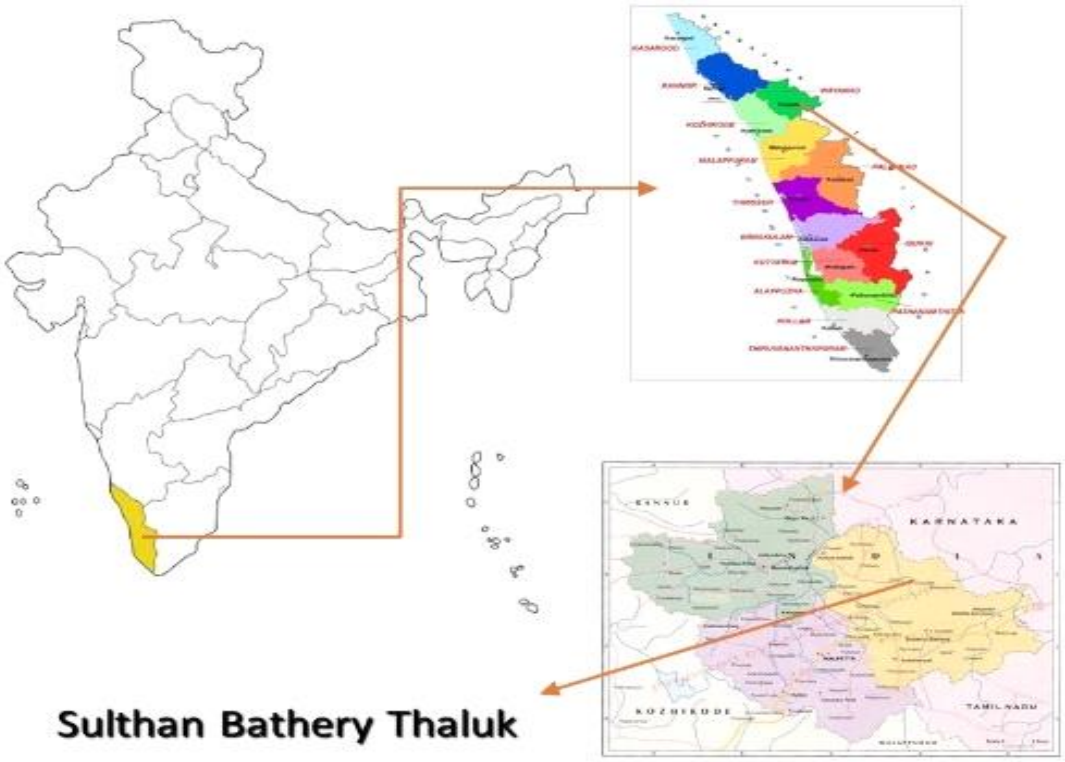

Figure 1: Location map of the study area

Survey of traditional knowledge

In the Western Ghats in Wayanad district, Sulthan Bathery thaluk, a systematic survey is conducted, and preliminary data was acquired in the designated locations of the Western Ghats. Approximately twenty-two locations where the majority of endemic species are expected to be found, including Parakkadavu, Vandikadave, Madappallykunnu, Seethamount, Perikkalloor, Padichira, Kalandykolly, Padichira, Thannitheruv, Sasimala, Channothukolly, Chekadi, Padiri, Pakkam, Dasanakkara, Kurichipatta.

Identification and other details including local and scientific names, availability and distribution areas, and other characteristics, were determined through questionary method with elder tribal members, local herbal practitioners, botanists, and senior forest staff. Also the information has been collected from local secondary database. The geological

distribution of indigenous plant species was identified by using GPS in the Western Ghats of the Sulthanbathery area is conducted[15-16].

Traditional knowledge of endemic plant species for medicinal use and local healing characteristics were gathered through the survey via interview with the elder local people and herbal practitioners. The accessible hierarchy of commercially significant herbaceous species and their degree of vulnerability were investigated through a field study and data collected from the forest department. During each visit to the research area, the occurrence and frequency of occupancy and distribution were meticulously examined, and specific species were photographed.

Among the idigeneous plant species, *Elephantopus scaber* L. was chosen for pharmacological effectiveness testing and the identification of their component bioactive principle due to their significant character. *E. scaber* L. is a member of *Asteraceae* family. The whole plant of *E.* scaber L. is a perennial herb and is well known as a Chinese folk medicine which is widely used in the treatment of nephritis, edema, dampness, pain in the chest, fever and cough of pneumonia, scabies, and arthralgia due to wounding [17-18]. The plant *E. scaber* L. along with its roots were collected was collected from the Pulpally village region, Wayanad district during the month of November, December, and January. The collected plants were situated in the clean place and devoid of any contamination and infestation. The fresh whole plant was visually inspected for foreign matter and sorted. It was then made into fine powder by a grinder machine and sieved through the mesh. Further Methanol extraction of *E. scaber* leaf (20 gm) done by distillation process using a Soxhlet extractor for 24 hours. The extracted methanol was filtered and introduced to rotary evaporator for solvent evaporation. The 10ml of remaining solvent was transferred to petri dish and dried at room temperature.

Evaluation of antimicrobial activity

The antibacterial activity against *E. scaber* was evaluated using the disc diffusion assay technique. The nutrient agar solution was inoculated with 1 x 103 CFU/mL of bacterial cells from cultures that had been produced overnight. The extract was injected into a sterile 6-mm-diameter disc and solvent used to dissolve the plant extracts. Further the plates were incubated for 24 hours at 37°C before determining the inhibition zone. The test was then repeated in triplicate.

HPLC analysis

The HPLC analysis was carried out by using, a Shimadzu LC-10AD VP system. Phosphoric acid was used as a solvent for the whole of the samples during the course of the analysis. The flow rate was set at 1 mL per minute, and the injection volume was determined to be 10 µL. At 280 nm, the absorbance spectrum was measured, and then obtained values were compared to the data standard[19].

LC/MS-MS analysis

The LC/MS-MS analysis was performed using a Shimadzu LC/MS-MS (Shimadzu) instrument in the range of 50-520 m/z and an Electrospray ionization (ESI) was operated in both negative and positive mode. To strengthen the LC/MS-MS apparatus, a UV detector, autosampler, and HPLC pump were added to it. The ion spray voltage was -4200. 0, and the flow rate was 1 mL/min.

Result and Discussion:

Extractions of *Elephantopus scaber* L., was employed in this research, containing increased amounts of phenolics, flavonoids, tannins, and other phytochemicals with important medicinal benefits. The extracts differently inhibit Gram-positive bacteria and Gram-negative bacteria. Cutting-edge technologies such as HPLC and LC/MS-MS evidenced the presence of phytochemicals.

Antimicrobial disc diffusion technique

The disc diffusion method was used to examine the leaf extract of *E. scaber* L. for antibacterial activity. The microbial strains such as *Escherichia coli, Pseudomonas aeruginosa, Bacillus subtilis*, and *Staphylococcus aureus* (Table 1) used for analysis. Extracts showed greater zone of inhibition at 10 µg/mL and 20 µg/mL compare to penicillin (Fig. 2 and 3). The experiment reveled that at 20 µg/mL, the zone of inhibition against *Escherichia coli, Pseudomonas aeruginosa, Bacillus subtilis* and *Staphylococcus aureus* were observed 2. 9 ± 0. 03, 3±0. 02 for, 2. 9 ± 0. 02 for, and 3. 2 ± 0. 03 respectively. The greater evidence of zone of inhibition was observed at 20 µg/mL than at 10 µg/mL [20] for all microbial strains similarly the shoot and root was shows wider inhibition zone than penicillin (Table 1).

Table 1: Antimicrobial activity of *Elephantopus scaber* L. against *E. coli*, *P. aeruginosa*, *B. subtilis*, and *S. aureus*

Zone of inhibition (in cm)				
Target	**10 µg/mL**	**20 µg/mL**	**Standard**	**Negative control**
Elephantopusscaber L. (leaf)				
E. coli	2. 4 ±0. 02	2. 9 ±0. 03	2. 1 ± 0. 02	NI
P. aeruginosa	2. 8 ± 0. 01	3 ± 0. 02	2. 2 ± 0. 03	NI
B. subtilis	2. 6 ± 0. 03	2. 9 ± 0. 02	2. 6 ± 0. 02	NI
S. aureus	2. 5 ±0. 04	3. 2 ± 0. 03	2. 8 ± 0. 01	NI
***Elephantopus scaber L.* (shoot and root)**				
E. coli	2. 6 ± 0. 03	3. 1 ± 0. 02	2. 5 ± 0. 04	NI
P. aeruginosa	2. 2 ±0. 02	2. 8 ± 0. 02	2. 5 ± 0. 02	NI
B. subtilis	2. 7 ± 0. 04	3 ± 0. 01	2. 2 ± 0. 03	NI
S. aureus	2. 5 ± 0. 02	2. 9 ± 0. 03	2. 1 ± 0. 02	NI
±: represents the standard error; NI: lack of inhibition; Standard: 10 µg Penicillin; Negative control: saline solution; Values are triplicates of means.				

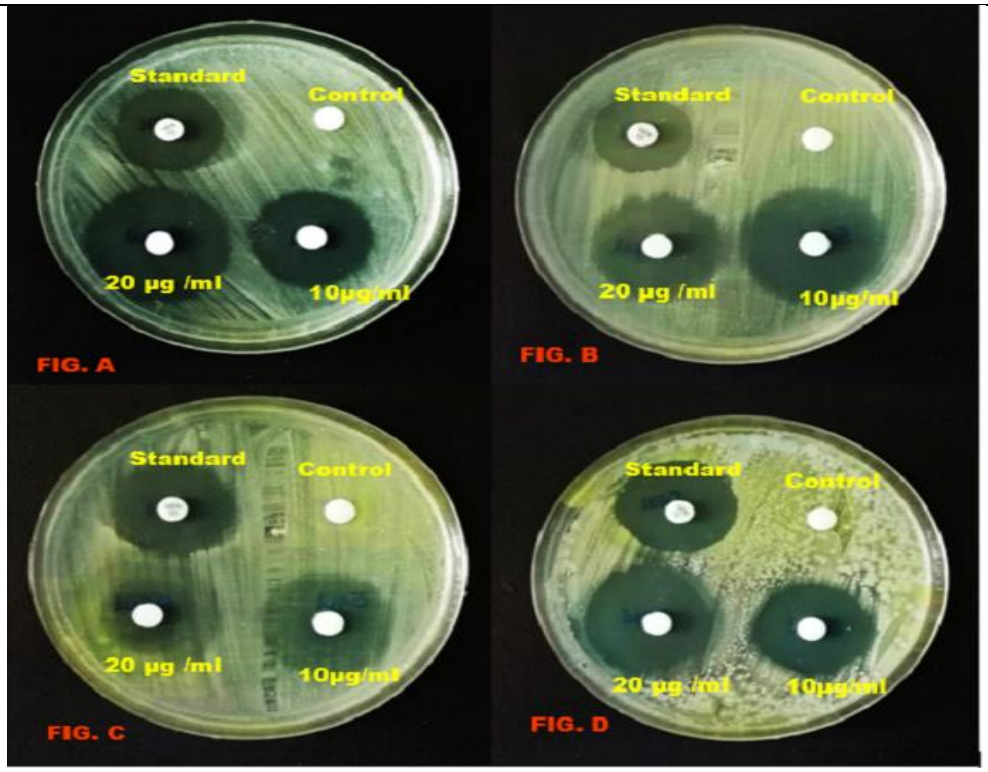

Figure 2: Antimicrobial activity of *Elephantopus scaber L.* leaf against A. *E. coli*, B. *P. aeruginosa*, C. *B. subtilis*, and D. *S. aureus*

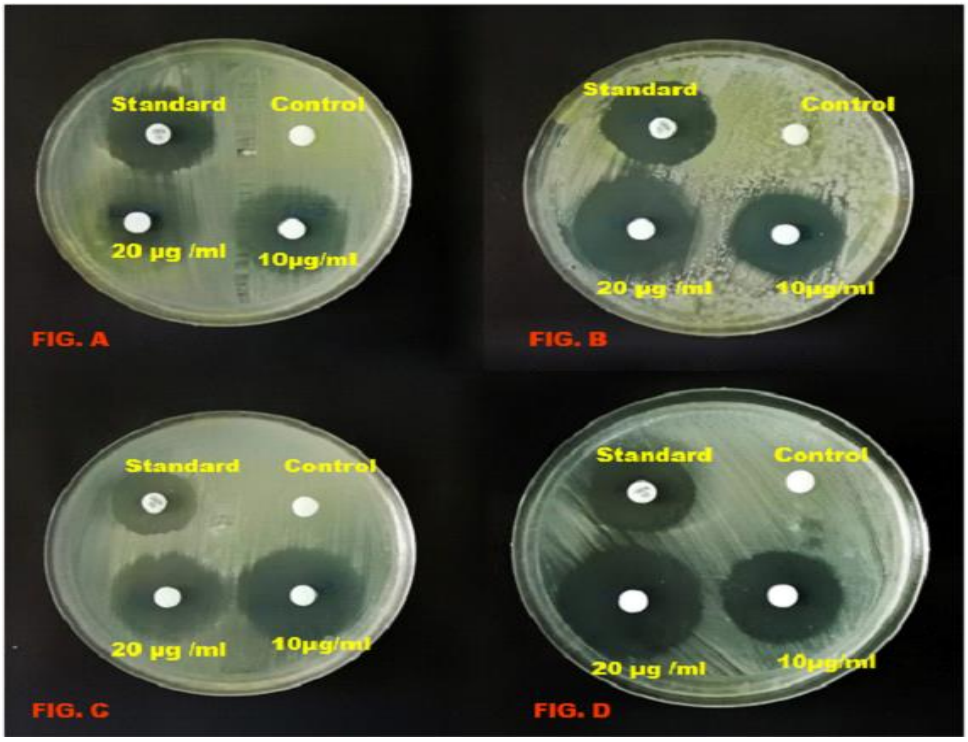

Figure 3: Antimicrobial activity of *Elephantopus scaber L.* shoot and root against A. *E. coli*, B. *P. aeruginosa,* C. *B. subtilis* and D. *S. aureus*

LC/MS-MS analysis

Leaf:

The mass spectrum of leaf extract was evidenced the presence of phytochemicals at the peaks 136. 2, 240. 1,362. 4,104. 3,341. 2,104. 3,316. 3m/z values (Fig. 5) which correspond to 4-OH-Benzoic Acid (Phenolic derivative), β-Carboline-1-Propionic Acid (Alkaloid), 11-Dehydroklaineanone (Alkaloid), diethylenetriamine (Acid), Ononin (flavonoid), protonated diethylenetriamine (Ethylenediamine), and Laurycolactone B (flavonoids) respectively[19].

Root and Shoot:

The LC/MS-MS of *E. scaber* is illustrated in Fig. 6. The resultant peaks identified were 513. 5, 409. 4, 423. 5, 509. 5, 466. 5, 388. 0 m/z values which correspond to cycloastragenol (astragaloside), Eurycomanone (flavonoids), 13α(21)-Epoxyeurycomanone(flavonoids),12,15-Diacetyl-13α(21)-epoxy-eurycomanone (flavonoids), 15-Acetyl-13α (21)-Epoxyeurycomanone (flavonoids), 2-Hydroxy-3,2',6'-trimethoxy-4-(2,3-epoxy-1-hydroxypropyl)-5-(3-hydroxy-1-propenyl)-biphenyl (phenol) of the phytochemicals identified fall under flavonoids, and phenolic derivative from the shoot and root extracts of *E. scaber.*

HPLC analysis

The HPLC fingerprinting and qualitative analysis for leaf extract of *E. scaber* L. was done (Fig. 4). A total of 5 major peaks were extracted from the HPLC analysis with prominent retention factor. Peaks 1 and 2 were two major peaks with R_t values of 3. 02 and 3. 28 which corresponds to amlodipine Besylate and Aspirin. Peak 3 has an R_t value of 3. 31 which corresponds to Indomethacin. Peak 4 has an R_t value of 3. 42 which corresponds to Valsartan. Peak 5 has an R_t value of 6. 53 which corresponds to triprolidine and peak 6 has an R_t value of 6. 58 which corresponds to the Curcumin[22-24].

Similarly the HPLC fingerprinting and qualitative analysis for shoot and root of *E. scaber* L. (Fig. 5). A total of 5 major peaks were extracted from prominent retention factor. Peaks 3 and 5 were two major peaks with R_t values of 3. 48 and 5. 3 which corresponds to diynoic acid and tetraenoic acid, respectively. Peak 1 and 2 having R_t values of 2. 59 and 2. 93 corresponds to the presence of hydroxyphenylethylamide and decatrienamide respectively. Similarly peak 4 has R_t value of 6. 53 which corresponds to pellitorine [25]. Chemical composition of extract for phytochemical were represented in Table 3 and 4.

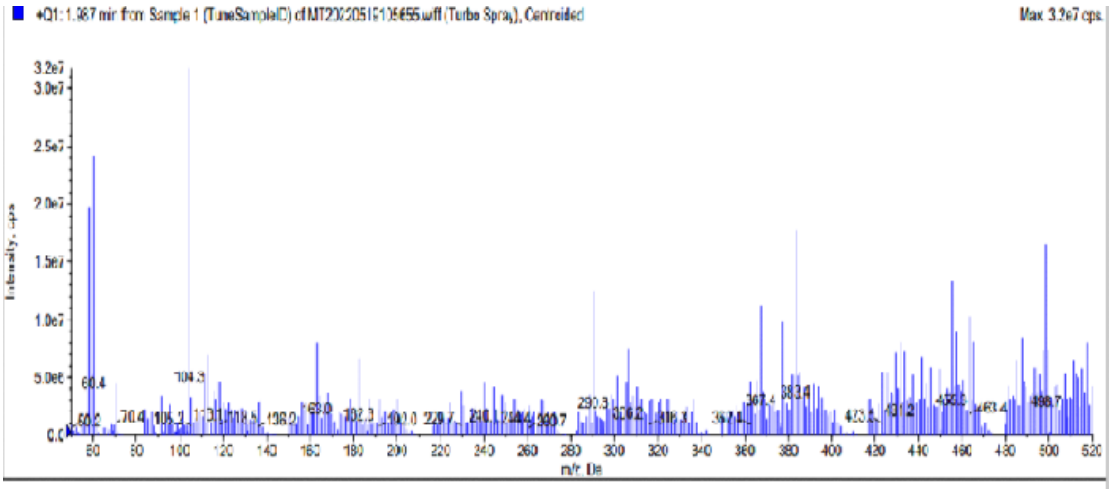

Figure 4: LC/MS-MS analysis in leaf of *Elephantopus scaber* L.

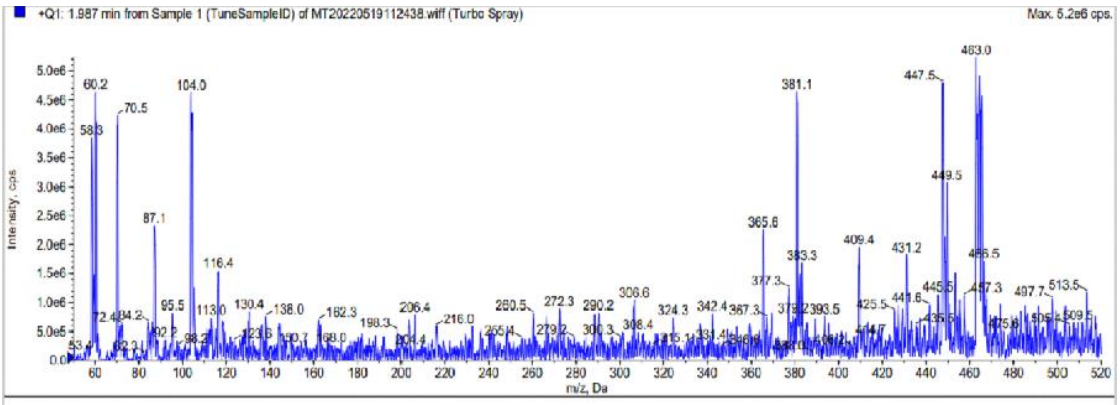

Figure 5: LC/MS-MS analysis in root and shoot of *Elephantopus scaber* L.

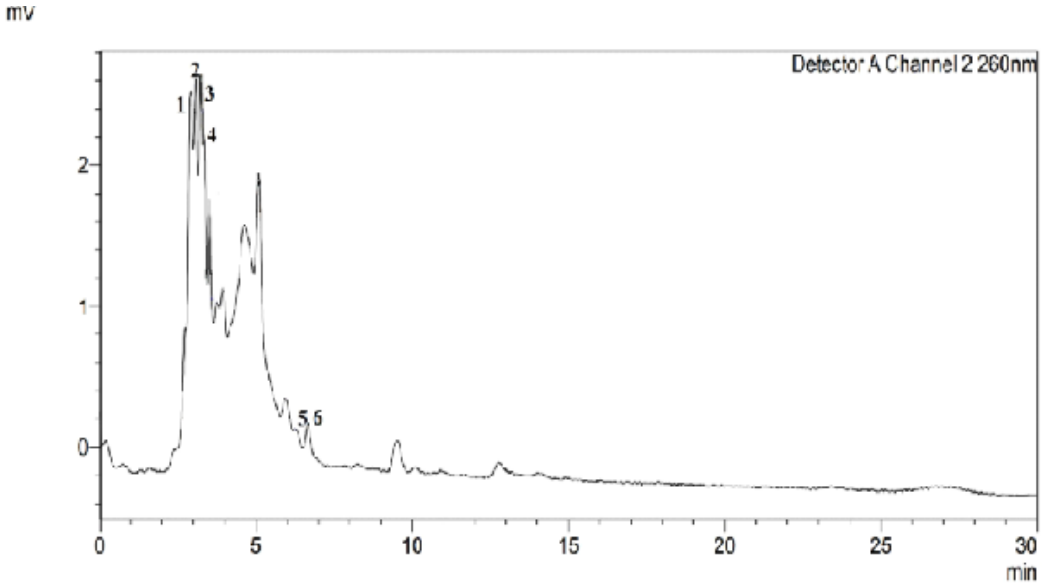

Figure 6: HPLC of *Elephantopus scaber* L. leaf

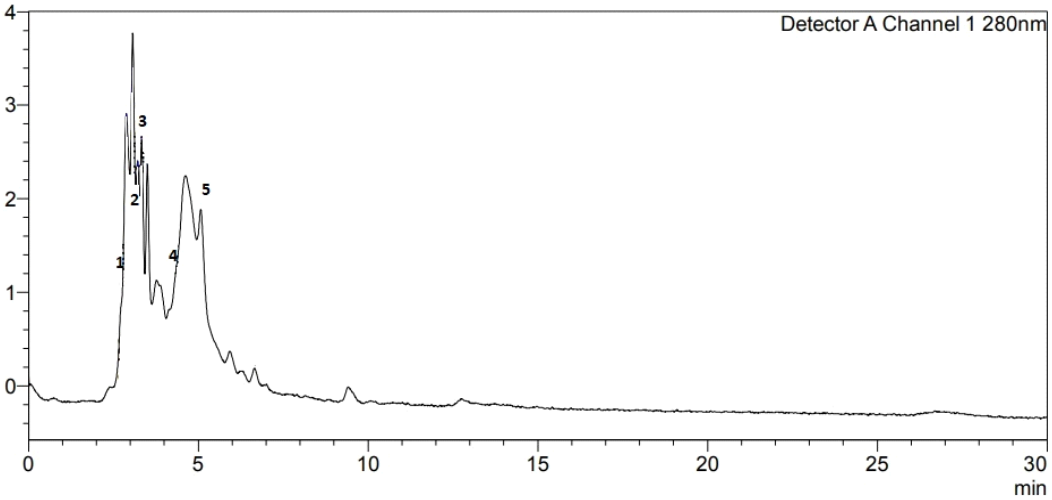

Figure 7: HPLC of *Elephantopus scaber* L. shoot and root

Table 2: Chemical composition in leaf of *Elephantopus scaber* L.

***Elephantopus scaber* L.**			
Peak no.	**Compound**	**Area**	**Retention time**
1	Amlodipine besylate	31839	3. 02
2	Aspirin	16532	3. 28
3	Indomethacin	19626	3. 31
4	Valsartan	20596	3. 42
5	Triprolidine	2866	6. 53
6	Curcuminand	2253	6. 58

Table 4: Chemical composition of *Elephantopus scaber* L. shoot and root

***Elephantopus scaber* L.**			
Peak no.	**Compound**	**Area**	**Retention time**
1	hydroxyphenylethylamide	2150	2. 59
2	decatrienamide	40739	2. 93
3	*diynoic acid*	20596	3. 48
4	pellitorine	27781	3. 76
5	*tetraenoic* acid	42939	5. 3

Conclusion:

This exceptional antibacterial effect is mostly due to the presence of a significant number of alkaloids and flavonoids in methanol extracts of the leaves of *Elephantopus scaber* L. It was noted that *Elephantopus scaber* L choosen among the 150 distinct medicinal plants from the study area. which one was chosen for pharmacological effectiveness testing and the identification of their component bioactive principle utilizing preliminary screening showed promising good antibacterial properties. The role traditional knowledge of local people significantly considers for scientific explores new medicine.

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TECHNOLOGY TRENDS IN FOOD PACKAGING

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Abstract:

It is crucial for businesses to look into ways to increase productivity in terms of ensuring safety, using recyclable packaging materials, applying flexible and defined technology, and adopting tried-and-true principles of leadership in today's world of global markets, fierce competition in every product, and rising consumer demand. The state-of-the-art in the food packaging and processing industry is examined in this chapter in light of recent developments in the fields of (i) smart packaging and materials, such as the application of nanotechnology and information technology; (ii) controls and automation technology, requirements, and their application scenarios; and (iii) manufacturing control rules and their improvements for the food industry. The aforementioned and related topics are thoroughly reviewed and provided in the correct order. From the review of the literature, it is evident that although scientists have concentrated on particular extraction, packaging, and manufacturing components, a broader approach to system analysis is required in order to fully grasp the extent of all processes. We conclude that it is critical to look into the reasons why the applications of these developments in practice appear to lag behind related field studies.

Keywords: *Packaging, Materials, Technology, Industry*

Introduction:

In today’s world of global markets and stiff competition in every product, it becomes necessary for companies to explore ways to improve their productivity in terms of maintaining safety, using sustainable materials in packaging, implementing flexible and standardized technology, and adopting proven management principles [1]. Towards this end, companies have been striving to improve the efficiencies of their operations through improvements in the processes. Reducing wastes and shortening lead times becomes even more imperative in the food industry due to the perishable nature of the product. Moreover, recent advances in technology such as Radio Frequency Identification (RFID) and nanomaterials afford companies greater opportunities to streamline the processing,

packaging, and manufacturing schemes [2]. Visualizing the above, this paper presents a comprehensive review of processing, packaging and manufacturing aspects of food industry. There are many similarities between the food processing and packaging industry and the traditional manufacturing industry. Hence, manufacturing concepts like lean principles, production systems and mass customization principles can easily be applied to the food industry as well. Even though researchers have focused on applying these techniques to the food industry, there seems to be a gap between research and its implementation in the industry [3]. Make a case for continued collaboration between academic and industry in order to bridge the yawning gap between research in the field of food processing technologies and its implementation in the industry. In this work, we look into the trends as well as the state-of-the-art in food processing and packaging industry with emphasis on the materials, machines and methods used in the industry that provide companies with a competitive edge in the marketplace. The paper has three parts. In the first part, we present the essence of the smart packaging and show how the associated materials play major role in this respect. The next section deals with the trends in automation and control schemes along with usage of latest technology. The final section reviews the proven principles of productivity-oriented management strategies and the relevant work of the researchers in relation to food industry.

Processing and packaging

Processing and packaging are the two important phases of operations in the food industry. Processing also includes pre-processing and cleaning which sometimes is referred to as post harvesting processes. The final phase is the packaging stage. A great deal of automation strategies are constantly being utilized in every phase of processing and packaging. Traditional processing principles are based on thermal processing where the combination of temperature and time plays a significant role in eliminating the desired number of microorganisms from the food product without compromising its quality. Optimization of thermal techniques (e. g. aseptic processing and osmic and air impingement heating) is a measure of effectiveness and efficiency. Non-thermal processing methods such as PEF (Pulsed Electric Field), UV (Ultraviolet), and Ozone yield products with more ‘fresh-like’ flavour than those produced by traditional thermal processes due to fewer chemical and physical changes although they are not completely effective in reducing the activity of bacterial spores. Since there is an abundance of literature dealing with the

above scientific techniques and methods, we prefer to concentrate on trends in packaging and materials [4].

Biodegradable material for packaging

There is an increasing demand for identifying biodegradable packaging materials and finding innovative methods to make plastic degradable. Biodegradation is the process by which carbon-containing chemical compounds are decomposed in the presence of enzymes secreted by living organisms. The use of bioplastic is to replicate the life cycle of biomass by conserving the fossil fuels, carbon dioxide and water production. There are three requirements for the fast degradation process viz. temperature, humidity and type of microbes. The global market for biodegradable polymers exceeds 114 million pounds and is expected to rise at an average annual growth rate (AAGR) of 12. 6% to 206 million pounds in 2010 [5]. Acceptable bioplastics are listed below (Chandra and Rustgi, 1998; Griffin and Turner, 1978; James, Fitzpatrick, Lewis, and Sonneveld, 2005; Jamshiddi, Hyon, and Ikada, 1988; Park, Lim, Shin, and Choi, 2001; Plastics Task Force, 2008).

Cellulose:

Cellulose is isolated from its crystalline state in micro fibrils by chemical extraction. It is fusible and soluble in hydrogen bond-breaking solvents such as N-methylmorpholine-N-oxide. Because of its infusibility and insolubility to others, its derivatives can also be used to make it more processable. This property is exploited for packaging applications.

Starch:

Starch normally consists of a mixture of 20 to 30% amylose and 70 to 80% amylopectin. Biodegradation of starch-based polymers is due to enzymatic attack at the glycosidic linkages between the sugar groups, leading to a reduction in chain length and splitting out of lower molecular weight sugar units. As regards to its application in biodegradable plastics, it is either physically mixed with its native granules or melted and blended on a molecular level with the appropriate polymer.

Poly-beta-hydroxyalkanoates (PHB):

PHB, a member of poly hydroxyl alkanoates, degrades under the presence of various microorganisms, which upon contact with the polymer secrete enzymes that break the polymer into smaller parts. The three most unique properties of PHB are (i) 100% resistance to water, (ii) 100% biodegradability, (iii) thermoplastic process ability.

Polylactide Acid (PLA) plastics:

PLA is emerging as one of the most attractive packing material because of its excellent biodegradability, process ability, and biocompatibility. Injection molding, blow molding, thermoforming, and extrusion process PLA, a thermoplastic. Its degradation is dependent on time, temperature, low molecular weight impurities, and catalyst concentration. PLA films have better ultraviolet light barrier properties than low density polyethylene (LDPE). It has lower melting and glass transition temperatures. PLA is mainly composed of lactic acid (2-hydroxy prop ionic acid) and contains pendent methyl group on the alpha carbon atom which gives rise to a specific structures. This in turn increases the molecular weight and when sufficiently high it becomes insoluble in water [6].

Smart packaging

A package can be made smart through its functional attributes that add benefits to the food and hence the consumers. It is essentially an integrating method that deals with mechanical, chemical, electrical and/or electronically-driven functions that enhance the usability or effectiveness of the food products in a proven way. Some of the aspects of smart packaging are time-temperature food quality labels, usage of self-heating or self-cooling containers with electronic displays indicating use-by dates and information regarding the nutritional qualities and origin of the product in numerous languages. Here are some examples (i) self-cooling beer using zeolite-technology makes it possible to drink cool beer anywhere, (ii) self-heating coffee container based on the CaO exothermic reaction is becoming available, (iii) packaging using electronics technology and Li battery power sources that enhances the branding citation in a crowded consumer product category is an influencing feature. Another consideration that works for smart packaging is based on changing some characteristics of the materials coated inside the package. Above and all, a conventional package can be made smart by an RFID (Radio Frequency Identification) tag. The functionality is electronic and the major beneficiaries are the stakeholders along the entire supply chain [7].

Trends in productivity oriented management systems

Larger industries are vulnerable to volatile management strategy. Advanced management principles such as lean principles, packaging execution systems (PES), supply chain management, mass customization, etc., have a significant role to play in the food industry. Execution of these principles can yield significant rewards in terms of reducing

costs and increasing the overall efficiency of the system. The following section deals with the attributes as regards to improvements in production management strategies [8].

Lean principles

The food and beverage industries are facing increased regulations from FDA (2009) and USDA (2009) vis-a-vis quality control and traceability. The compliance to these regulations, which in many cases result in increased costs, necessitates process improvements in other areas to reduce costs. The same article and another by report that in many cases, the packaging machinery remains severely under-utilized. This may be attributed to shorter production runs and frequent changeovers [9]. Thus, it becomes imperative to develop more efficient production techniques and increase the overall equipment effectiveness (OEE) in order for companies to be cost effective. Lean principles pioneered by Womack and Jones (1996) [10] have been applied to numerous industries to yield drastic improvements in efficiencies and reductions in costs. The five lean principles highlighted by Womack and Jones (1996) all of which have the same underlying central concept of doing more and more with less and less include, (i) identify value of product/ service to customer, (ii) identify value-stream using Value Stream Mapping, (iii) ensure continuous flow, (iv) ensure customers pull value using Kanban systems, and (v) continuously strive for perfection through kaizen. The activities in any organization can be divided into three main categories viz. value-added activities that contribute to the usefulness of the product/service, necessary non-value-added activities that can be eliminated albeit through significant improvements, and non-necessary non-value-added activities that can be eliminate immediately with little or no effort. Eliminating wastes (muda) and reducing lead times assumes even greater significance in the food processing industry especially due to the perishable nature of the products. There has been increased focus [11] on implementing lean principles in the food processing industry with the aim of staying competitive [12, 13].

Recent developments in packaging execution systems

Applying lean principles to food processing and packaging requires accurate information regarding packaging operations. Packaging Execution System (PES) is a derivative of its parent, Manufacturing Execution System (MES) that is specifically geared towards intuitive goal. PES integrates packaging operations into the organization's overall operations management system for providing a holistic view of the entire organization. Different aspects of the industry fit together in the PES system and the corresponding tools

that enable the integration of the organization's operations. Baliga (1998) explains how the MES system tailored to meet the requirements of packaging and assembly area thus improving traceability and efficiency [14]. Packaging systems are seldom integrated with the existing MES. Cheng, Yang, Kuo, Feng, and Jeng (2000) develop an Equipment Manager system that can be integrated with the existing MES to control packaging machinery [15]. The system also allows for a quantitative analysis of the equipment efficiencies. Ryvita of the British Foods Group (E. F. Scientist, 2008b) implemented a factorywide information reporting system that enables them to track quality issues and compute OEEs for their equipment [16].

Conclusions:

Although extremely comparable to typical manufacturing businesses, the food processing and packaging sector faces its own set of difficulties. Because of the growing influence, these businesses have on the environment and consumer health, they frequently face onerous restrictions. Companies must also cope with items that have a very short shelf life, which makes it essential to work to cut lead times as much as feasible. In this paper, we examined the current technological state of the art in the food processing and packaging sector in light of recent developments in (i) packaging and materials, including applications of nanoscience, (ii) automation and control technology and standards, and (iii) production management principles. The fields mentioned above, their relevant ones were thoroughly reviewed, and organized. It is evident from the aforementioned review of the literature that, despite researchers' attention being drawn to particular elements of the processing and packaging business, a more comprehensive systems analysis of the complete activities is required. Furthermore, it is crucial to look at why the field's research seems to advance more slowly than how these developments are put into practice. In the earlier section, some prospective areas were noted. In order for the food processing and packaging business to gain from the most recent scientific advancements in this area, these issues as well as others must be resolved.

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GREEN ENERGY – CURRENT STATUS AND FUTURE POTENTIALS

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Introduction:

Everything which surrounds us is collectively called as the environment. Environment forms a life supporting system for us, since, it is from the environment that we get food to eat, water to drink and air to breathe and all requirements of day-to-day life. In other words, we can say that the basic needs of human life are fulfilled by the materials available in the nature. These materials are air, water, soil, minerals, coal, petroleum, animals and plants. These stocks of nature which are useful to mankind, are called natural resources. Natural resources can be classified into two categories as Renewable resources and Non –Renewable resources.

1. Renewable resources

These resources are present in unlimited quantity in the nature and having the capacity to get replaced by quick recycling through natural cycles. Oxygen in air is renewable resource because it is replaced by the plants by the process of photosynthesis. Some of other resources are solar radiation water and wind. Renewable energy resources are generated directly from nature for example from the sun, rain, wind, tides and it is possible to generate it over and over whenever it is needed. Renewable energy sources are abundant and are definitely the cleanest energy sources in the earth. The advantages of Renewable energy are that wind, sun, ocean and geothermal energy is abundance and completely free of charge. The renewable energy sources have very low or zero carbon emissions, so they are environmental friendly.

2. Non –Renewable resources

Most energy that is used in the world today is generated from non renewable energy sources. This energy can be re-generated over a short period of time. Natural gas and oils are derived from ancient plants and animals remains or fossils. These remain what we have been left with after millions of years of fluctuation in pressure and temperature non renewable energy resources include oil, coal, natural gas and nuclear energy. The advantage non renewable energy sources are it is ready, cheap and easy to use. The non-

renewable energy sources are that they are finite and will expire sometime in the future. Non renewable energy sources are not environmental friendly and can have serious affect on our health. The stock of these resources is limited in nature. These resources once used cannot be replaced within a reasonable time. Some of non-renewable resources are soil, forest, wild animals, minerals, fossil fuels. If used too rapidly improper ways they cannot be regenerated. Green energy is any energy type that is generated from natural resources, such as sunlight, wind or water. Green energy is important for the environment as it replaces the negative effects of fossil fuels with more environmentally-friendly alternatives. Derived from natural resources, green energy is also often renewable and clean, meaning that they emit no or few greenhouse gases and are often readily available. Even when the full life cycle of a green energy source is taken into consideration, they release far less green house gases than fossil fuels, as well as few or low levels of air pollutants. This is not just good for the planet but is also better for the health of people and animals that have to breathe the air. Green energy can also lead to stable energy prices as these sources are often produced locally and are not as affected by geopolitical crisis, price spikes or supply chain disruptions. The economic benefits also include job creation in building the facilities that often serve the communities where the workers are employed. Renewable energy saw the creation of 11 million jobs worldwide in future, with this number set to grow as we strive to meet targets such as net zero. Due to the local nature of energy production through sources like solar and wind power, the energy infrastructure is more flexible and less dependent on centralised sources that can lead to disruption as well as being less resilient to weather related climate change. Green energy also represents a low cost solution for the energy needs of many parts of the world. This will only improve as costs continue to fall, further increasing the accessibility of green energy, especially in the developing world.

Types of renewable energy resources

The idea of green energy is introduced in November 2006 as a renewable energy standard offer program. That offer was in short called SOP or RESOP. It introduced a 20-year feed-in tariff for hydro, wind, solar, and biomass projects. The Ontario Green Energy Act (GEA), officially the green energy Green Economy Act 2009 was introduced in the Ontario Legislature on February 23, 2009 to expand renewable energy production and encourage energy conservation. The word ‘Green’ makes our mind think about a world

without pollution and Eco friendly. So the Green energy. Reflects the idea about the generation of energy from natural resources.

1. Solar energy
2. Wind energy
3. Hydro energy
4. Tidal energy
5. Geothermal energy
6. Biomass energy

1. Solar energy:

Solar energy is radiant light and heat from the sun that is harnessed using a range of ever-evolving technologies such as solar heating, Photovoltaic's, solar thermal energy, solar architecture, molten salt power plants, and artificial photosynthesis. It is an essential source of renewable energy, and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of a photovoltaic systems, concentrated solar power, and solar water heating to harness the energy. Passive solar techniques include orienting a building to the sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

2. Wind energy:

Wind energy is a form of solar energy. The wind is caused by the uneven heating of the atmosphere by the sun, variations in the earth, surface, and rotation of the earth. Mountains, bodies of water, and vegetation all influence wind flow patterns. Wind energy describes the process by which wind is used to generate electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. A generator can convert mechanical power into electricity. Wind turbines, like windmills, are mounted on a tower to capture the most energy. At100 feet (30 meters) or more aboveground, they can take advantage of the faster and less turbulent wind. Turbines catch the wind's energy with their propeller-like blades. Usually, two or three blades are mounted on a shaft to form a rotor. when the wind blows, a pocket of low-pressure air forms on the downward side of the blade. The low-pressure air pocket then pulls the blade toward it, causing the rotor to turn. This is called lift. The force of the lift is actually much stronger than the wind's force against the front side of the blade, which is called drag. The combination o the front side of the blade,

which is called drag. The combination of lift and drag causes the rotor to spin like a propeller, and the turning shaft spins a generator to make electricity.

3. Hydro energy:

Hydropower can be defined as a source of renewable energy obtained from flowing water, and is one of the most reliable, technically exploitable, and environmentally friendly renewable energy alternatives. Hydroelectric energy is the conversion of hydropower from running water to electricity. If the initial source of energy is water, then it is referred to as hydroelectric power or hydropower. Some hydroelectric power plants are located on rivers, streams, and canals; but for regular, steady, reliable, and sustainable energy generation, water storages behind dams are necessary. Dams store water for later releases to serve irrigation, domestic, and industrial purposes as well as power generation. The reservoir acts much like a battery, storing water to be released as needed. Through hydro energy, electricity can be generated in two ways: one is the "run of river" scheme and the other is significant water storage. Both of these methods require dams. Dam performs two significant tasks for hydroelectric power plant, the first task is that it stores enough amount of water which can be utilized when it does not rain and another one is it allows water to fall from the gates of dams called penstock on turbines. The more the waterfalls the faster turbine will rotate and generate greater energy to generate power. Hydropower is a capital-intensive energy source with low operations and maintenance costs and essentially no fuel costs. Increasing the use of renewable energy sources, including hydropower, is a key strategy to limit the extent of future climate change. The environmental issues that are related to hydropower generation units such as dams, run-of-river, and pumped storage plants, have negligible effects on atmospheric pollution.

4. Tidal energy:

Tidal energy is generated from the Earth's oceanic tides. These tidal waves are the forces that form due to gravitational attraction exerted by celestial bodies. These forces create corresponding motions or currents within the world's oceans. Due to the strong attraction to the oceans, a bulge within the water level is made, causing a short-lived increase in water level. Now due to Earth's rotation, this huge volume of ocean water meets the shallow water adjacent to the shoreline and creates a tide. This natural phenomenon is repetitive and takes place in an unfailing manner, due to the consistent rotation of the moon's orbit around the earth. A tidal generator is required to convert the energy of tidal flows into electricity. The potential of a site for tidal electricity generation is directly

proportional to greater tidal variation and better tidal flow velocities. These together can dramatically increase tidal energy generation. As we know that Earth's tides take place due to the gravitational force of Earth with the Moon and Sun, so tidal energy is practically inexhaustible and classified as a renewable energy resource. The movement of tides causes a loss of energy within the Earth-Moon system.

5. Geothermal Energy:

Geothermal energy is the heat from the Earth. It's clean and sustainable. Resources of geothermal energy range from the shallow ground to hot water and hot rock found a few miles beneath the Earth's surface, and down even deeper to the extremely high temperatures of molten rock called magma. To produce power from geothermal energy, wells are dug a mile deep into underground reservoirs to access the steam and hot water there, which can then be used to drive turbines connected to electricity generators. There are three types of geothermal power plants; dry steam, flash and binary.

6. Biomass Energy:

Biomass is a clean, renewable energy source. Biomass is organic, meaning it is made of material that comes from living organisms, such as plants and animals. The most common biomass materials used for energy are plants, wood, and waste. Biomass contains energy first derived from the sun. Plants absorb the sun's energy through photosynthesis, and convert carbon dioxide and water into nutrients (carbohydrates). The energy from these organisms can be transformed into usable energy through direct and indirect means. Biomass can be burned to create heat (direct), converted into electricity (direct), or processed into biofuel (indirect). The logic behind biomass energy is simple. Trees and plants absorb carbon dioxide from the air, use photosynthesis to isolate the carbon, and then use it to build tree trunks, bark and leaves. But when the plant dies, it rots down and much of the carbon is released back into the atmosphere as carbon dioxide.

Conclusion:

There is no hesitation in saying that people are becoming increasingly conscious of the importance of using renewable sources of energy but still a lot of work needs to be done in this domain. For instance, awareness programs must be started in various regions by local Engineers and Scientists to make people responsive of the importance of alternative energytechnologies. They must also discourage them to use fossil fuels due to their evident demerits to the environment and living beings. Courses on renewable sources must be made compulsory to students at school, college and university levels in order to

make them realize their significance and to increase their knowledge in this sphere. The governments should revise the power policies to cope with the energy crisis and to make full use of renewable energy sources. Innovative solutions must be brought by experts in the field to solve the energy catastrophe. Technology exchange programs must be initiated by developed countries in order to help the developing countries to establish, build and reinforce the renewable energy sector.

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STATUS OF PAG BASED METHODS IN EARLY PREGNANCY DIAGNOSIS IN BOVINES

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Introduction:

Successful pregnancy is the most important factor to ensure an efficient and economically sound beef or dairy operation. In order to reach that end point, reproductive loss must be avoided. Early identification of pregnancy failure is key to determining the most effective management strategies and the ability to predict this loss offers greater opportunity to minimize its impact. Loss of pregnancy may occur at any time between conception and calving; however, some time points are more critical than others. Pregnancy failure affects all cattle; however, high producing dairy cattle are more susceptible to decreased pregnancy rates than dairy heifers and beef cows (Diskin *et al.,* 2011; Pohler *et al.,* 2015a; Pohler *et al.,* 2016a, b). Although fertilization rate in cattle is often greater than 85% (Santos *et al.,* 2004, Diskin and Morris, 2008) there have been reports of differences in fertilization rates in beef and dairy cattle that result in a large amount of reproductive failure (Breuel *et al.,* 1993, Sartori *et al.,* 2002; Santos *et al.,* 2004, 2009); however, the focus of this review will be on post fertilization failure and detection. In addition, fetal losses (>day 45 of gestation) are low at approximately 3% (Inskeep and Dailey, 2005). Thus, reproductive loss during the embryo stage (day 0 to 44) of development is substantial. Early embryonic loss can be classified as loss that occurs before day 28 of gestation. Although the embryonic heartbeat can be detected by this time via real-time ultrasonography, the conceptus does not yet resemble a calf. Causes of early embryonic mortality include lethal genetic mutations, uterine asynchrony, and maternal recognition failure (Ayalon, 1978; Diskin and Morris, 2008). Early embryonic loss is generally accepted to account for 20 to 40% of pregnancy failure (Sreenan and Diskin, 1986; Inskeep and Dailey, 2005; Santos *et al.,* 2004, 2009). During the late embryonic period, through day 44, growth can be characterized by the development of limb buds, eye orbits and the formation of placentomes. Although late embryo mortality accounts for less than 10% of pregnancy loss, it has significant implications for the producer and has been

suggested to cause greater financial burden then early EM (Diskin and Morris, 2008). By day 45, the conceptus takes the true form of a fetus with split hooves, ribs and displays limited movement (Curran *et al.,* 1986). After days 45 to 60 pregnancy loss decreases and is less than 5% through the second and third trimester of pregnancy.

Placenta

Proper placentation is crucial for pregnancy development and ultimately pregnancy success. Active placentation in the cow occurs between day 28 and 40 of gestation (Aires *et al.,* 2014). Bovine placentation involves adhesion between the maternal-caruncle structures and fetal cotyledonary tissues to form placentomes. Superficial interdigitation begins around day 20 in cattle between microvilli of the trophectoderm and uterine epithelium. True placentomes, marked by increased villi length and raised tissue in caruncular endometrium are distinct by days 31 to 33 of gestation. By day 39, placentomes are easily discernable and have long, occasionally branching villi (King *et al.,* 1979). Binucleated trophoblast cells (BNCs) appear in the fetal chorion of ruminants at days 18 to 19 of gestation and comprise 15 to 20% of the trophectoderm throughout pregnancy. Binucleated trophoblast cells migrate to the maternal epithelium from the fetal chorion after maturation but do not penetrate past the basement membrane (King and Atkinson, 1987). Contact between the maternal and fetal interface at the microvilli junction allows migration of BNC's towards the basement membrane to begin (Wooding and Wathes, 1980, Wooding and Burton, 2008). Products of BNC's, including hormones, placental lactogen and pregnancy associated glycoproteins (PAGs), are packaged in secretory granules and enter maternal circulation across the basement membrane (Pohler *et al.,* 2015a).

Pregnancy-Associated Glycoproteins (PAGs)

Pregnancy-associated glycoproteins constitute a family of inactive aspartic proteinases (Xie *et al.,* 1991) comprising 22 genes located on chromosome 29 in the bovine (Telugu *et al.,* 2009) with different patterns of expression throughout pregnancy and produced mainly by the binucleate cells of the placenta (Xie *et al.,* 1991; Green *et al.,* 2000; Patel *et al.,* 2004) but also by the trophectoderm (Xie *et al.,* 1991). Placentation in ruminants is noninvasive and is classified as synepitheliochorial cotyledonary, which describes the fetal-maternal syncytium formed by the fusion of trophoblast binucleate cells and uterine epithelial cells (Wooding, 1992). The giant binucleate cells are large cells containing two nuclei and are the invasive component of the trophoblast representing 15 to 20 % of the total cellular population within the mature placenta. Mature chorionic

binucleate cells at all stages of bovine pregnancy migrate into the uterine epithelium and release the contents of cytosolic granules containing PAG's through exocytosis where they enter the maternal circulation (Wooding and Whates, 1980; Wooding, 1983; Zoli *et al.,* 1992b).

Although PAGs are often thought of to be produced by BNCs, Green et al. (2000) reported that PAGs can be sorted into two separate families based on their expression in trophoblast cells. Some PAGs are expressed in both BNCs and mononucleated trophoblast cells while others are solely produced in BNCs (Green *et al.,* 2000). Although their physiological role is unknown, a large number of distinct PAGs and more than two dozen specific PAG genes have been described. Based on accumulation of PAGs at the junction between uterus and placenta and known proteolytic activity of certain PAGs, it has been hypothesized that PAGs may help process growth factors or may have adhesion actions (Wallace *et al.,* 2015). Based on evidence that PAGs may inhibit certain immune cells, they may also play a role in disguising antigens from the maternal immune system (Perry *et al.,* 2005). After appearance of BNCs and epithelial adhesion of trophoblast, the first sizable increase in

PAG concentration occurs between days 22 to 24 of gestation. Concentrations of PAG continue to increase through day 36, followed by subsequent decrease in concentration until day 60 of pregnancy followed by a steady increase through the second and third trimesters of pregnancy. In the weeks preceding parturition, a substantial increase in circulating concentrations of PAG occurs that peaks at calving. This may be attributed to significant placental growth at the end of gestation or the release of stored PAG from other tissues (Green *et al.,* 2005; Pohler *et al.,* 2013). Eight weeks post parturition, PAGs are not detectable in maternal circulation (Green *et al.,* 2005).

Commercial PAG tests

Currently, three nonpregnancy tests based on detection of PAGs in maternal blood are commercially marketed:

- ✓ BioPRYN - BioTracking, LLC, Moscow, ID http://www. biotracking. com/dairy
- ✓ DG29 - Conception Animal Reproduction Technologies, Beaumont, QC http://www. conception-animal. com/test_an. html
- ✓ IDEXX Bovine Pregnancy Test - IDEXX Laboratories, Inc., Westbrook, ME, http://www. idexx. com/view/xhtml/en_us/livestock-poultry/ruminant/lpd-bovine-pregnancytest. jsf

None of the tests listed above are cow-side or on-farm, so blood samples must be collected by farm personnel and sent by courier to a local or regional laboratory that runs the assay. Results are then returned to the farm via email, usually within 24 to 72 h.

Recently, IDEXX Laboratories (Westbrook, ME) released a milk PAG test marketed through regional DHIA testing centers throughout the United States.

Incorrect negative findings might result from low and varying levels of PAGs among different individuals between the 25th and 32nd days (19). After conception, PAGs can be detected in maternal blood as early as 22 to 24 days after insemination.

Pregnancy diagnosis using milk PAG test

Detection of PAGs in milk samples eliminates the need for drawing blood samples and can be done at the DHIA testing center on the same milk samples sent in for determining milk components and somatic cell score. Because PAGs have a long half-life in circulation after calving, cows must be a minimum of 60 days postcalving for accurate results. In addition, PAGs increase slowly in milk early in gestation, so cows must be ≥28 days post-insemination for the milk PAG test to be accurate. Milk PAGs increased from 25 days after TAI to an early peak 32 days after TAI. Milk PAGs then decreased from 32 days after TAI to a nadir from 46 to 67 days after TAI followed by a gradual increase in PAG levels from 74 to 102 days after TAI.

Conclusion:

Using the PAG based Pregnancy Test, the presence of PAG in milk/ blood plasma can be detected with suitable analytical accuracy for pregnancy detection in dairy herds. The detection of PAG throughout gestation offers great scope for the application of the test through herd recording schemes.

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SEWAGE WATER AS A SOURCE FOR HEAVY METAL CONTAMINATION AND LONG-TERM EFFECT UPON IRRIGATION

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Abstract:

Mankind is currently confronted with one of the greatest challenges in its history: how to adequately use its limited freshwater resources. The challenge implicates the use of water for drinking, agriculture, and the preservation of fragile freshwater ecosystems. The rational use and protection of water resources and supplying human kind with adequate clean fresh water or, to be concise, "water problems" are among today's most acute and complex scientific and technical problems. Under arid and semi-arid environmental conditions, in which sewage water irrigation is a pre-requisite for agricultural development, the importance of effluent as a source of irrigation water is as great as the need for its disposal. Effluent becomes exceptionally valuable where other sources of water are scarce, and its utilization for irrigation frees high quality water for other uses. Irrigation of agricultural crops with sewage wastewater is associated with several non-biological risk factors; perhaps the most significant being heavy metal contamination.

Keywords: Sewage-irrigation-heavy metals-contamination-effect-soil-health

Introduction:

Water availability is expected to decrease in many regions. Yet future global agricultural water consumption alone is estimated to increase by ~20% by 2050 and will be even greater in the absence of any technological progress or policy intervention. Water for irrigation and food production constitutes one of the greatest pressures on freshwater resources. According to UN- Water Statistics, agriculture accounts for ~70% of global freshwater withdrawals (up to 90% in some fast-growing economies).

India supports more than 16% of the world's population with only 4% of the world's fresh water resources (Kaur *et al.,* 2012). The per capita domestic water demand in India is likely to increase from the estimated 31 m^3/person/year in 2000 to about 46 and 62 m^3/person/year by 2025 and 2050, respectively. This increase includes a substantial watersupply coverage increase for both urban and rural areas (Amarasinghe *et al.,* 2007).

Due to increasing population and rapid consumption of water resources, the per capita average annual freshwater availability has been reducing since 1951 from 5177 m^3 to 1869 m^3 in 2001 and 1588 m^3 in 2010. It is expected to further reduce to 1341 m^3 in 2025 and 1140 m^3 in 2050. Hence, there is an urgent need for efficient water resource management through enhanced water use efficiency and waste water recycling (Ranade and Bhandari, 2014).

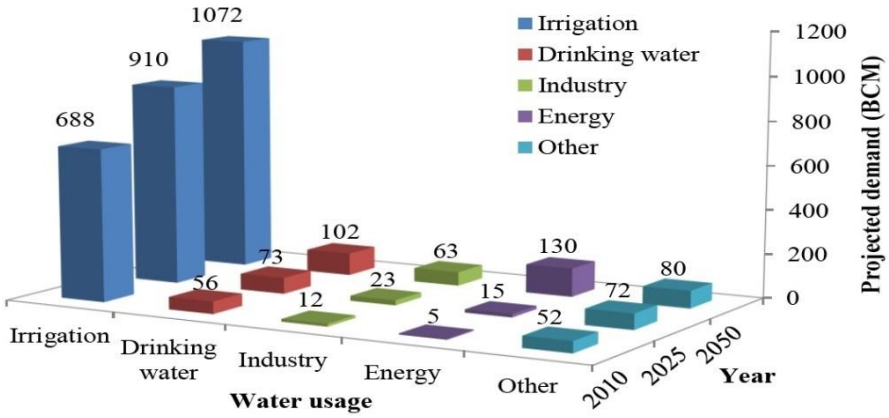

Figure 1: Projected water demand by different sectors (CWC, 2010)

With growing concerns for sustainable development world over, planners of natural resources are focusing their attention on vulnerability arising from availability and use of water resources.

Currently, agriculture accounts for more than 80% of India's water use. But growing demand from other uses such as municipal and industrial, is leading to increased competition among uses, especially near urban areas. The 2050 projections show aggregate water demand increasing to 1,447 km^3; while agriculture retains its relative dominance, other uses are projected to increase their relative share (Fig. 1).

Sewage irrigation as an alternative:

There is an increasing trend to require more efficient use of water resources, both in urban and rural environments. The reuse of water for agricultural irrigation is often viewed as a positive means of recycling water due to the potential large volumes of water that can be used. Recycled water can have the advantage of being a constant, reliable water source and reduces the amount of water extracted from the environment. In addition, in some cases treatment requirements may be need to be less than for water used in an urban environment due to less potential human contact.

Based on current estimates of available municipal wastewater, the International Water Management Institute (IWMI) has calculated the irrigation potential as shown in Table 1.

Table 1: Estimates of irrigation potential with municipal wastewater from Class I and II cities in India (Amerasinghe *et al*., 2013)

Type of Wastewater	Volume of Wastewater (mld)	Potential IrrigableLand (ha)
Treated	11,787	70,722
Untreated	26, 467	1,032,213

The estimates of IWMI show that, irrigation of 70,722 hectares of land is possible with the treated municipal wastewater from Class I and Class II cities in India alone. Use of huge volumes of such nutrient loaded wastewater for agriculture reduces the dependency on other water resources for irrigation.

Merits and demerits of irrigation with sewage:

Irrigation with sewage effluent provides crops with water and nutrients. At the same time, it provides a convenient means of sewage disposal through land treatment, preventing potential health and environmental hazards caused by the uncontrolled flow of wastewater. Effluent becomes exceptionally valuable where other sources of water are scarce and use of waste water for irrigation conserves fresh water (Feigin *et al.,* 2012). Irrigating with wastewater also reduces the level of treatment required and fertilization costs, since soil and crops serve as bio-filters.

Sewage effluent can be a usable water resource for agriculture if suitable precautions are taken and consideration should be given to possible long-term effects of sewage irrigated land that increases salts, nutrients and trace elements. If properly managed, the nutrients and trace elements in the sewage effluent can be an asset to agriculture.

The use of treated wastewater in agricultural irrigation has also been found to have additional agronomic benefits associated with soil structure and fertility. Treated wastewater has a high nutritive value that may improve plant growth, reduce fertilizer application rates and increase the productivity of less fertile soils. Diverse studies have indeed shown that treated wastewater irrigation increases soil organic matter. as well as the concentrations of different nutrients involved in plant growth such as nitrogen,

phosphorus, iron, manganese, potassium, calcium, magnesium and others (Gatica and Cytryn, 2013).

Sewage water irrigation significantly increased photosynthesis, net assimilation rate and dry matter production in crops. Enhanced activity of dehydrogenase and phosphatase enzymes, organic carbon was observed in sewage irrigated fields when compared to bore well irrigated fields (Salakinkop and Hunshal, 2014).

Besides crop farming, wastewater is used also for aquaculture in Africaand in Central, South, and Southeast Asia (Bangladesh, Cambodia, China, India, Indonesia and Vietnam). In many areas, treated wastewater is used for fodder production, groundwater recharge and other environmental purposes such as enhancing water supply for wetlands, wildlife refuges, riparian habitats and urban lakes and ponds.

There are concerns and unknowns, however, about the impact of the quality of the recycled water, both on the crop and on its end users. Water quality related issues that create real or perceived problems in agriculture include nutrient and sodium concentrations, heavy metals and the presence of contaminants such as human and animal pathogens, pharmaceuticals and endocrine disruptors. Society's response on the use of crops that have been irrigated with recycled waters impacts the market value of crops.

The use of wastewater with improper treatment for irrigation leads to detrimental effects on soil quality. These include increased salinity and decreased soil pH as well as increased soil hydrophobicity. A major concern in using sewage effluent for irrigation is the presence of high concentrations of hazardous substances such as trace elements, stable organics and complex synthetic micro pollutants (Feigin *et al.,* 2012).

Irrigation of agricultural crops with recycled wastewater is also associated with several non-biological risk factors; perhaps the most significant being heavy metal contamination. In this context, different studies have shown the accumulation of heavy metals such as cadmium (Cd), nickel (Ni), chromium (Cr), lead (Pb) and other elementsin soil and plants under wastewater irrigation regimen (Gatica and Cytryn, 2013).

Heavy metals and their sources:

Heavy metal contamination in the environment has become a serious problem dueto the addition of metals from natural and anthropogenic sources to the environment (Rathnayake *et al.,* 2010).

Heavy metals occur naturally in the environment from pedogenetic processes of weathering of parent materials and also through anthropogenic sources (Fig. 2). The

most significant natural sources are weathering of minerals, erosion and volcanic activity (Wuana *et al.,* 2011) while the anthropogenic sources depend upon human activities such as mining, smelting, electroplating, use of pesticides and phosphate fertilizer discharge, as well as sewage water irrigation (e. g., livestock manures, composts and municipal sewage sludge), atmospheric deposition, *etc.*

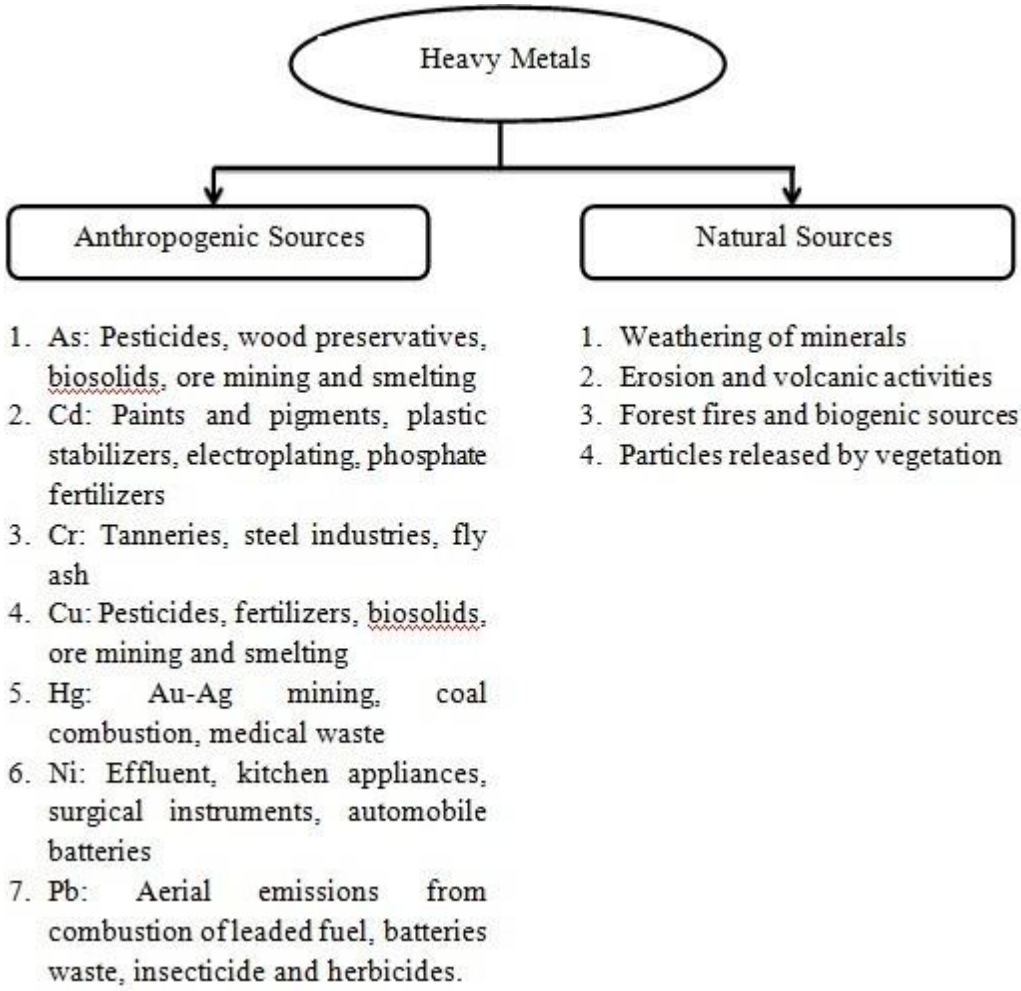

Figure 2: Sources of heavy metals in the environment (Dixit *et al.,* 2015)

Due to the disturbance and acceleration of nature's slowly occurring geochemical cycle of metals by man, most soils of rural and urban environments accumulate one or more of the heavy metals above defined background values high enough to cause risks to human health, plants, animals, ecosystems, or other media. The heavy metals even in trace levels in the soil and water environment are getting more concern because of their high toxic effect upon the higher trophic levels.

The environmental pollution by heavy metals comes from anthropogenic sources such as smelters, mining, power stations and the application of pesticides containing metal, fertilizer and sewage sludge and the irresponsible disposal of wastes by various industries.

Heavy metals are mobile in nature due to their speciation and the various physicochemical characters (viz pH, EC, CEC) of the soil. So, a fraction of the total mass leaches to the aquifer or becomes bio-available to living organisms through food chain transfer.

Irrigation of agricultural lands with sewage water results in the accumulation of trace levels of heavy metals (Omron *et al.,* 2012).

Sewage as a source of heavy metal in soils:

The accumulation of DTPA- extractable heavy metalssuch as Zn (208%), Cu (170%), Fe (170%), Ni (63%) and Pb (29%) in long term sewage irrigated (20 yrs) soils. While Omron *et al*. (2012) reported accumulation of total concentration of heavy metals such as Zn (130%), Pb (55%), Fe (82%), Ni (84%), Mn (30%), Cu (40%), Cr (75%), Co (78%) and As (67%) in the same.

Heavy metal analysis in sandy and sandy clay soils of pH 5. 1- 8. 1 irrigated with sewage water for 10 years showed that the concentration of heavy metals ranged from.

7. 0 to 145 for Cu, 14 to 228 for Zn, 0. 5 to 3. 4 for Cd, <0. 01 to 21 for Ni, 33 to 225 for Cr and 4 to 59 for Pb in the 0–20 cm soil depths. The concentrations had increased significantly in the vegetable gardens compared with control soils and subsoil. Annual heavy metal loading rates showed that within 5–60 years, the heavy metal concentrations would exceed their permitted limits in soils, depending on site.

Effect of heavy metals on soil health:

Soil is essential for the living world, especially for human population. With the rapid economic development, water shortage has become an important factor to limit people's lives and social development. The practice of using wastewater for irrigation developed, which was rich in plant nutrients and organic matter. This practice resulted in increase of soil fertility, but on the other hand wastewater composition is variable and contains high levels of toxic metals, therefore heavy metal contamination of agricultural soils has also become increasingly serious in sewage irrigated area.

Soil pollution by heavy metals is a significant environmental problem worldwide. In particular, heavy metal pollution of surface soils due to intense industrialization and urbanization has become a serious concern in many developing countries (Wei *et al.,* 2010; Abanuz, 2011; Mireles *et al.,* 2012). The accumulation of heavy metals in surface soils is overfed by human activities such as industrial production, traffic, farming and irrigation. Large areas of land are contaminated by heavy metals released from smelters, waste

incinerators, industrial wastewater and from the application of sludge or municipal compost, pesticides and fertilizers. Irrespective of their sources in the soil, accumulation of heavy metals can degrade soil quality, reduce crop yield and the quality of agricultural produce and thus negatively impact the health of human, animals and the ecosystem (Nagajyoti *et al.,* 2010).

Metals exist either as separate entities or in combination with other soil components. These components may include exchangeable ions sorbed on the surfaces of inorganic solids, non-exchangeable ions and insoluble inorganic metal compounds such as carbonates and phosphates, soluble metal compound or free metal ions in the soil solution, metal complex of organic materials and metals attached to silicate minerals. Metals bound to silicate minerals represent the background soil metal concentration and they do not cause contamination related issues compared with metals that exist as separate entities.

The mean pH values of all the soil samples analysed by Nwaogu *et al*. (2014) from soils polluted with individual metals indicate that the heavy metal polluted soil samples had low pH values 4. 10- 4. 30 relative to the control pH 7. 20. This revealed that the addition of these metals at these concentrations lowered the pH of the soil sample. Nickel adsorption depended greatly on pH, regardless of soil or sampling depth, and increased sharply with the increase in pH from 4. 0 to 6. 0 (Soares *et al.,* 2011).

Heavy metals at elevated concentrations are known to affect soil microbial population and their associated activities, which may directly influence the soil fertility. az Heavy metals such as Cd, Hg, Mn and Ni at 150 and 200 µg/g concentrations led to significant decline in viable plate count or complete inhibition of growth of aerobic heterotrophic bacteria after 21 days of incubation.

Effect of heavy metals on plant health:

Heavy metal accumulation in plants depends upon plant species and the efficiencyof different plants in absorbing metals and it is evaluated by either plant uptake or soil-to-plant transfer factors of the metals (Jan *et al.,* 2010). The metal accumulation in different plant parts depends on the availability and chemical form of metals in soil, their translocation potential and type of plant species with their stage of maturity.

Heavy metals such as cadmium, chromium and lead can be taken up by plants resulting in toxic concentration in the food chain or pollute groundwater and surface water by deep percolation or run-off. Many of the trace elements present in wastewater

originate from industrial effluent which is as said above should be treated before being discharged into a municipal sewer (Feigin *et al.,* 2012).

Elevated levels of heavy metals in soil may lead to uptake by plants but there isno significant relationship between the concentration in soil and plants since it depends on many different factors such as soil metal bioavailability, plant growth and metal distribution to plant parts. High concentration of heavy metals in the soil disrupt physiologically important functions in plants, causes an imbalance of nutrients and have anadverse effect on the synthesis and functioning of many biologically important compounds such as enzymes, vitamins and hormones.

Exposure of cabbage plants to 500 mM of $Co^{2+,}$ Ni^{2+} and Cd^{2+} in sand culture led to increased accumulation of the metals, inhibition of growth and induction of visible

symptoms of metal toxicity. Ni^{2+} treated plants exhibited black spots near leaf margins. Wilted appearance of Ni^{2+} treated plants, when water was not limiting in the rooting medium, suggest impediment in facilitated movement of water from roots to the leaves. Excess Co^{2+} and Ni^{2+} effect was more marked on chlorophyll a than chlorophyll b, causing decrease in chlorophyll a:b ratio. At equimolar supply, Ni^{2+} was most effective in decreasing chlorophyll concentration.

The influence of nickel- contaminated soils on fenugreek (*Trigonella corniculata* L.) growth and mineral composition and inferred that the total content of Ni in plant tissues increased consistently with increasing rates of applied Ni, the roots accumulated much higher amount of Ni compared to the shoot. Crops showed characteristic toxicity symptoms of intervienal chlorosis in pots receiving ≥40 mg Ni kg^{-1} soil.

The effect of nickel contamination on the growth and secondary metabolite composition of St. John's wort (*Hypericum perforatum* L.) which isa medicinal plant used in the treatment of neurological disorders. When the seedlings were grown in a sterile, controlled environment supplemented with 25- or 50-mM nickel, they completely lost the capacity to produce or accumulate hyperforin, a medicinally important secondary metabolite and demonstrated a 15-20-fold decrease in the concentration of pseudohypericin and hypericin. These results provide the first indication that metal contamination can change the chemical composition of St. John's wort, thereby, seriously impacting the quality, safety and efficacy of natural plant products produced by medicinal species.

Vegetables are vital to human diet as they contain essential components needed by the human body such as carbohydrates, proteins, vitamins, minerals and also trace elements. Excessive accumulation of metals in vegetables may pose serious threat to the local residents, who consume crops or vegetables grown in contaminated areas. Consumption of vegetables is one of the pathways by which heavy metals enter the food chain.

Singh *et al*. (2010a) quantified the concentrations of heavy metals, viz. Cd, Cr,Cu, Ni, Pb and Zn in soil, vegetables and the waste water used for irrigation in plots

The wastewater used for irrigation had the highest concentration of Zn followed by Pb, Cr, Ni, Cu and Cd. Concentrations of Cd, Pb and Ni have crossed the safe limits for human consumption in all the vegetables. Target hazard quotient showed health risk to the local population associated with Cd, Pb and Ni contamination of vegetables.

A study conducted by Singh *et al*. (2010b) revealed that heavy metal (Cd, Cu, Pb, Zn, Ni and Cr) concentrations were several folds higher in samples like cereal crops, vegetables and milk sampled from wastewater irrigated site when compared to clean water irrigated ones. Cd, Pb and Ni concentrations were above the 'safe' limits of Indian and WHO/FAO standards in all the vegetables and cereals, but within the permissible limits in milk samples. Milk is an important route of food chain transfer of heavy metals from grass to animals. The higher values of metal pollution index and health risk index indicated heavy metal contamination in the wastewater irrigated site that presented a significant threat of negative impact on human health. Rice and wheat grains contained less heavy metal as compared to the vegetables, but health risk was greater due to higher contribution of cereals in the diet.

Parashar and Prasad (2013) assessed the impact of sewage irrigation on heavy metal contamination on spinach, cabbage, beetroot, radish, okra, tomato and cucumber. In the edible portions of spinach, the Cd concentration was higher than the permissible limits of the Indian standard during summer, whereas Pb concentrations were higher in winter seasons. The study concluded that the use of treated and untreated wastewater for irrigation increases the contamination of Cd, Pb in edible portion of vegetables causing potential health risk in the long term from this practice.

Sheetal *et al*. (2016) grew mustard (*Brassica juncea*) var. Pusa Jaikisan in soil supplemented with different concentrations of nickel, chromium, lead and mercury as a leafy vegetable. The study revealed that the metals increased significant reductions in

biomass, photosynthetic rate and chlorophyll a and b contents compared to control plants. However, plants stress tolerance mechanisms, including proline content and activity of antioxidant enzyme increased under different treatments.

Effect of heavy metals on human health:

Heavy metals persist in the environment, are non-biodegradable and have the potential to accumulate in different body organs. The consumption of heavy metal-contaminated food can seriously deplete some essential nutrients in the body that are further responsible for decreasing immunological defences, intrauterine growth retardation, impaired psycho-social faculties, disabilities associated with malnutrition and high prevalence of upper gastrointestinal cancer rates (Chandran *et al.,* 2012). The health effects in humans by some heavy metals are furnished in Table 2.

Musi River and its environs were assessed for heavy metal contamination by Chary *et al*. (2008). The study area was assessed for Zn, Cr, Cu, Ni, Co and Pb in soils, forage grass, milk from cattle, leafy and non-leafy vegetables. Human risk was assessed in people known to consume the contaminated foods by analyzing metals concentrations in venous blood and urine. Results showed high amounts of Pb, Zn, Cr, and Ni compared to permissible limits. HQ was found to be high for Zn followed by Cr and Pb with special reference to leafy vegetables particularly spinach and amaranthus.

Cd damages the calcium metabolism, which will cause calcium deficiency and resultin cartilage disease and bone fractures, etc. Agency for Toxic Substances Management Committee has listed Cd as the sixth most toxic substance that damages human health.

Pb mainly enters human body through the digestive tract and respiratory tract, and then goes into the blood circulation in the form of soluble salts, protein complexes or ions, etc. 95% of the insoluble phosphate lead accumulates in bones. Pb is strongly pro-organizational. It affects and damages many of the body organs and systems, such as kidney, liver, reproductive system, nervous system, urinary system, immune system and the basic physiological processes of cells and gene expression (Chen, 2011).

Cu, Zn and Ni are essential trace metals in the human body, but if the body takes excessive Cu, Zn and Ni from the outside environment, they will damage human health. Ni and Cu are tumor promoting factors, whose carcinogenesis effect has attracted global concerns. Workers who are in close contact with the nickel powder are more likely to suffer from respiratory cancer and the content of Ni in the environment is positively correlated with nasopharyngeal carcinoma (Chen, 2011).

Table 2: Toxic effect of some heavy metals on human health

Heavy Metal	EPA Regulatory Limit (ppm)	Toxic Effects
Ag	0. 10	Exposure may cause skin and other body tissues to turn gray or blue-gray, breathing problems, lung and throat irritation and stomach pain.
As	0. 01	Affects essential cellular processes such as oxidative phosphorylation and ATP synthesis
Ba	2. 0	Cause cardiac arrhythmias, respiratory failure, gastrointestinal dysfunction, muscle twitching and elevated blood pressure
Cd	5. 0	Carcinogenic, mutagenic, endocrine disruptor, lung damage and fragile bones, affects calcium regulation in biological systems
Cr	0. 1	Hair loss
Cu	1. 3	Brain and kidney damage, elevated levels result in liver cirrhosis and chronic aneamia, stomach and intestine irritation
Hg	2. 0	Autoimmune diseases, depression, drowsiness, fatigue, hair loss, insomnia, loss of memory, restlessness, disturbance of vision, tremors, temper outbursts, brain damage, lung and kidney failure
Ni	0. 2 (WHO permissible limit)	Allergic skin diseases such as itching, cancer of the lungs, nose, sinuses, throat through continuous inhalation, immunotoxic, neurotoxic, genotoxic, affects fertility, hair loss
Pb	15	Excess exposure in children causes impaired development, reduced intelligence, short-term memory loss, disabilities in learning and coordination problems, risk of cardiovascular disease
Se	50	Dietary exposure of around 300 μg/day affects endocrine function, impairment of natural killer cells activity, hepatotoxicity and gastrointestinal disturbances
Zn	0. 5	Dizziness, fatigue *etc.*

Huge quantities of industrial and domestic effluents are generated in India which are used or disposed of on lands for irrigation purposes that create both opportunities and problems. Opportunities exist as sewage water from municipal origin are rich in nutrients, organic matter and appreciable amounts of major and micronutrients. Heavy metal contamination of long-term sewage water irrigated lands is an arising problem among others.

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AN OVERVIEW OF CLASSIFICATION OF FUNGI UPTO CLASS (AS PER AINSWORTH-1973)

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Classification of fungi upto class (as per Ainsworth-1973)

Kingdom - Mycota

Division I: Myxomycota

i) **Class: Plasmodiophoromycetes**
ii) **Class: Hydromyxomycetes**
iii) **Class: Myxomycetes**
iv) **Class-Acrasiomycetes**

Division II: Eumycota

Sub-division – 1): Mastigomycotina
- i) Class: Chytridiomycetes
- ii) Class: Hypochytridiomycetes
- iii) Class: Oomycetes

Sub-division 2): Zygomycotina
- i) Class: Zygomycetes–
- ii) Class: Trichomycetes

Sub-division – 3): Ascomycotina
- i) Class: Hemiascomycetes.
- ii) Class: Loculoascomycetes
- iii) Class: Plectomycetes
- iv) Class: Laboulbeniomycetes.
- v) Class: Pyrenomycetes
- vi) Class: Discomycetes

Sub-division – 4): Basidiomycotina
- i) Class: Teliomycetes
- ii) Class: Hymenomycetes
- iii) Class: Gasteromycetes

Sub-division – 5): Dueteromycotina
- i) Class: Blastomycetes
- ii) Class: Hyphomycetes
- iii) Class: Coelomycetes

Outline of classification of fungi (as per Ainsworth G. C, 1973)

According to some, fungi may be given the rank equivalent to sub-kingdom or division of plant kingdom, due to this difference of opinion, many schemes have been proposed for fungal classification. All these schemes based on the features of somatic phase, kind of spores, sporangia, nature of life cycle, presence or absence of sexual stage. In

1969, Whittekar suggested five kingdom system of classification of organisms in which group fungi has been considered as a separate kingdom based on evolutionary relationship. There is no universally accepted scheme of classification for fungi. Ainsworth (1966 to 1973) classified fungi into two divisions based on the presence or absence of plasmodium or pseudo-plasmodium.

Kingdom: Mycota: Free living parasites / symbionts, saprophytes. Cell wall composed of chitin and glucan, food reserve glycogen, oil, manitol**,** reproduction vegetative, asexual or sexual. It includes two divisions.

Division I: Myxomycota: (slime moulds) fungi, with plasmodium or pseudoplasmodium, wall-less and unusual fungi, assimilatory phase plasmodium, presence of motile forms. This division includes 4 classes

i) **Class: Acrasiomycetes:** Pseudoplasmodium present, cellular slime moulds.
ii) **Class: Hydromyxomycetes (Labyrinthumycetes):** Net plasmodium present.
iii) **Class: Myxomycetes:** Presence of free-living saprobic plasmodium.
iv) **Class: Plasmodiophoromycetes:** Parasitic free-living plasmodium within host cells.

Division II: Eumycota (true fungi): fungi with definite cell wall and usually assimilatory phase filamentous, absence of plasmodium or pseudoplasmodium. It includes 5 sub divisions and their respective classes based on the basis of morphology of reproductive structures, presecne or absence of a cell wall.

Sub-division 1): Mastigomycotina: Motile cells zoospores, perfect state spores- **oospores,** this sub division includes three classes

i) **Class: Chytridiomycetes:** Unicellular forms, zoospores with single posterior (whiplash) flagellum.
ii) **Class: Hypochytridiomycetes:** Unicellular, zoospores with single anterior (tinsel) flagellum.
iii) **Class: Oomycetes:** Mycelium aseptate, biflagellate zoospores (whiplash and tinsel type)

Sub-division 2): Zygomycotina: Mycelium aseptate (coenocytic), asexual spores non-motile formed within sporangium, perfect state spores- **zygospores.** This Sub division includes two classes-

i) **Class: Zygomycetes:** Saprophytic and parasitic forms (endophytic mycelium)

ii) **Class: Trichomycetes:** Often parasitic on arthropods (Invertebrates animal like insect), ectoparasites.

Sub-division- 3): Ascomycotina: Perfect state spores- **ascospores,** fruiting body ascocarp. Mycelium unicellular or multicelled, septate. This sub division includes six classes:

i) **Class: Hemiascomycetes:** Ascocarp absent, asci naked, thallus yeast like mycelium.

ii) **Class: Loculoascomycetes:** Ascocarp and ascogenous hyphae present, asci bitunicate (two walled), fruiting body perithecium (ascostroma with locules.)

iii) **Class: Plectomycetes:** Ascocarp (cleistothecium) formed, ascogenous hyphae present, asci unitunicate, ascospores nonseptate.

iv) **Class: Laboulbeniomycetes:** Ascocarp (perithecium) and ascogenous hyphae present, thallus reduced, asci within ascocarp, asci unitunicate, ectoparasitic on arthropods.

v) **Class: Pyrenomycetes:** Ascocarp and ascogenous hyphae present, thallus reduced, asci unitunicate within ascocarp (perithecium), asci with pore or slit.

vi) **Class: Discomycetes:** Ascocarp and ascogenous hyphae present, thallus mycelial, asci unitunicate within cup like ascocarp (apothecium), asci with pore. (operculate)

Sub-division-4): Basidiomycotina: Septate mycelium, asexual spores absent, perfect state spores- **basidiospores,** basidiocarp may be formed in some species. Mycelium septate, septa with complex doli pore. This sub div includes three classes-

i) **Class: Teliomycetes:** Parasitic on vascular plants, basidiocarp absent, teliospores grouped in sori or scattered within host tissues.

ii) **Class: Hymenomycetes:** Mostly saprophytic, basidiocarp present, basidia are septate or nonseptate with basidiospores, (ballistospores.)

iii) **Class: Gasteromycetes:** Mostly saprophytic, basidiocarp present, basidia arranged within hymenium, basidia nonseptate (basidiospores not ballistospores).

Sub-division – 5): Dueteromycotina: Septate mycelium, asexual spores present, perfect state spores absent, rare or unknown. **Sexual reproduction absent**. This sub div-includes **three classes**.

i) **Class: Blastomycetes:** Budding cells with or without pseudomycelium, true mycelium is poorly developed or absent.

ii) **Class: Hyphomycetes:** True mycelium well developed, mycelium sterile / with asexual spores- conidiospores, pycnidium absent.

iii) **Class: Coelomycetes:** Budding cells absent, mycelium sterile or bearing with asexual spores, spores formed in pycnidium or in acervulus.

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MICROPROPAGATION TECHNIQUES FROM PETIOLE EXPLANTS OF *CUCURBITA MAXIMA*

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Abstract:

The present study established reliable and reproducible protocol for rapid multiple shoot induction from Petiole explants of *Cucurbita maxima* using different concentrations and combinations of Cytokinins. The multiple inside cells moreover development of nitrogen in Soybean callus (Child, 1974). Multiple shoot induction was achieved in one of the important medicinal plant of Cucurbitacae family, *Cucurbita maxima*. MS medium supplemented with 1. 0 mg/l BAP + 3. 0 mg/l NAA and 2. 0 mg/l L-Glutamicacid was found to be optimum to induce shoots. Success achieved on these aspects would certainly promote in green revolution Dehne). The effect of Benzyl amino purine in inducing shoot induction was already reported in some of the important medicinal plants (Komalavalli and Rao, 2000). The Petiole explants were inoculated on MS medium supplemented with various cytokinins i. e., BAP and NAA. Addition of BAP at 3. 0 mg/l concentration or NAA at 3. 0 mg/l to the MS basal medium, induced regeneration from the stem node explants. Micro propagation involves multiplication of genetically identical individual by asexual reproduction within a short span of time with tremendous potential for the production of high quality plant based medicines (Murch *et al.,* 2000).

Keywords: petiole, Micropropagation, Techniques, NAA, BAP, *Cucurbita maxima.*

Introduction:

Moreover improvement in primary productivity by conservation of C_3 plants in to C_4 ones through genetic engineering techniques hopefully would increase the primary productivity. *In Vitro* regeneration Via somatic embryo genesis has drawn more attention than other methods because it can produce a large number of plants in a relatively short time (Walker *et al.,* 2001) The number of protoplasts showed increase during shorter treatment time and reaches a peak at 4-5 hours of after this many reports of soyabean somatic embryogenesis were published (Pathak*. et al.,* 2014). *In Vitro* Regeneration of plants via micropropagation has much potential for plant propagation and gene transfer In

Soybean somatic embryo have been obtained from cultured immature cotyledons Soybean from embryogenic callus line derived from the shoot tip explants (Parvathi and Venkateshwarlu, 2018) The development of protoplast systems has increased the plants for use in both Biochemical and genetic research. Ugandhar *et al.* (2011) has been also reported that high amount of Cytokinin and lower amount of Auxins is the best combination for Somatic embryogenesis which is in accordance of our study. The plants of Cucurbitaceae suffer from several diseases including the water melon mosoic virus (Greber, 1978), Cucumber green mottle mosoic virus (Nijsden, 1984) and *Cucurbita maxima* also suffers from downey and powdery mildews which seriously limits the crop production. petiole buds from pumpkin were reported by Jelaska (1974). The similar findings were also reported by Singh (2005). The promising possibility of selecting for herbicide resistance *in vitro* was supported by many workers in many plants.

Materials and Methods:

Raising the level of BAP (0. 5 to 2. 0 mg/l) resulted in the increase in the number of shoots from hypocotyls and cotyledon explants of Niger (Nikam and Shitole, 1993). Biological mechanisms exist in cultured cells which determine the resistance to biocide chemicals and provide the theoretical promise for selection *in vitro* methods. Explants with In Vitro multiple shoots proliferated on TD2-containing media were transferred to MS Medium containing different concentrations (BAP2. 0-3. 0mgl+) Multiple shoot intonation from petiole explants was observed within 20-25days after inoculation. The effect of different five types of growth regulators on direct plantlet regeneration of tomato from petiole explants (Ugandar and Venkateshwarlu, 2018) MS Basal Medium was supplemented with various plant growth regulators and 3. 0% Sucrose. The PH of the media was adjusted to 5. 8, solidified with 0. 8% Difco-bacto Agar and Autoclaved at 103. 4 KPa or 121°C for 15-20min. A single explants was placed in each culture tube and incubated (at25± 1°C with a 16h photoperiod under fluorescent light (40-50m^2 s^{-1}). The Result from this study has shown that BAP induced the activation of Totipotency at the stem node explants, which resulted in the formation of multiple shoots. The stem node segments of 2. 0 – 3. 0 cm long were cultured and surface sterilized with 0. 1% $HgCl_2$ for 5-7 minutes and rinsed with sterile distilled water. They were cultured on MS medium containing 2. 5% sucrose and 0. 8% Agar-Agar and different concentrations of BAP, NAA and L-Glutamic acid. The pH of the medium was adjusted to 5. 8 and later was autoclaved at

120^0C for 17 minutes. Cultures were incubated under 16 hrs, illumination (250 lux) at 25 ± 2^0C temperature.

Results and Discussion:

The cells were able to grow in 1mm (milli mol) 2-4D, while the control suspension was the metabolism of 3. 0-4. 0mg. l 2,4-D. The number of shoots developed on the explants ranged from 1-4 to 2-3 by the addition of BAP at a concentration of 1. 0 mg/l or NAA at 3. 0 mg/l. (Plate – I). MS medium fortified with 2. 0 mg/l BAP or 3. 0 mg/l L-Glutamic acid also induced shoot buds on Petiole explants. Addition of NAA failed to produce many shoots but enlarged the Petiole segments. A number of investigations show that intact plant resistance to pathogens also manifest itself when their cultivated tissues cells or protoplast are treated with the respective toxins disease resistant plants produced by this techniques are corn, tobacco, cloves, potato and sugarcane *Cucurbita maxima.* Petiole cuttings were inoculated on MS basal medium fortified with various cytokinins i. e., BAP and NAA. Coconut water also had a role in triggering the formation of multiple shoots. Raising the level of BAP (3 mg/l to 4 mg/l) resulted in an increase in the percentage of shoots developed from Stem node cuttings. There was no significant increase in the number of shoots on NAA at low and high concentration. Low concentration of L-glutamic acid (0. 5 – 1. 0 mg/l, along with BAP (1. 0 mg/l, has produced significant mean number of multiple shoots that ranged from 2-3 to 5-6 in both the explants. The mean number of shoots developed on the explants ranged from 1-4 to 2-3 by the addition of different concentrations of BAP and NAA. The results from study have shown the initiation of shoot buds and formation of multiple shoots from different explants. Regeneration of plantlets in cultured tissue has been described to be accomplished Petiole culture establishment and multiplication of cultured tissue of the same host plant if successfully developed. These techniques can be extensively applied for mass rearing of nematodes *in vitro* and screening of resistant breeding material and nematicides. (Table-1, Plate-1 Fig: 1 Explant, Fig: 2 Callus, Fig: 3 Plantlets and Fig: 4 Lab photo)

TABLE 1: Micropropagation techniques from petiole explants *Cucurbita maxima.*

Growth Regulators	Petiole	
	% frequency of Shoots	Mean No. of Shoots
MS + 0. 5 mg/l BAP + 1. 0 L-Glutamic acid +2,4D	35	Callus
MS + 1. 0 mg/l BAP + 2. 0 L-Glutamic acid+2,4D	30	Green Callus
MS + 2. 0 mg/l BAP + 3. 0 L-Glutamic acid+2,4D	25	Callus+shoots (1-2)
MS + 3. 0 mg/l BAP + 4. 0 L-Glutamic acid+2,4D	10	Small shoots (2-4)
MS + 1. 0 mg/l NAA + 0. 5mg/l	15	Green Callus
MS + 2. 0 mg/l NAA + 2. 0mg/l	25	Green Callus with Small buds
MS + 3. 0 mg/l NAA + 2. 5mg/l	20	Callus with shoots (1-2)
MS + 4. 0 Mg/l NAA + 3. 0mg/l	15	Multiple shoots (2-4)

Plate 1: Micropropagation techniques from Petiole explants *Cucurbita maxima.*

Figure 1: Explant

Figure 2: Callus

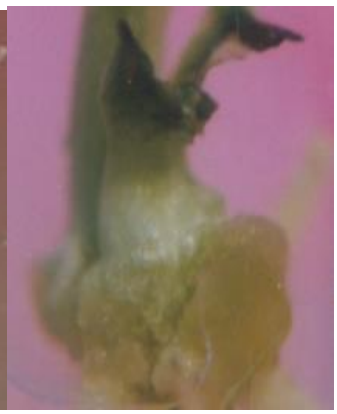

Figure 3: Plantlets

Figure 4: Lab work

Conclusion:

The purpose of this work was to study the effect of different concentrations of growth regulators on direct plantlet regeneration of *Cucurbita maxima* from Petiole explants. Rooted plantlets were successfully hardened under culture conditions and established in the field conditions. The method of repeated transfer of explants is considered to be useful for large scale production of plants, as it avoids isolation and culture of new explants. This is considered as one of the methods to increase the response in explants has suggested that repeated transfer of explants on multiplication media containing cytokinins succeeds in activating the plant materials. Cell cultures may contribute in at least four major ways to the production of natural products. Production of useful compounds by cultured plant cells has become a field of special interest in various biotechnological programs

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BELL'S PALSY: AN IN-DEPTH EXPLORATION OF FACIAL NERVE PARALYSIS

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Abstract:

In this chapter, we undertake a thorough exploration of Bell's Palsy, an abrupt peripheral facial nerve dysfunction. We delve into its intricate pathogenesis, which encompasses viral triggers, immune responses, and genetic predispositions. We meticulously elucidate the clinical presentations, ranging from subtle facial asymmetry to severe paralysis, accompanied by symptoms like altered taste sensation and heightened sensitivity to sound. This chapter underscores the importance of patient education and psychological support, recognizing the profound emotional and social impact of Bell's Palsy. Furthermore, it emphasizes the urgency of ongoing research to unravel the intricate mechanisms behind this condition, with the aim of improving our therapeutic options and enhancing patient outcomes in this intricate neurological disorder.

Keywords: Bell's Palsy, Paralysis, Drooping, Facial Paraesthesia

Introduction:

Bell's palsy is an idiopathic, acute, unilateral, partial, or full paralysis of the face. Bell's palsy is caused by a lower motor neurone pattern. The weakening might be partial or full, and it can be accompanied by slight pain, numbness, sensitivity to sound, and changed taste (Holland and Bernstein, 2014). The anatomical structure of the human face nerve, notably its mixed neural profile incorporating motor, sensory, and parasympathetic fibres, can explain this clinical appearance. The facial nerve's proclivity to create multiple connections with neighbouring cranial nerves may also explain the sporadic occurrences of altered face aesthetic due to cranial nerve V, vestibular dysfunction due to cranial nerve VIII, or pharyngeal symptoms due to cranial nerves IX and X (Eviston *et al.,* 2015). Decreased lacrimation and salivation may also occur because of parasympathetic action (Adour *et al.,* 1978). Worsening occurs within first 48-72 hours. The duration of facial dysfunction, the extent of facial healing, and the deterioration of quality of life all correspond with the severity of the palsy (Eviston *et al.,* 2015). Patients who exhibit signs

of improvement during the first three weeks of developing symptoms have a better likelihood of complete recovery; thus, the sooner healing begins, the less likely problems and residual paraesthesia would emerge (Singh *et al.,* 2022).

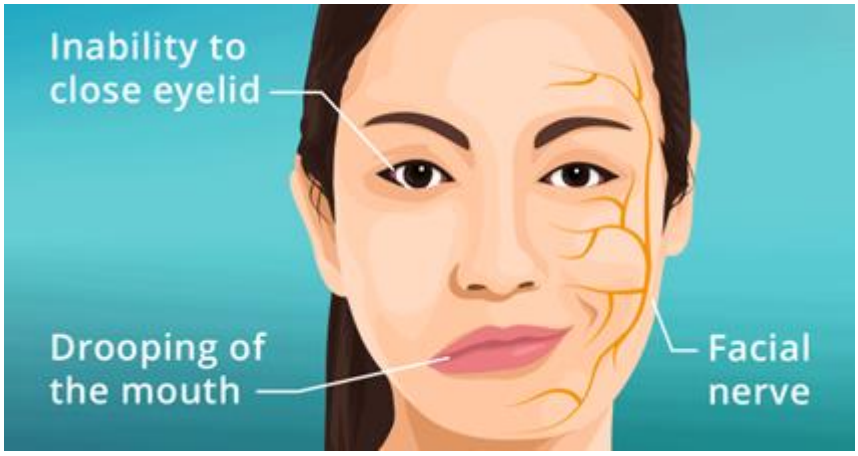

Figure 1: Bell's Palsy (Source: hohmanrehab.com)

Anatomy of Bell's palsy

In the anatomy of Bell's palsy, there are four brainstem nuclei associated with cranial nerve VII, which is the facial nerve. These nuclei are responsible for different functions:

- The facial motor nucleus controls the muscles responsible for facial expressions.
- The superior salivatory nucleus sends fibers for tear and salivary gland secretion.
- The nucleus solitarius receives taste fibers from the anterior two-thirds of the tongue.
- The trigeminal sensory nucleus receives sensory fibers from a small part of the external ear.

The facial nerve exits the brainstem at the cerebellopontine angle, just below the trigeminal nerve and alongside the nervus intermedius, which is responsible for tearing, salivation, and taste. It then enters the internal auditory canal within the temporal bone, traveling along with the eighth cranial nerve.

Within the temporal bone, the facial nerve follows a relatively long 30-mm course, which is the longest among all cranial nerves. This makes it susceptible to swelling and compression.

Three branches of the facial nerve emerge within the temporal bone:

The greater superficial petrosal nerve, originating at the geniculate ganglion, carries secretory fibers for the lacrimal and palatine glands to the pterygopalatine ganglion. From

there, postganglionic fibers for tear secretion follow the infraorbital nerve and branch off to innervate the lacrimal gland.

The other two branches include a small branch to the stapedius muscle in the middle ear and the chorda tympani, which receives taste fibers from the tongue and sends fibers to stimulate the salivary glands.

The facial motor fibers exit the stylomastoid foramen to supply the muscles responsible for facial expressions. As the facial nerve travels through the parotid gland, it divides into five primary branches: temporal, zygomatic, buccal, mandibular, and cervical branches.

In cases where there are facial nerve lesions above the geniculate ganglion, there can be more severe ophthalmic symptoms because both tear secretion and the closure of the eyelids are affected. Central lesions can lead to an unusual phenomenon known as crocodile tears, where regenerating fibers from the chorda tympani grow down the neural pathway responsible for lacrimal gland secretions (Mavrikakis, 2008).

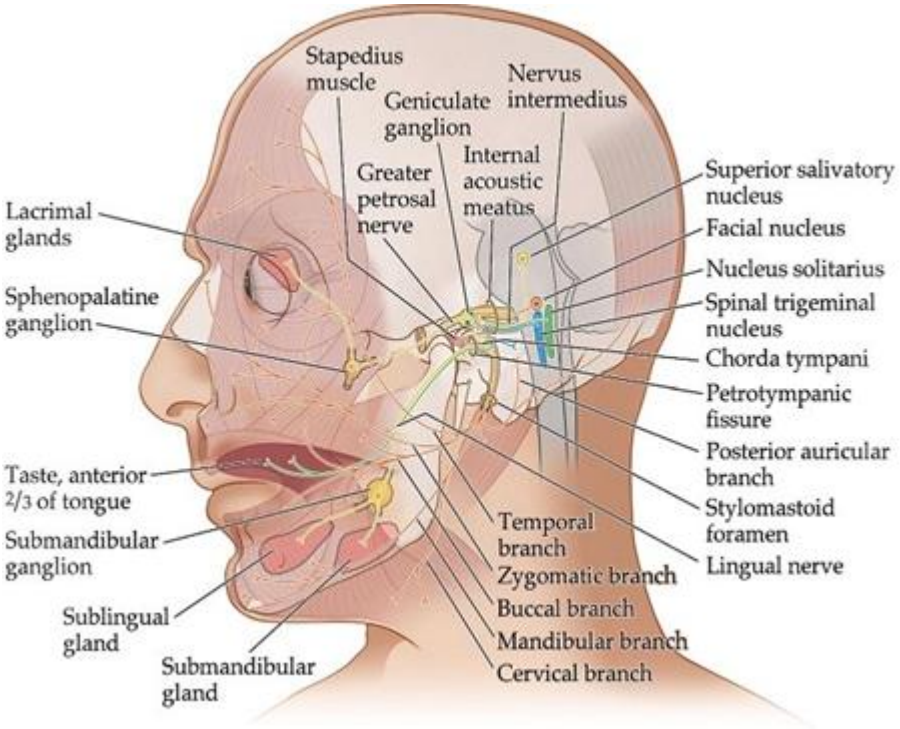

Figure 2: The facial nerve and itd branches (Source: Reich, 2017)

Epidemiology

Bell's palsy is a type of cranial mononeuropathy that occurs frequently. It affects both men and women equally and has a somewhat higher prevalence in middle and later life, but it undoubtedly happens at all ages. The described population incidence rates vary from 11.5 to 40.2/100 00010, with individual studies revealing comparable annual

incidences in the United Kingdom (20.2/100 000), Japan (30/100 000), and the United States (25-30/100 000) (Eviston *et al.,* 2015). The bulk of research fail to demonstrate clustering and pandemic occurrences. The risk is higher during pregnancy, following having a viral upper respiratory tract infection, in immunocompromised people, and in people with diabetes and hypertension. There is no discernible latitudinal variation in occurrence, nor is there a racial or ethnic bias. Some epidemiological data show seasonal variation, with cold months having a little greater frequency than warm months, and a minor preference for dry climates over non-arid ones (Myers *et al.,* 1999).

Symptoms

The clinical presentation of Bell's palsy is characterized by a sudden onset of symptoms, with their severity peaking within 48 to 72 hours. These symptoms can range from mild fatigue to a severe paralysis of the facial muscles on the same side as the affected nerve (Singh *et al.,* 2022).

- Facial paralysis: One of the hallmark symptoms of Bell's palsy is facial paralysis on the same side as the affected facial nerve. This can result in the inability to perform basic facial movements, such as closing the eye, smiling, or raising the corner of the mouth.
- Drooping of half of the face: Due to the muscle weakness and paralysis, half of the face can appear droopy and uneven compared to the unaffected side.
- Eyebrow sagging: The eyebrow on the affected side may also sag, contributing to the asymmetry of the face.
- Nasolabial fold flattening: The fold that runs from the nose to the upper lip, known as the nasolabial fold, can flatten on the side affected by Bell's palsy.
- Ear pain or hearing impairment: Some individuals may experience pain around the ear on the affected side or even hearing impairment due to the involvement of the facial nerve.
- Dry eye and dry mouth: Parasympathetic nerve involvement can lead to reduced tear and saliva production, resulting in dryness of the eye and mouth, respectively.
- Hyperacusis: Nerve fiber breakdown in the stapedius muscle can cause hyperacusis, a heightened sensitivity to sound, making every day noises uncomfortably loud.
- Altered taste: Changes in taste perception are also possible. Some people with Bell's palsy may notice differences in how food tastes.

- Facial paraesthesia: In some cases, individuals may mistakenly interpret motor symptoms (related to muscle movement) as sensory changes. This can lead to sensations like tingling or numbness in the face.

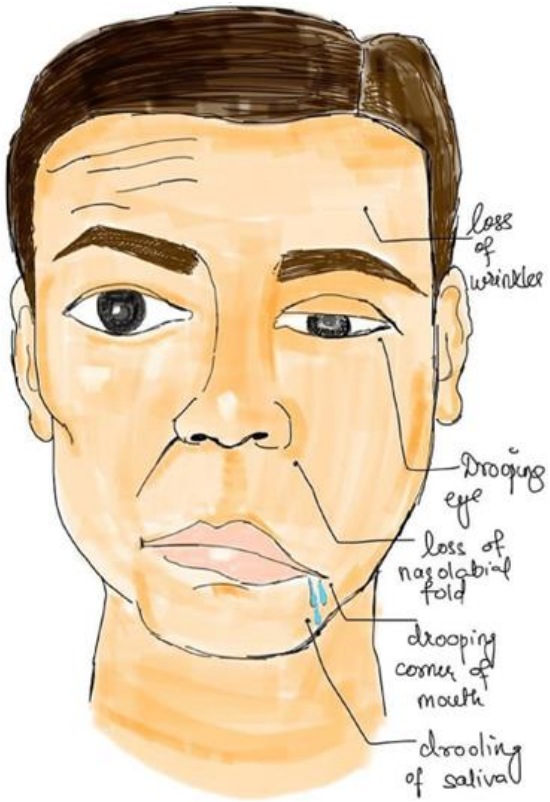

Figure 3: Clinical features of Bell's Palsy (Singh *et al.,* 2022)

Etiology

The cause of Bell's palsy is unknown and may differ from person to person. Edema of the facial nerve within the small fallopian canal has been found after Bell's palsy decompressive surgery, correlating with MRI enhancement of the facial nerve in Bell's palsy. In predisposed patients, such as the elderly or those with diabetes mellitus or hypertension, the origin of the edema could be ischemia, similar to other recognized ischemic cranial neuropathies affecting the abducens and oculomotor nerves. However, this does not account for the large number of young people, including children, who have Bell's palsy (Reich, 2017).

Viral infection

According to Gilden, Herpes simplex virus (HSV) type 1 ''is probably the source of most cases of Bell's palsyI[and] indicates virus reactivation from incubation in the geniculate ganglion instead of original infection.'' Isolation of HSV DNA from endoneurial fluid in Bell's palsy; increased salivary shedding of HSV DNA in patients versus controls;

polymerase chain reaction (PCR) evidence of HSV type 1 in the geniculate ganglia; and an HSV type 1 experimental animal model of Bell's palsy are all supporting evidence. Despite this data, Gilden admitted that ''how the virus destroys the face nerve is unknown".

Inflammation

Numerous research indicate that BP is caused by acute, inflammatory demyelination. The first line of proof for this etiology is supported by histologic alterations in the facial nerve, which were first recognized by Liston and Kleid, and whose characteristics are given here (McAllister *et al.,* 2013).

1. Round, tiny inflammatory cells infiltrate the nerve from the internal auditory meatus to the stylomastoid foramen.
2. There is a breakdown of neuron myelin sheaths, which involves macrophages.
3. There is more inter-neuronal space.
4. The bony fallopian canal is normal, with no evidence of fallopian canal bone compression of the facial nerve.

BP and Gullian Barre syndrome both have been linked to inflammatory demyelinating neuritis. The myelin sheath is a layer made up primarily of Schwann cells that covers the axons of nerve cells. Schwann cells insulate axons extending from neurons in the peripheral nervous system, preventing electrical impulses from being transmitted from one neuron's axon to another. Guillain-Barré syndrome, sometimes known as BP, is an acute demyelinating illness of the peripheral nerve system. Majority of uncomplicated BP cases result in complete recovery, the main lesion may consist of the surrounding myelin sheaths and their native cells, the Schwann cells, but not the nerve itself. Autoimmunity causes demyelination of the facial nerve, which is corroborated by a recent review of Greco *et al.* (2012).

It has also been proposed that BP is a polyneuropathy, with facial paralysis frequently encompassing other cranial nerves. The presence of small round lymphatic cells and the breakdown of myelin sheaths are common histologic features of autoimmune responses, with viral infection causing an autoimmune reaction against a component of peripheral myelin, resulting in cranial nerve demyelination and, in particular, facial nerve demyelination. The mechanism underlying this is still unknown. Serum samples from patients with BP, on the other hand, include higher amounts of cytokines such as interleukin-1 (IL-1), IL-6, and tumor necrosis factor-alpha (TNF-) compared to control group levels. In contrast to control populations, lower percentages of total T cells (CD3)

and T helper/inducing cells (CD4) have been reported in the acute phase of BP. Within the first 24 days of clinical paralysis, there was clearly a drop in peripheral blood T lymphocyte percentages and a rise in B lymphocyte percentages in BP. All of the clinical and immunological data presented above point to cell-mediated effector activation and the involvement of immune systems in BP.

Cold exposure

Recent epidemiological research has found that extreme temperature exposure is also associated with the occurrence of BP. Campbell and Brundage used a centralized monitoring system combining medical encounter and demographic data to study climate and season associations of BP risk. The findings showed that season and climate were both independent predictors of BP risk. There is a definite relationship between the cold season and the number of reported cases (Zhang *et al.,* 2020).

Ischemia

BP is an acute idiopathic lower motor neuron palsy that is usually unilateral and self-limiting. Most cases of BP resolve within 4-6 months and almost always within a year. Secondary ischemia, tertiary ischemia, or their sequelae have been implicated in cases that do not resolve, and this can result in thickening of the facial nerve sheath, creating a few bands of fibrous tissue that cause nerve constriction and compression, hampered recovery. Nerves are composed of different layers, including an outer tough grey layer called the periosteal layer, and just beneath it, a vascular plexus layer. The density of endoneuria capillaries within this vascular layer plays a critical role in determining how susceptible a nerve is to ischemic damage. When this vascular layer is compromised, it can lead to local ischemia (inadequate blood supply) and result in various nerve-related issues (Zhang *et al.,* 2020).

There are three distinct types of vascular ischemia that can affect nerves:

1. Primary Ischemia: This is a rare condition characterized by reduced blood supply due to vasospasms. It is more likely to occur in clinical conditions like diabetes mellitus.
2. Secondary Ischemia: In this type, initial arteriole constriction is followed by capillary dilation, increased permeability, and potential nerve damage. This can create a harmful cycle leading to nerve necrosis.
3. Tertiary Ischemia: Progressing from secondary ischemia, this stage involves more severe vasospasms, which can lead to perivasculitis and endarteritis. This may

result in fibrosis of the facial nerve sheath, requiring surgical intervention to prevent permanent facial paralysis.

Diagnosis

Method for doing a clinical assessment for Bell palsy During the Counselling, look for asymmetry; pay special attention to the corners of the mouth, the nasolabial folds, and blinking (Patel and Bell, 2015).

1. General evaluation - otoscopy, and palpation for neck-region masses and face, as well as a skin analysis
2. Examine the motor skills:
    - Raise both of your brows.
    - Firmly close both eyes.
    - Smile
    - Blow your cheeks.
    - Purse your lips.
    - Display both the top and bottom teeth
3. Evaluate sensory function if a clinical need exists.
    - Sensation in the ear and face
    - Taste perception in the tongue's front two thirds
4. Evaluate reflexes.
    - Tap the glabella to trigger the orbicularis reflex, then look for asymmetry in the blink pattern.
    - Consider the bell phenomena as your eyes move upward forced while closing eyes.

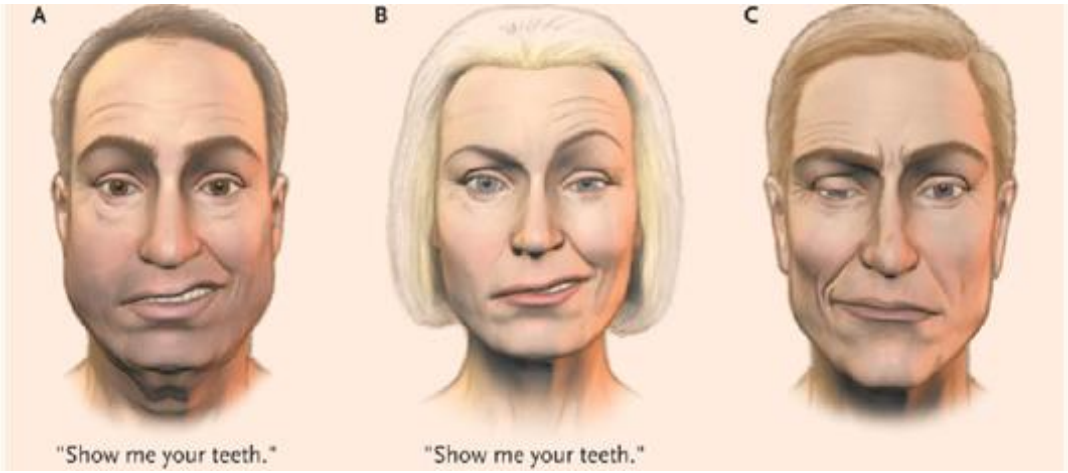

Figure 4: Central and Peripheral Facial Weakness (Gilden, 2004)

Table 1: The House-Brackmann facial nerve grading system (Baugh *et al.,* 2013)	
Grade I - Normal	◆ All facial areas exhibit regular function. ◆ No signs of weakness or irregularities are noticeable.
Grade II - Slight Dysfunction	◆ There is a slight weakness discernible upon close examination. ◆ There might be minimal involuntary muscle movements (synkinesis). ◆ While at rest, the face shows normal symmetry and muscle tone. ◆ Facial movements include moderate to good function in the forehead, complete eye closure with minimal effort, and slight mouth asymmetry.
Grade III - Moderate Dysfunction	◆ Grossly, there is an obvious but not disfiguring difference between the two sides of the face. ◆ Some noticeable but not severe involuntary muscle movements, muscle tightening (contracture), and/or spasms may be present. ◆ The face maintains normal symmetry and muscle tone at rest. ◆ Facial movements encompass slight to moderate forehead movement, complete eye closure with effort, and slight weakness in the mouth with maximal effort.
Grade IV - Moderately Severe Dysfunction	◆ There is evident weakness and/or disfiguring asymmetry. ◆ At rest, the face retains normal symmetry and muscle tone. ◆ Facial movements involve no forehead movement, incomplete eye closure, and asymmetry in the mouth with maximal effort.
Grade V - Severe Dysfunction	◆ Only minimal facial movement is perceptible. ◆ Resting facial symmetry is disrupted. ◆ Facial movements include no forehead movement, incomplete eye closure, and slight mouth movement.
Grade VI - Total Paralysis	◆ No facial movement is observed. ◆ The facial muscles are completely paralyzed.

Diagnostic evaluation

Serologic testing, electrodiagnostic procedures, and imaging examinations are not usually required to identify Bell palsy. However, if the patient has sparing of the forehead muscle, multiple cranial neuropathies, symptoms of infection, or persistent weakening beyond 3 weeks, referral to the appropriate specialist (neurologist, otolaryngologist, optometrist, ophthalmologist) is indicated.

Laboratory examination

A differential complete blood cell count may indicate infection or a lymphoproliferative disease. Screening for diabetes mellitus with fasting blood glucose or hemoglobin A1c may be useful when appropriate. In Lyme disease-endemic areas, patients should be tested for the disease using an enzyme-linked immunosorbent assay or an indirect fluorescent antibody test. If positive, a Western blot should be performed to confirm the diagnosis of Lyme disease.

Check serum antibodies for herpes zoster if vesicles are seen during the test. Angiotensin-converting enzyme, human immunodeficiency virus, and inflammatory markers can all be examined in the right clinical situation.

Cerebrospinal fluid analysis is often ineffective in identifying Bell palsy, but it can distinguish it from Guillain-Barré syndrome, leptomeningeal carcinomatosis, and central nervous system infection.

Imaging

Imaging is generally not the initial recommended approach when assessing Bell's palsy, unless there are unusual symptoms or examination findings. This is because 5% to 7% of facial palsy cases can be attributed to tumors, whether they are benign or malignant, such as facial neuromas, cholesteatomas, hemangiomas, or meningiomas. Consequently, in patients with a gradual onset of symptoms that don't show improvement over approximately three weeks, it is advisable to conduct contrast-enhanced computed tomography or gadolinium-enhanced magnetic resonance imaging of the internal auditory canal and face to rule out underlying tumor-related causes.

Electrodiagnostic testing

Regarding the diagnostic process for Bell's palsy, electrodiagnostic testing is typically not included in the evaluation of acute cases. However, for patients experiencing complete paralysis, these tests can be valuable in assessing the extent of nerve damage and predicting the likelihood of recovery. This is particularly relevant because individuals with complete paralysis have a higher risk of not fully regaining their facial function. It's

important to note that electrodiagnostic studies should be scheduled at least one week after the onset of symptoms to ensure accurate results and avoid false-negative outcomes. Overall, a comprehensive evaluation, which may involve imaging and electrodiagnostic studies in specific cases, helps healthcare professionals make a more precise diagnosis of Bell's palsy and rule out other potential causes, including tumors.

Differential diagnosis (Tiemstra and Khatkhate, 2007)

Disease	**Cause**
Lyme disease	Spirochete *Borrelia burgdorferi*
Otitis media	Bacterial pathogens
Ramsay Hunt syndrome	Herpes zoster virus
Sarcoidosis or Guillain-Barré syndrome	Autoimmune response
Tumor	Cholesteatoma, parotid gland
Supranuclear (central)	
Multiple sclerosis	Demyelination
Stroke	Ischemia, hemorrhage
Tumor	Metastases, primary brain

Poor prognosis

Factors that suggest an unfavorable outlook in Bell's palsy include:

1. Total facial paralysis.
2. Lack of improvement within three weeks.
3. Being older than 60 years.
4. Intense pain.
5. Presence of Ramsay Hunt syndrome (related to the herpes zoster virus).
6. Coexisting medical conditions like hypertension, diabetes, or pregnancy.
7. Significant deterioration of the facial nerve, as indicated by electrophysiological testing.

Treatment

The primary objectives of treating Bell's palsy during the acute phase are to accelerate recovery and prevent complications related to the cornea. Treatment should commence promptly to hinder the replication of the virus and its impact on subsequent physiological processes affecting the facial nerve. It is also crucial to provide psychological support, which may necessitate regular follow-up appointments.

Eye care:

Regarding eye care for Bell's palsy patients, the main focus is on safeguarding the cornea against dryness and potential damage due to difficulties in closing the eyelid and tear production. Patients should be educated to promptly report any new symptoms such as pain, discharge, or changes in vision. To address these concerns, lubricating eye drops should be administered hourly during the day, and a basic eye ointment should be applied at night.

Corticosteroid treatment:

Recent systematic reviews have shown that corticosteroids can effectively treat Bell's palsy when administered within the first seven days, providing an additional 17% of patients with a favorable outcome on top of the 80% who naturally recover. Some studies have also demonstrated the benefits of using steroids. For example, patients with severe facial paralysis showed significant improvement within 24 hours after steroid treatment. When administered within 72 hours, combining aciclovir with steroids enhanced recovery rates.

In a randomized controlled trial, patients treated with high-dose parenteral steroids within 72 hours exhibited a significant improvement in recovery rate and a quicker return to work, although there was no statistical difference in the final outcome. While more randomized controlled trials are needed, they would require a substantial number of patients in each group.

Based on the current evidence, we recommend the use of oral prednisone along with aciclovir for patients with moderate to severe Bell's palsy, ideally starting treatment within 72 hours. Immunocompetent patients without specific contraindications are prescribed prednisone at a dose of 1 mg/kg per day (maximum 80 mg) for the first week, which is then tapered over the second week. It's worth noting that about a fifth of patients progress from partial palsy, so these individuals should also receive treatment (Ramsey *et al.,* 2000).

Antiviral medication:

Using antiviral medications in the treatment of Bell's palsy is considered reasonable due to the likely involvement of herpes viruses. Aciclovir, which is a nucleotide analogue, disrupts the activity of herpes virus DNA polymerase and hinders the replication of DNA. However, aciclovir has relatively low bioavailability (15% to 30%), so newer drugs in the same class are being tested. Valaciclovir (a prodrug of aciclovir), famciclovir (a prodrug of penciclovir), and sorivudine have demonstrated improved bioavailability, dosing

schedules, and clinical effectiveness in treating conditions like shingles (Snoeck *et al.,* 1999).

Zoster sine herpete:

While a daily dose of 2000 mg of aciclovir may not be sufficient for treating Ramsay Hunt syndrome with vesicles, it appears to work effectively for patients with zoster sine herpete. Based on current evidence, if there is no significant pain or evidence of vesicles, this dosage, when combined with steroids, is considered appropriate for the treatment of Bell's palsy associated with the herpes zoster virus.

Future research might reveal that patients experiencing severe post-auricular pain, profound palsy, or the presence of the herpes zoster virus could benefit from starting higher-dose antiviral therapy initially.

Surgery:

Surgical procedures aim to alleviate pressure on the facial nerve. However, middle fossa craniotomy carries risks such as seizures, hearing loss, cerebrospinal fluid leakage, and facial nerve damage. As a result, decompression surgery for Bell's palsy is not routinely offered in the United Kingdom.

Physical therapies:

Various physical therapies, including massage and facial exercises, are recommended for patients, but there is limited clinical trial data available to confirm their effectiveness. Recent evidence provides some support for facial retraining, often known as mime therapy, which involves biofeedback (Beurskens and Heymans, 2003).

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INNOVATIONS IN LIFE SCIENCE

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"Life comes from earth and life returns to the earth."

"Life is from B to D from Birth to Death." But what's between B to D? It's 'C'. So what is 'C'? It's a CHOICE.

Our life is a matter of choice live well and it will never GO WRONG.

Life itself has no meaning. Life is an opportunity to create meaning. Life is a very valuable gift which is given by God to us and we must be thankful to him for giving such a precious gift. Life is not only valuable for the human but it is also equally valuable for other human being.

Life is a quality that distinguish matter that has biological process such as signaling and self-sustaining process from matter that does nit and is defined by the capacity for growth reaction to stimuli metabolism energy transformation and reproduction.

Any science that deals with living organism their life process and their interrelationships as biology medicine or ecology is nothing but the life science. Life science studies life in all its form, past and present. This can include plants, animal, virus and bacteria, single celled organisms and even cells. It is a field of science that studies living thing and how they interact with each other and the world around them.

Innovations in life sciences:

Life science is a group of advance biology. It is also known as biological science. It is an advanced and thoroughly inspiring discipline of studies. It provides detailed information about the different branches related to life science. Biochemistry, Ecology, Immunology, Biotechnology, Genetics, Molecular Biology, Cytology, Histology, Neurology, Physiology, Embryology etc. are different field of life science. It is a scientific study of life, cell organ cell and organism. It does not study natural object is that are not living (Inanimate.)

In recent years, innovations in life sciences have been nothing short of revolutionary. From groundbreaking advancements in genomics to the development of cutting-edge therapies, the field has witnessed a remarkable transformation.

Genome editing technologies like CRISPR-Cas9 have paved the way for precise modification of DNA, opening up possibilities for treating genetic disorders and even

preventing certain hereditary conditions. The ability to edit genes with such precision has far-reaching implications for medicine, agriculture, and beyond.

In the realm of personalized medicine, there have been significant strides. Tailoring treatments based on an individual's genetic makeup and characteristics has become increasingly feasible, leading to more effective and targeted therapies. This shift from a one-size-fits-all approach to a personalized one is enhancing treatment outcomes and minimizing adverse effects.

Advancements in regenerative medicine are also capturing attention. Stem cell research, tissue engineering, and organ transplantation breakthroughs are offering new hope for patients with previously untreatable conditions. The prospect of regenerating damaged tissues and organs could redefine the possibilities of healthcare.

Additionally, the integration of artificial intelligence and machine learning in life sciences is accelerating research and drug discovery processes. These technologies analyze vast datasets, identify patterns, and predict outcomes, expediting the development of new drugs and therapies.

Life science enable as understanding of the environment and the other living species with whoever we share the earth. This knowledge guide conservation efforts and helps us to save our shared planet. It makes our life easier. It improve our health. It is an important employment source. It helps us understand how the world works. It allows us to develop new technologies, medicines and other innovations that improve our quality of life. With the help of genetic testing and imagery techniques allowing doctors to identify the diseases earlier and more accurately help to better treatment outcomes. It improve diagnosis. It provides more effective treatments gives better quality of life, helps in agricultural industries.

Its innovations provide doctors with tools they need to treat patients with greater efficacy with the development of treatments and therapy it improve the quality of life. Its innovation have positive impact on patients care with improved diagnosis more effective treatments better quality of life and reduce cost of care is a valuable asset in healthcare.

Life science also improve crop yields and increased food safety, as well as enabling the development of new breeds of animal and plants. It control crops diseases with the use of genetic engineering. It is also helpful to develop new products by the recycling method. It provide potential to drive medical breakthroughs, improve healthcare delivery and develop new treatments and cures of diseases.

However innovation of life science comes with its own challenge. One of the biggest challenge is the cost of development. Developing and testing new treatments and therapy is very expensive. It makes difficult for smaller companies and research group to enter the field of life science innovation as they not able to cost the development.

Another challenge in life science innovation is the time it take to develop new treatments and therapy. It may have to wait for long period of life before their product can be approval for use.

In conclusion there are many challenges in life science innovation. From high cost of development to the long time for product approval, these challenges can be a major barrier for companies and organization who wish to enter the field of life science innovation. However by to overcoming these challenges, life science innovation can provide tremendous benefits as it can lead to new treatments and therapies that can improve the lives of many.

In summary, innovations in life sciences are reshaping the landscape of healthcare and biology. The precision, personalization, and integration of cutting-edge technologies are not only expanding our understanding of life but also offering unprecedented avenues for improving and extending it.

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EXPLORING CONTEMPORARY RESEARCH CONCERNS IN MARINE BIOLOGY

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Abstract:

The chapter provides a detailed exploration of marine biology, encompassing the physiology, ecology, and challenges of marine organisms within their aquatic habitats. It underscores the importance of marine ecosystems like coral reefs, seagrass meadows, kelp forests, and estuaries while highlighting the threats posed by human activities and climate change. Emphasis is placed on the vast diversity of marine life, including yet-to-be-discovered species, and the significant influence of ocean currents, water temperatures, and salinity on marine ecosystems and global climate systems. It underscores the critical role of marine biology in understanding and conserving our planet's marine biodiversity and ecosystems. Furthermore, the abstract summarizes key techniques and initiatives utilized in the study of marine ecosystems and biodiversity. It emphasizes the importance of standardized data collection methods and Essential Ocean Variables (EOVs) for monitoring marine health. Specific techniques like Light Traps, Continuous Plankton Recorders (CPR), Reef Life Surveys (RLS), and Harmful Algal Bloom (HAB) monitoring are discussed for their valuable contributions to global marine ecosystem conservation. Lastly, the abstract explores the exciting development of seismic surveys in marine biology research, acknowledging both their advantages and disadvantages. Seismic surveys, utilizing low-frequency sound signals, offer multi-dimensional, high-resolution observations of the ocean's depths with extensive horizontal coverage. However, the intense noise generated can disrupt marine life, affecting behaviour and physiology. Potential impacts on zooplankton, fishes, baleen whales, and sea turtles are considered, emphasizing the need for responsible and sustainable use of seismic surveys to protect marine ecosystems.

Keywords: Marine Biology, Ecosystem, Seismic Survey.

Marine biology:

Marine biology comprises a specialized domain within the field of biological sciences primarily focused on investigating and addressing the physiological and ecological aspects of organisms inhabiting marine environments. Marine biology is a multifaceted

scientific discipline focused on the comprehensive study of aquatic organisms. It explores various aspects of marine life, including life cycles, behaviours, and ecological interactions within the marine environment. A distinguishing aspect of marine biology is its ecological perspective on species classification. Unlike traditional taxonomy, which relies on genetic relationships, marine biology classifies species based on their ecological niches, emphasizing whether they primarily inhabit marine or terrestrial environments. This approach recognizes the coexistence of species with both marine and terrestrial preferences within various biological families, genera, and phyla. Marine-biology provides insights into the intricate world of aquatic life, highlighting the interplay between marine organisms and their dynamic environments. It challenges conventional taxonomic paradigms, contributing to a deeper understanding of the diverse life forms thriving beneath the ocean's surface (Pan and Pratolongo, 2022).

The Earth's oceans represent its most distinctive and imposing natural habitat, spanning 71% of its surface area. This vast interconnected aqueous environment sustains an incredibly diverse range of life forms, ranging from minuscule viruses and bacteria to colossal marine creatures. Furthermore, it encompasses some of the most intriguing and inaccessible ecosystems on our planet. Marine biology is the scientific discipline dedicated to exploring how oceanic organisms live and interact within their environment, holds inherent significance and captivation. It has piqued human curiosity and exploratory instincts for generations. The study of marine biology has assumed heightened importance and urgency as people endeavour to comprehend and manage the changes occurring in our oceans. We now recognize that functional ocean ecosystems provide indispensable services crucial to human survival.These ecosystems contribute to the production of approximately half of the oxygen we breathe, play a vital role in stabilizing our climate, sustain ecosystems that safeguard our coastlines, provide a bountiful source of healthy food, host a multitude of diverse organisms, yield natural products of medicinal and biotechnological value, and support various forms of recreation and tourism. Fortunately, there is a growing global awareness, concern, and engagement in marine environmental issues. Consequently, an increasing number of people worldwide are displaying heightened interest in the science of marine biology and are actively seeking a deeper understanding of our impacts on the oceans (Sumich and Morrissery, 2004). The ocean serves as a habitat for an astounding array of organisms that have evolved to thrive in the unique conditions of the marine environment. The characteristics of these organisms and the diversity of marine life are outcomes of the various properties of the oceanic habitat. Over the course of time, the oceans have undergone significant transformations since their initial formation. They have

expanded, covering more extensive areas and reaching higher elevations than in any previous period. Additionally, the ocean basins have continued to deepen due to the accumulation of new water from volcanic emissions and the chemical breakdown of rocks. Geological forces dating back over 3 billion years have also played a substantial role in shaping the physical environment of the oceans. The origin of life in the ocean, whether it began on the deep-sea floor or in the warm waters near the coast, remain subjects of ongoing speculation and research within the field of marine biology (Mladenov, 2020).

Exploring marine ecosystems:

- **Coral reefs**

Coral reefs represent highly diverse ecosystems, inhabited primarily by coral polyps that assume various forms, such as large reef-building colonies and smaller solitary organisms. These reefs are home to thousands of coral species, some thriving in warm, shallow, tropical seas while others exist in the cold, dark ocean depths. These coral reefs occupy a wide range of environments, offering sustenance and shelter to various organisms and providing numerous ecological benefits. Warm-water coral reefs, found in sunlit, warm, alkaline waters, exhibit rapid growth and calcium carbonate structure maintenance. At greater depths (40–150 meters), mesophotic coral reefs, with limited light, accumulate calcium carbonate at lower rates but remain crucial habitats for diverse species, including those vital for fisheries. In even deeper waters, down to 2,000 meters or more, cold-water coral reefs reside in the dark abyss.

Despite their significance, coral reefs face substantial threats from human activities, encompassing pollution, over-exploitation, physical damage, and climate change. In the latter case, even lower greenhouse gas emissions scenarios, such as Representative Concentration Pathway RCP 4.5, may lead to the demise of most warm-water coral reefs by 2040–2050. Cold-water corals also confront dangers from rising temperatures and ocean acidification, though the direct impact of climate change is less certain. There is minimal evidence that coral reefs can adapt swiftly enough to cope with rapid ocean warming and acidification, given their long lifespans and slow evolution rates. Assumptions that coral reefs will migrate to higher latitudes as they warm are unsupported, as the appearance of tropical species in high latitudes is an insufficient indicator of entire coral reef ecosystem shifts. Instead, coral reefs are expected to deteriorate rapidly over the next two decades, presenting fundamental challenges to the 500 million people who depend on them for sustenance, income, coastal protection, and various services. Unless significant progress is made in achieving the goals of the Paris Climate Change Agreement in the next ten years, hundreds of millions of people could experience escalating poverty, social disruption, and

regional instability. Both the warm and cold-water corals produce calcium carbonate skeletons that gradually form three-dimensional reef structures, offering habitats to numerous fish and species. These reefs, though occupying less than 0.1% of the ocean floor, host at least 25% of known marine species, with many yet to be discovered. In deeper parts of these warm-water reefs, carbonate-dominated structures become less prevalent as light decreases. Mesophotic coral reefs, found at depths of 40–150 meters, provide extensive habitat, but their species diversity remains high due to limited accessibility. Mesophotic reefs are likely to cover a similar area as shallow warm-water coral reefs. Cold-water coral reefs extend to depths of 3,000 meters, although some grow in waters as shallow as 50 meters, like those on the Norwegian shelf. Below 200 meters, light levels become insufficient for photosynthesis, and cold-water corals do not form symbiotic relationships with Symbiodinium. Instead, they rely on particle feeding. Advances in underwater technologies have revealed extensive cold-water coral reefs in various oceans, offering critical habitat to many species, including commercially important ones. Human communities derive multiple benefits from coral reefs, including sustenance, income, recreation, coastal protection, cultural value, and ecological services. Despite their biodiversity, productivity, and importance to humans, both warm and cold-water coral reefs face severe impacts from human activities, stemming from local and global influences. Changes in ocean temperature and chemistry due to human activities are significantly diminishing the distribution, abundance, and survival of entire coral reef ecosystems.

- **Seagrass meadows**

Seagrass beds are frequently cited as vital foraging sites for various species, including commercially valuable ones. Some species even directly feed on seagrass due to the abundance of potential prey items. Predator behaviour in seagrass beds varies, with some species actively searching for food while others employ a "hover and wait" strategy due to the challenges posed by moving vegetation.The role of seagrass beds in supporting fisheries depends on factors like food supply and the abundance of associated fauna. Studies have attempted to assess food selectivity and trophic linkages within these habitats. Despite the apparent abundance of food in seagrass beds, increased growth in fishery species is not always observed, suggesting that factors such as food quality and foraging time, influenced by predation risk, also play crucial roles.Seagrass ecosystems are well-documented as providing effective defence against predation, as demonstrated in numerous studies. While many investigations support this protective function, its effectiveness varies depending on the structure of the seagrass bed, often benefiting specific size classes of fish, such as smaller species and juveniles, or species with cryptic

characteristics. Evaluating the protective capacity of seagrass for particular exploited species can help identify which seagrass beds in a region offer optimal protection or foraging conditions. Reduced predation pressure allows more time for foraging, energy acquisition, and accelerated growth. There is often a trade-off between the benefits and drawbacks associated with the structural complexity of seagrass habitats. Complexity benefits smaller fish species by providing refuge but can hinder visual predators by obscuring their prey. Organisms may need to balance habitat complexity suitable for protection with that which facilitates foraging. Predator-prey interactions have been a significant focus in seagrass fisheries literature. Studies have examined variations in predation pressure between bare sand and seagrass habitats, with the majority indicating that seagrass beds offer superior refuge options. The protective role of seagrass during this vulnerable stage has been corroborated in laboratory experiments, field observations, and tethering studies (Unsworth *et al.,* 2014).

- **Kelp forests**

Large brown macroalgae known as kelps, primarily found in the Laminariales order, are distributed across approximately 25% of the world's coastlines, spanning temperate and subpolar regions in both the Northern and Southern Hemispheres. These kelp ecosystems serve as foundational components in coastal marine environments. Kelps play a crucial role by creating complex biogenic habitats and displaying high rates of primary productivity, contribute to enhanced local biodiversity, support inshore food webs, and promote secondary productivity. Kelp forests represent some of the Earth's most productive and diverse ecosystems, providing essential ecosystem services upon which human societies rely. These services include acting as nursery habitats for economically significant fisheries species, offering biogenic storm defence, and participating in nutrient cycling. However, the distribution, structure, and productivity of kelp forests are susceptible to various environmental factors (such as light, temperature, nutrients, and substrate) and ecological factors (like grazing, competition, and disease). Variability in these factors can result in rapid and widespread changes at the ecosystem level. These populations declined in 38% of the ecoregions studied but increased or remained stable in 68% of them. Multiple drivers, including ocean warming, interacted at regional and local scales to influence these trends.

In conclusion, recent climatic changes have unquestionably altered the structure and distribution of kelp forest ecosystems worldwide. Beyond structural changes, ocean warming has likely affected key processes like primary productivity, carbon capture, resilience to physical disturbances, and habitat provision. However, it's worth noting that not all kelp populations have responded uniformly to warming trends, with some

exhibiting long-term stability. Kelp forests are critical coastal ecosystems that offer vital ecosystem services and habitat for various marine life stages. Nonetheless, they have experienced widespread declines due to various stressors, including climate change-amplified marine heatwaves, eutrophication, altered trophic structures, and human-induced factors. These stressors can impact multiple stages of kelp life cycles, with consequences for ecological and human communities. A region of particular kelp diversity is the Salish Sea, which spans Washington State and British Columbia. This region is home to 21 identified kelp species, with bull kelp (*Nereocystisluetkeana*) serving as the primary canopy-forming species. Most kelps in this area grow as small forests along the shore, facing significant seasonal temperature and salinity fluctuations. These kelp forests are vital habitats for threatened or endangered species like Pacific salmon, rockfish, herring, and abalone. Recent declines in Puget Sound's kelp forests have raised concerns, prompting the Puget Sound Kelp Conservation and Recovery Plan. The drivers of these declines are complex and include factors like rising sea surface temperatures, changes in watersheds, and shifts in marine ecosystems. Mapping efforts in other Salish Sea regions show varying trends in kelp populations, suggesting that stressor impacts differ across basins, but direct comparisons are challenging due to differences in study scales and timing (Hollarsmith *et al.,* 2022).

- **Estuaries**

Estuaries constitute a pivotal element of coastal regions, encompassing an expansive surface area estimated at approximately $1.1 * 10^6$ km^2 on a global scale. These complex ecosystems are subject to diverse definitions, often influenced by the research objectives and disciplinary backgrounds of those who investigate them, as well as the specific processes under scrutiny. Broadly defined, estuaries are semi-enclosed coastal water bodies characterized by a direct connection to the open ocean, where the saline seawater interacts with freshwater originating from land drainage. Over the course of the Holocene epoch, estuaries have undergone remarkable adaptations in response to rapid changes in environmental conditions driven by evolving climatic factors. The evolutionary trajectory of estuaries in the context of rising relative sea levels primarily hinges on two key processes: the deposition of allochthonous mineral sediments and the in-situ accumulation of organic matter. These processes facilitate vertical accretion rates that parallel the ascending sea levels, effectively shaping the estuarine landscape. The circulation within estuaries is governed by the contrasting densities of seawater and freshwater discharged from rivers. This differential density leads to the formation of estuarine circulation patterns critical to these ecosystems' functionality (Duffy, 2021).

Estuaries can be categorized into four distinct types based on their geomorphological features:

Coastal plain estuaries: These estuaries typically manifest as submerged river valleys, retaining their original topographical characteristics as rising sea levels progressively inundate these landscapes.

Bar-built or lagoon estuaries: These estuaries develop in gently sloping coastal areas, enclosed by natural features like spits or barrier islands, with narrow inlets facilitating water exchange with the open ocean.

Fjords (Fiords): Formed through the actions of Pleistocene glaciers, fjords are characterized by U-shaped, deepened river valleys. Glacial deposits create bars and sills that limit the exchange between estuarine and coastal waters.

Tectonically produced estuaries: These estuaries result from geological processes such as subsidence, block slides, faulting, volcanic activity, and landslides, which can isolate land from the ocean, leading to the formation of unique estuarine environments.

The estuaries are thus complex coastal ecosystems that have evolved over geological timescales, influenced by changing environmental conditions and geological processes. Understanding the diverse types of estuaries and the factors shaping their development is vital for preserving and managing these crucial habitats (Karleskint *et al.,* 2012).

(Credits: www.earthspacecircle.blogspot.com; www.globalmaritimehistory.com; www.sites.psu.edu)

Dynamics of marine ecosystem:

- **Marine flora and fauna**

In the realm of oceanic biodiversity, estimating species counts presents a multifaceted challenge. The ocean, older than terrestrial habitats, has fostered life for over 3.7 billion years, and the fossil record attests to its historical richness. Presently, we've identified around 226,000 marine species, but research suggests a potential range of 700,000 to a million species. Remarkably, well-known creatures like whales and dolphins form a small fraction of marine life, constituting only 2-3% of all ocean organisms. Each year, we uncover over 150 new marine fish species, with roughly 5,000 more unknown species awaiting description, a task anticipated to span 30 years. Notably, even larger organisms like crabs, lobsters, shrimp, and fish continue to surface. An estimated 2-8 cetacean species and around 10 marine reptile species are yet to be discovered. (UNESCO)
The ocean's vastness and prolonged existence, coupled with its water abundance, contrast sharply with the land's climate extremes. The ocean's expanse, covering 71% of Earth's surface, offers substantial habitat area, promoting species richness. Deep-sea environments, covering two-thirds of Earth's surface, possess immense potential for discovering unknown species. Yet, diversity can vary with depth and geography. Interestingly, microscopic marine life, like certain protists, bacteria, fungi, and meiofauna, exhibits extensive dispersal, resulting in less biogeographic endemism compared to larger organisms. Consequently, while local species richness thrives, global diversity remains relatively modest. Determining the total number of species poses a challenge, given incomplete knowledge. Approximately two-thirds of marine species have been described, with model-based and expert estimates aligning in many cases. Therefore, the ocean likely houses around 300,000 species, while terrestrial and freshwater environments host approximately 1.7 million. Marine mammals, comprising cetaceans, pinnipeds, sirenians, and marine fissipeds, thrive in diverse marine ecosystems. Sea turtles, with streamlined bodies and air-breathing capabilities, inhabit tropical and subtropical ocean waters. Marine fauna encompasses a vast array of animals, from microscopic zooplankton to massive creatures like blue whales, and their interactions within ocean ecosystems are crucial for environmental impact assessments. This encompasses organisms living in the ocean or relying on it, such as sharks, turtles, seals, sea lions, penguins, and crabs, as well as seabirds and attached seabed species like sponges and corals, which are often addressed under the category of Benthic Communities and Habitats. Many oceanic organisms, both plant and animal, experience drifting phases during their life cycles. This includes plankton, which is aptly named from the Greek word "planktons," meaning 'wandering.' These drifting organisms encompass various types, such as zooplankton, phytoplankton, bacteria, viruses, and even juvenile stages of larger swimming animals. Some coastal and terrestrial species

can also be carried by ocean currents, impacting species diversity on islands. Furthermore, animals like sea turtles and jellyfish can be tracked using satellite tags in relation to local currents. However, some smaller organisms, like copepods, rely on estimates of their drift patterns based on ocean currents (Karleskint *et al.,* 2012).

In another context, marine flora, comprising bacteria, actinobacteria, cyanobacteria, fungi, microalgae, seaweeds, mangrovesand halophytes, are essential oceanic resources, representing over 90% of ocean biomass. These diverse organisms contain valuable medicinally potent chemicals, particularly polyphenols and sulphated polysaccharides, with properties like antioxidation, immune stimulation, and anticancer activity. This review aims to shed light on the largely unexplored potential of marine flora in the search for anticancer compounds, considering the rising cancer incidence and the need for safer and more affordable medicines (Bhoopathy *et al.,* 2010).

- **Ocean currents**

Ocean currents represent the persistent, unidirectional flow of seawater, influenced by gravitational forces, the Coriolis Effect due to wind, and variations in water density. The motion of oceanic water manifests in two fundamental dimensions: horizontally, recognized as currents, and vertically, denoted as upwellings or downwelling. Ocean currents profoundly impact marine life by transporting organisms, redistributing heat, and nutrient dispersion. Recent advancements involve collaboration between biologists and oceanographers. Accurate prediction of currents, driven by solar heating and wind, has improved, revealing their influence on connectivity, migration, and climate-induced changes in marine communities. Currents vary in scale from sub-mesoscale to entire ocean basins like the Gulf Stream. Measuring currents is done Eulerian (fixed location) or Lagrangian (drifter tracking). Numerical models and satellite data complement direct measurements. Global climate change alters ocean currents episodically, affecting population connectivity and migration. Declines in European eels may be linked to North Atlantic current changes. Currents also impact prey distribution, animal movement, and predator targeting (Hays, 2017).

- **Water temperatures**

In most cases, ocean temperatures range from -2°C to 28°C, with variations near hydrothermal vents and land. Ocean temperatures range from -2°C to 30°C (28-86°F), with surface water warmer in low latitude regions and much colder at the poles. Eastern ocean basins tend to be colder due to surface currents. An average ocean temperature is about 4°C.A typical mid-latitude ocean temperature profile shows a warm surface layer (<1000m), a mixed layer influenced by surface winds, and a rapid temperature decline below, known as the thermocline. Deep ocean temperature remains stable at around 2°C.Ocean surface temperatures vary with latitude due to solar radiation balance. Low

latitudes receive more heat, resulting in higher average temperatures, while mid and high latitudes experience greater seasonal temperature changes. Water's high heat capacity moderates annual ocean temperature changes. Tropical surface waters vary seasonally by 1-2°C, midlatitudes by 8°C, and polar regions stay near freezing. Proximity to land and surface water stability amplify annual temperature ranges nearshore. Solar radiation variations contribute to ocean surface temperature differences from warm tropics to cold polar regions. Solar radiation angles, varying with latitude, affect ocean surface temperatures. Deeper ocean layers are colder due to reduced sunlight penetration, with an average deep ocean temperature of 4°C.Ocean temperature variations with depth impact marine plankton and biogeochemical processes, potentially influencing global carbon cycling and climate feedbacks over geological timescales. Understanding temperature-dependency helps decipher Earth's long-term climate and ecological evolution (Boscolo-Galazzo, 2020).

- **Salinity**

Salinity is a fundamental aspect of ocean composition and the seawater is indeed salty, the subtleties of variations in ocean surface salinity refers to the concentration of dissolved salts. These variation, even in small degrees, wield considerable influence over both the water cycle and the intricate mechanisms governing ocean circulation. Salinity typically stands at 35 ppt but can vary from 28-41 ppt, with the highest levels found in the northern Red Sea.Over the course of Earth's existence, various natural processes have contributed to the saltiness of the ocean. One such process involves the weathering of rocks, which introduces minerals, including salt, into the ocean. Additionally, the salinity of the ocean rises through the processes of ocean water evaporation and the formation of sea ice. However, it's important to note that these factors, which elevate salinity, are perpetually balanced by opposing mechanisms that decrease salinity. These counterbalancing processes include the continuous inflow of freshwater from rivers, the deposition of rain and snow, and the melting of ice. To delve deeper into the concept, it is imperative to consider the relationship between salinity and the water cycle. Understanding why the sea is saline requires an exploration of how water transitions through its various physical states within the ocean ecosystem: liquid, vapor, and ice. When in its liquid state, water has the ability to dissolve rocks, sediments, and interact with emissions from volcanic activity and hydrothermal vents. This intricate interplay results in a complex solution of mineral salts distributed throughout our ocean basins. Conversely, when water exists in the form of vapor or ice, it is essentially devoid of salt content (Boscolo-Galazzo, 2020).

A key factor to appreciate is that a significant portion of global evaporation (86%) and precipitation (78%) transpires over the ocean. Consequently, ocean surface salinity

emerges as a pivotal variable for comprehending how the input and output of freshwater influence the dynamics of the ocean. By closely monitoring ocean surface salinity, we can directly observe fluctuations in the water cycle, encompassing phenomena like land runoff, sea ice formation and melting. Additionally, research indicates shifts in seawater salinity, with freshening occurring in high-latitude and rain-dominant tropical regions, while sub-tropical areas characterized by high evaporation rates experience an increase in salinity. These alterations in the water cycle have the potential to significantly impact not only ocean circulation dynamics but also the broader climate systems that shape the world we inhabit (Boscolo-Galazzo, 2020).

Techniques used to study marine ecosystems:

The current concerns regarding Earth's ecosystems and the ongoing loss of biodiversity highlight the imperative to assess variations in biodiversity across different spatial and temporal scales, ranging from local to global. In the ocean, challenges such as over-fishing and other threats to species' populations not only deplete vital resources for society but also lead to significant alterations in ecosystems, endangering numerous mammals, birds, reptiles, and fish. The collection of consistent data through uniform methods and procedures or the generation of compatible variables for analysis is crucial for global and regional assessments. For instance, the European Union's Marine Strategy Framework Directive (MSFD) mandates comprehensive measurements of biodiversity and ecosystem performance to monitor the condition of European marine waters, with the goal of achieving a Good Environmental Status by 2021. Similarly, the World Ocean Assessment underscores the necessity for standardized information reporting. Consequently, there is an ongoing effort to develop "essential" variables essential for biodiversity monitoring and comprehending ecosystem dynamics. Nevertheless, the specific methodologies for measuring these variables and effectively managing and analysing the resulting data remain to be fully elaborated upon. In this context, our review delves into the methodologies employed for observing and sampling marine biodiversity in the field, offers examples of methods and active global monitoring initiatives, and explores the evolution of data systems designed to aid data dissemination and analysis. It's important to recognize that well-established or widely used methods may not necessarily be the most cost-effective or suitable for biodiversity monitoring. Therefore, we also highlight the potential of less conventional methods in addition to those traditionally regarded as standard. This synthesis serves as an introductory guide to the future of monitoring and assessing marine biodiversity (Dickinson and Gunn, 2022).

Essential ocean variables:

The Intergovernmental Oceanographic Commission (IOC) of UNESCO has taken the lead in spearheading the development of a comprehensive ocean observation framework

through the Global Ocean Observing System (GOOS). This framework is centred around what are termed "Essential Ocean Variables" (EOVs). An EOV, as the name suggests, is a critical oceanic parameter that possesses two key attributes: it has a substantial impact in addressing both scientific and societal challenges, and it is practical to observe consistently over time. The scope of EOVs extends beyond the realm of physical oceanic properties to encompass biogeochemical and biological variables, collectively referred to as "ecosystem EOVs." These ecosystem EOVs play a pivotal role in enhancing our understanding of marine ecosystems, complementing the existing suite of physical oceanic variables. In parallel, the Group on Earth Observations Biodiversity Observation Network (GEO BON) has been actively working on the definition of "Essential Biodiversity Variables" (EBVs) (Pereira *et al.*, 2013). Recognizing the potential synergy between the two initiatives, GOOS has collaborated with GEO BON to establish the GOOS Panel on Biology and Ecosystems (GOOS Bio-Eco). This panel is tasked with the formulation and evaluation of ecosystem EOVs.The responsibilities of GOOS Bio-Eco encompass various facets of ecosystem EOVs, including their documentation, best practices, readiness for observation, implementation strategies, coordination of monitoring efforts, and the suitability of the resulting data and information streams for informing policy decisions. Importantly, GOOS Bio-Eco takes into account societal demands and the human-induced pressures affecting marine biodiversity and ecosystems when identifying these EOVs.

In 2013, the inaugural GOOS Biology technical expert workshop was convened in Townsville, Australia, leading to the compilation of a preliminary list of 42 prospective ecosystem EOVs. From this extensive roster, 10 were singled out based on their potential for making a significant impact and their feasibility for sustained observation. These 10 selected ecosystem EOVs are categorized into four major domains essential for fostering a healthy and productive ocean: (1) Productivity, (2) Biodiversity, (3) Ecosystem Services, and (4) Human activities and pressures. Notable examples of these EOVs meeting these criteria include chlorophyll, harmful algal blooms (HAB), zooplankton biomass and abundance, as well as the extent and live coverage of vital marine communities such as coral reefs, mangroves, seagrasses, and salt marshes (Faulkner *et al.,* 2018). Thus the different techniques used to assess the oceanic activity along with the biological, physical and chemical effects are listed below:

❖ **Light traps:**

Light traps serve as a commonly employed tool in entomology for gathering insects, particularly for monitoring pest species. The American Centre for Disease Control has maintained a standardized light trap designed for mosquito surveillance for more than half a century. In addition to mosquitoes, this method is also effectively utilized to survey moths, beetles, and other insects that pose a threat to crops. However, the application of

light traps in aquatic environments has a relatively shorter history. Their initial use was primarily in freshwater settings to capture insects, and they quickly proved to be exceptionally proficient at collecting juvenile fish and zooplankton. Interestingly, they also capture a diverse array of benthic species that ascend from the seafloor during the nighttime hours. Notably, light traps have found extensive utility in research around coral reefs, where the intricate structure of the reef system renders alternative collection methods vulnerable to damage.

It's important to note that light traps may yield varying responses based on species, gender, and developmental stage, making them more suitable for certain organisms over others. Species may exhibit fluctuations in their abundance at different times during the night and lunar cycle. One distinctive advantage of light trapping is its non-invasive nature, ensuring that collected animals remain unharmed. This quality has proven invaluable for sampling museum specimens and laboratory animals. Nevertheless, it's worth noting that the effectiveness of light traps can be diminished in areas characterized by strong currents or excessive water turbidity. Moreover, there is still untapped potential in utilizing light traps to monitor mobile benthic and demersal organisms, primarily crustaceans. These organisms, often referred to as the 'fish food' component of biodiversity, play a crucial role in many ecosystems as a key trophic link. Regrettably, their contribution to marine biodiversity monitoring has been somewhat overlooked (Xiao *et al.,* 2021).

❖ **Continuous plankton recorder:**

The Continuous Plankton Recorder (CPR) survey stands as a remarkable achievement in the realm of marine biological research. It holds the distinction of being the world's most enduring and extensive marine biological survey, with a history that spans back to 1931. This survey encompasses the study of approximately 1000 different taxa over several decades. The CPR survey method involves the systematic collection of phytoplankton and zooplankton from the Earth's oceans and shelf seas. Remarkably, this data is gathered through the collaborative efforts of nearly 30 shipping companies operating ships of opportunity. These ships embark on around 50 trans-ocean routes at monthly intervals, autonomously amassing vital biological and physical data. This far-reaching effort covers an astonishing 20,000 kilometres of ocean per month, spanning from the frigid Arctic waters to the expansive Southern Ocean.The operation of the CPR survey is overseen by the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), which operates as an internationally supported charity, boasting a broad consortium of stakeholders. The legacy of the CPR spans more than six million nautical miles of sea sampled and an astounding 100 million data entries recorded. Plankton specimens are captured on silk bands and subsequently identified by experts. Moreover, in the past decade, the CPRs have been equipped with modern chemical and physical sensors, as well as molecular probes.

The combined resources of the CPR, including its comprehensive database and sample archive, offer a valuable asset for a wide array of environmental, ecological, and fisheries-related research endeavours (Zhou, 2021).

This includes applications such as the molecular analysis of marine pathogens, the development of forecasting models, and the provision of data for innovative approaches to ecosystem and fishery management. In 2011, SAHFOS, in collaboration with 12 other global research organizations employing the CPR, established the Global Alliance of CPR surveys (GACs). This alliance's primary objectives include the creation of new surveys, the development of a global database, and the publication of a global ocean status report. Presently, this global network of CPR surveys systematically monitors regions including the North Sea, North Atlantic, Arctic, North Pacific, and Southern Ocean. New surveys are currently underway in Australian, New Zealand, Japanese, and South African waters, with Brazilian and Indian Ocean surveys in the pipeline. While significant progress has been made in covering vast expanses of the world's oceans, certain gaps still exist, particularly in the South Atlantic, Indian, and Pacific Oceans.This collaborative global network also brings together the expertise of approximately 60 plankton specialists, scientists, and technicians hailing from 14 laboratories worldwide. By working in unison, centralizing their database, and forging strong partnerships with the maritime shipping industry, this network of CPR surveys offers a cost-effective and technologically advanced means to expand and enhance comprehensive marine biological sampling efforts on a global scale (Vsemirnova *et al.,* 2009).

❖ **Reel life survey:**

The Reef Life Survey (RLS) was initiated in 2007 with a groundbreaking vision: to harness the power of citizen science for robust marine biodiversity monitoring. Its primary objective was to engage recreational divers in the collection of scientific data pertaining to biodiversity, spanning various geographic regions, periods, and taxonomic categories that would otherwise be too costly for traditional scientific research. Additionally, RLS aimed to expand upon existing citizen science initiatives like Reef Check and REEF, which provided less detailed data. To facilitate this ambitious mission, the Reef Life Survey Foundation, a charitable organization, was established to oversee the fieldwork. This encompassed the development of appropriate data collection methods, training protocols, data entry procedures, and management systems. The survey methods were rooted in the techniques employed for over two decades by researchers at the University of Tasmania, particularly in the context of monitoring Marine Protected Areas (MPAs). The RLS methodology involves the systematic documentation of three key aspects of biodiversity along 50-meter underwater transect lines. Divers record not only the abundance and sizes of all fish but also the abundance of large (>2.5 cm in length) mobile invertebrates such as echinoderms,

crustaceans, and gastropods, along with cryptic fishes. Furthermore, the extent of sessile invertebrates, macrophytes, and abiotic habitat is quantified through the digitization of photo-quadrats, often using tools like Coral Point Count (Yang *et al.,* 2016).

Diver training is conducted on a one-on-one basis, with novice divers shadowing trained counterparts and replicating transect blocks until they achieve the necessary level of expertise. Interestingly, a comparison of data collected by trained volunteers and experienced scientists at the same sites revealed that the variation attributable to diver experience was not significant, accounting for less than 1% of the overall differences observed between sites and regions. The RLS program exhibits a form of self-regulation, where the most enthusiastic volunteers tend to produce the highest-quality data. This core group of volunteers actively participates and sustains their involvement over time. As a result, a global network of over 100 active RLS divers has been established. The application of RLS methods has yielded groundbreaking results, enabling the first-ever global analyses using standardized, quantitative, and species-level data across various higher taxa. This comprehensive effort has generated data on more than 4,500 species, spanning 2,800 sites and encompassing 600,000 species abundance records. It has covered 43 countries and 83 marine ecoregions, even extending to Antarctica. Many of these sites have been surveyed repeatedly, some annually since 2007. This wealth of data adds significant context to local surveys and provides substantial replication, enabling the examination of complex, interactive, and nonlinear threats to marine biodiversity, including the impacts of climate change, fishing, and invasive species. Notably, RLS has investigated a larger number of Marine Protected Areas (MPAs) than any prior standardized field data effort. Interestingly, their findings indicated that most MPAs did not exhibit detectable differences in fish communities compared to comparable fished areas, effectively labelling them as "paper parks." However, some MPAs stood out as highly effective, demonstrating a prevalence of large fishes and notable conservation success.The RLS dataset is anticipated to become increasingly valuable for various purposes, including assessing the ecosystem impacts of global threats across all levels of the marine food web, quantifying population trends for endangered species, and monitoring international commitments related to marine biodiversity in shallow reef ecosystems (Xiao *et al.,* 2021).

❖ **Harmfulalgal blooms**

HABs are occurrences in which microalgae proliferate extensively in marine or brackish waters, resulting in a range of detrimental consequences. These consequences encompass massive fish die-offs, contamination of seafood with toxins, and disruptions to ecosystems that humans perceive as harmful. To address these issues, comprehensive data on the distribution of toxic and harmful microalgae are collected through national surveillance programs. These programs are primarily designed to safeguard public health,

protect both wild and cultured fish and shellfish, and maintain the quality of bathing water. The methods employed for sampling and monitoring HABs are diverse. They include the use of plankton nets to capture microalgae, collecting water samples, and utilizing molecular tools to detect species or genus-specific algal toxins in fish and shellfish. Additionally, benthic HAB species are gathered from sediment, coral reefs, seaweed, or standardized screens. However, identifying HAB species is a formidable challenge, as many of them are inherently difficult to distinguish, even when employing advanced tools like light microscopes. The challenge of ensuring consistent microalgal taxonomy is addressed through the IOC Taxonomic Reference List of Toxic Plankton Algae within the World Register of Marine Species. For nearly two decades, the Intergovernmental Oceanographic Commission (IOC) of UNESCO has played a crucial role in advancing research related to HABs. They have facilitated efforts to improve observations of harmful algae, offered training opportunities to enhance monitoring capabilities, and supported regional and global networks for sharing knowledge and data. The provision of method manuals and guides is central to the observation of HAB species. The HAB manual serves as a foundational resource for methods and has been supplemented with monographs on real-time observation systems, intercomparisons of quantitative methods, and manuals for sampling and analysis (Vsemirnova *et al.,* 2009).

Global data pertaining to HAB occurrences and their associated impacts are consolidated within the Harmful Algae Event Data Base (HAEDAT), a component of the Ocean Biodiversity Information System (OBIS). The international collation and sharing of HAB data commenced in the 1980s and has been gaining momentum. This data forms the basis for the development of a 'Global HAB Status Report.' The objectives of this report are to provide an overview of HAB events and their societal consequences, offer a comprehensive assessment of the occurrence of toxin-producing microalgae worldwide, and evaluate the status and likelihood of changes in HAB frequencies, intensities, and distribution due to environmental shifts at both local and global scales. Notably, connections will be established with the International Panel on Climate Change (IPCC) to contribute to the reporting on the biological impacts of climate change. The resulting Status Report will serve as a valuable reference for the scientific community and decision-makers, offering insights into the occurrence and impacts of HABs on ecosystem services. IOC UNESCO collaborates with several project partners, including the International Atomic Energy Agency (IAEA), the International Council for Exploration of the Sea (ICES), the North Pacific Marine Science Organization (PICES), and the International Society for the Study of Harmful Algae (ISSHA), to advance research and address the challenges posed by HABs (Yu *et al.,* 2019).

Harmful Algal Blooms Detector **Marine Reel Life Survey**

(Credits:www.reellifesurvey.com;www.mba.ac.uk;www.aquaticresearchshop.com)

Current research trend:

New and exciting developments are anticipated to emerge in the realm of marine biology in the near future. One recent innovation in research involves the utilization of seismic waves to conduct surveys beneath the ocean's surface. These surveys aim to detect a wide range of biological and physical activities, as well as elemental sources. However, like a coin with two distinct faces, the use of seismic surveys presents both advantages and disadvantages. To comprehend this fully, let's begin by examining what is a seismic survey. A seismic survey is a scientific technique employed to explore and study the underwater environment. It primarily relies on the generation and detection of seismic waves, which are shockwaves produced by controlled explosions or mechanical sources, such as air guns, that are introduced into the ocean floor. These waves travel through the Earth's crust and underlying geological layers and are reflected back to the surface, where sensitive instruments known as hydrophones capture the data. The advantages of utilizing seismic surveys in marine biology are noteworthy. Firstly, they provide researchers with a unique and valuable tool for investigating the seabed's geological characteristics, including the identification of potential underwater resources like oil and gas deposits. Additionally, seismic surveys have proven effective in mapping the distribution of marine life, helping

scientists understand migratory patterns, habitat preferences, and population dynamics of various species. This knowledge is instrumental in conservation efforts and sustainable resource management. However, seismic surveys also come with several disadvantages and environmental concerns. The process of generating seismic waves can be noisy and disruptive to marine life, particularly to sensitive species like whales and dolphins that rely on echolocation for communication and navigation. The intense underwater noise produced during seismic surveys can lead to disturbance, displacement, or even injury to these animals. Furthermore, there are concerns about the potential impact of seismic surveys on the health of marine ecosystems and the behaviour of various species. In summary, while seismic surveys hold great promise for advancing our understanding of marine biology and geological processes beneath the ocean, they pose significant challenges and controversies. Striking a balance between the benefits and potential harm is a critical concern, necessitating careful consideration of the environmental and ethical aspects of this research method as it continues to evolve (Duffy, 2021).

Seismic survey:

The utilization of underwater sound for remote sensing of the internal structure of the ocean has a rich history, with various acoustic techniques having been employed for several decades. Ocean-bottom echosounders have been instrumental in monitoring the depths of thermoclines, acoustic tomographic systems have been utilized to detect temperature changes across entire basins, and acoustic Doppler current profilers (ADCPs) have allowed for the measurement of current velocities. High-frequency acoustic surveys (those exceeding 10 kHz) have produced striking images of near-surface internal waves and have successfully captured the intensity of turbulent mixing processes. However, seismic oceanography stands apart from other acoustic imaging methods due to two key distinguishing factors. Firstly, seismic oceanography employs low-frequency sound signals (typically less than or equal to 100 Hz), which exhibit the unique property of not rapidly attenuating with increasing depth in the ocean. This characteristic allows seismic oceanography to probe oceanic depths more effectively. Secondly, seismic oceanography employs a method where each point of interest is repeatedly sampled over relatively short time intervals (approximately 30 minutes), utilizing different configurations of acoustic sources and hydrophones. This approach significantly enhances the signal-to-noise ratio of the data obtained. The distinct features of seismic oceanography combine to provide it with a unique set of three critical advantages:

Multi-Dimensional High-Resolution Observation**:** Seismic oceanography offers a comprehensive two-dimensional, and often three-dimensional, perspective of the ocean's

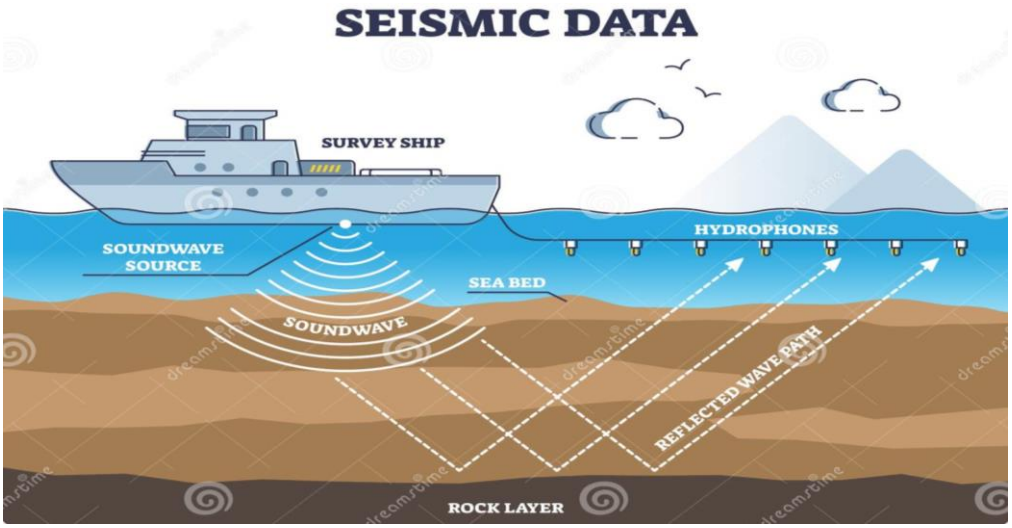
internal structure. It achieves high spatial resolutions in both horizontal and vertical dimensions, typically at the scale of about 10 meters. This capability surpasses many other observational tools, which often provide measurements in only one dimension.

Deep Abyssal Penetration: Unlike acoustic methods that operate at higher frequencies, seismic oceanography can capture the thermohaline structure of the ocean down to abyssal depths, which can extend to several kilometres. This capacity allows for the observation of abyssal regions that would otherwise remain poorly sampled.

Extensive Horizontal Coverage: Seismic data are continuously collected along transects that can span up to approximately 1,000 kilometres in length. This extensive horizontal coverage offers a holistic view of oceanic structures, including features like eddies, which are typically only sporadically sampled, such as through the deployment of occasional probes.

Marine seismic surveys employ powerful sound impulses, often exceeding 230 decibels (dB) in root mean square (RMS), to investigate the ocean floor for hydrocarbon reserves, conduct geophysical research, and establish territorial claims in accordance with the United Nations Convention on the Law of the Sea, as the use of seismic surveys expands, it becomes increasingly important to engage in more extensive regional and international discussions, partnerships, and planning to effectively manage potential environmental risks associated with these activities.The available data indicate several reasons for concern regarding the adverse impacts of anthropogenic noise on various marine species. These impacts encompass a range of issues, including the displacement of natural habitats, disruption of biologically significant behaviours, interference with communication signals, induction of chronic stress, and even the possibility of causing auditory damage. Importantly, the sound impulses generated by seismic surveys extend across temporal and spatial scales that are broader than those typically considered in standard environmental assessments. This means that the effects on marine organisms can manifest acutely, accumulate over time, and potentially result in chronic, ongoing consequences. Given that the noise generated by marine seismic surveys transcends national boundaries and affects marine life across international waters, it is advisable to propose the establishment of an international regulatory instrument. This instrument could potentially take the form of an annex to the existing International Convention on the Prevention of Pollution from Ships, specifically designed to address the issue of noise pollution from marine seismic surveys. Such an international framework would facilitate coordinated efforts to mitigate the environmental impacts associated with these surveys, ensuring the responsible and

sustainable use of underwater sound in ocean exploration and resource extraction while protecting marine ecosystems and species.(CRC Press.(2022).)



(Credits: www.dreamstime.com)

Effects of seismic sounds on the marine environment:

Exposure to sound in the marine environment can have a range of consequences for aquatic animals, encompassing physical harm, alterations in behaviour, and physiological changes. These effects are contingent upon the proximity of the animal to the sound source, with closer proximity increasing the likelihood of physical injury, such as mortality and tissue damage. Conversely, more distant sources are more inclined to induce behavioural and physiological stress responses. Behavioural modifications resulting from sound exposure are particularly intricate to assess because they are heavily context-dependent, and the reactions may not correspond linearly to the intensity of the received sound. Immediate responses to seismic sound, for instance, may be transient and localized, such as an alarm response, making them relatively easier to identify and measure. However, sustained increases in background noise spanning months over extensive areas can lead to chronic effects, such as reduced prey avoidance, which are considerably more challenging to quantify. Physiological responses to sound exposure include elevated levels of stress hormones and compromised immune systems. These physiological changes are chiefly determined by an animal's metabolic rate, which can be gauged by monitoring factors like respiration, oxygen consumption, excretion, or food consumption rates (Dunlop *et al.,* 2018).

It is essential to acknowledge that direct effects of seismic sound on individual marine animals, if severe enough, such as mortality or interference with feeding, can cascade into indirect negative impacts on animal populations. This is especially concerning when combined with other stressors that may be affecting these populations. The

subsequent sections delve into the specific effects of seismic survey sound on various marine species, including zooplankton, fishes, whales (with a focus on baleen whales like right and humpback whales), and sea turtles, to the extent that available information permits. It's worth noting that the North Atlantic right whale, a critically endangered species, is of particular concern in the Georgia region (Sarah, 2019).

- **Physical effects:**

Seismic surveys' noise emissions can inflict physical harm on marine organisms. In instances of severe harm, this can lead directly to the organism's demise. However, indirect mortality may occur when injuries, though not directly fatal (such as organ damage and loss of sensory hair cells), impede the creature's capacity to feed or evade predators.

I. Zooplankton

Despite the pivotal role zooplankton play in marine food webs, our knowledge regarding the physical effects of seismic activity on them remains limited. Many commercially and recreationally significant fish species, as well as the North Atlantic right whale, rely on zooplankton as a primary food source. Substantial reductions in zooplankton numbers across vast regions could disrupt the marine food chain, resulting in diminished fish and whale populations.

Changes in Abundance and Mortality: While scientific investigations on the impact of seismic noise on zooplankton are scarce, recent reports indicate adverse consequences. For instance, a study by McCauley and colleagues in 2017 revealed significant reductions in zooplankton populations off the southeastern coast of Tasmania following experimental airgun detonations. These exposed populations exhibited a median decrease of 64% in abundance compared to control groups (pre-blast), with 58% of the 34 individual taxa identified displaying at least a 50% reduction in abundance. Additionally, there was a two- to three-fold increase in the percentage of deceased organisms, as measured by vital stains. The study suggested that the airgun blast likely harmed the delicate hair-like receptors zooplankton use for navigation, potentially causing diminished abundance and eventual mortality. Calculations indicated that the impact on mortality was over two orders of magnitude greater within 1.2 kilometres of the blast compared to previous research estimates. Subsequent models, based on McCauley's findings, propose that zooplankton located 15 kilometres from an airgun blast may experience a 14% reduction in abundance (Carroll *et al,* 2017).

In a subsequent study by Fields and colleagues in 2019, copepods were collected and placed in experimental bags at varying depths and distances from seismic airguns. Immediate mortality was measured by counting the number of deceased individuals one

hour after exposure. It was found that immediate mortality significantly differed from control groups when the distance from the airguns was 5 meters or less. One week of post-airgun blast, the mortality of zooplankton positioned 10 meters from the blast was 9% higher than that of the control groups but not significantly different for samples located 20 meters from the blast. However, the increase in mortality, compared to controls, did not exceed 30% at any distance from the airgun blast. In contrast to McCauley et al. (2017), this study suggests that seismic blasts have limited effects on the mortality of copepods within 10 meters of the blast and no measurable impact at greater distances (Sarah, 2019).

II. Fishes

Fishes possess three pairs of otolith organs responsible for detecting particle motion. These organs consist of the otolith itself and sensory hair cells that transduce the mechanical stimulus of particle motion into electrical signals for processing in the central nervous system. Fishes are nearly the same density as water, while the bony otolith is significantly denser, resulting in differential amplitude and phase responses to sound. Consequently, hair cells in contact with the otolith undergo shearing displacement, which they convert into neurological responses interpreted as sound.

Temporary Threshold Shift: Intense sound exposure can lead to hearing threshold shifts, which can be temporary (TTS) or permanent (PTS) and result from physical damage to the sensory hair cells within the auditory system. In fishes, TTS is not classified as an injury since sensory hair cells are continually replenished and replaced when damaged. The duration required for hearing to return to normal after exposure to a sound causing TTS varies and depends on numerous factors, including the intensity and duration of sound exposure. While experiencing TTS, individual fish may face an elevated risk of mortality due to disruptions in their ability to communicate, avoid predators, or locate prey. Nonetheless, the effects and significance of varying levels of TTS on free-living fishes remain unexplored (Carroll *et al,* 2017).

III. Barotrauma

Injuries resulting from high sound levels and increased air or water pressure collectively constitute barotrauma. Fishes with swim bladders are more susceptible to physical injury from underwater sound exposure than those without swim bladders because sound waves cause the swim bladder to expand and contract with fluctuating pressures, potentially causing trauma as it impacts internal organs.A significant portion of the research on fish barotrauma due to low-frequency sound has focused on pile driving, which generates acute, high-intensity, low-frequency sound similar to airguns used in seismic surveys. A literature review conducted in 2017 by Carroll and colleagues found that

exposure of freshwater fishes to pile driving led to substantial damage to internal organs, including the swim bladder, liver, kidney, and gonads. Fish species with enclosed swim bladders appeared more susceptible to barotrauma from pile driving than those with swim bladders connected to the gut. Larger fish were more prone to injury than smaller ones, potentially due to differences in swim bladder resonance, although smaller fish exhibited delayed onset of injuries and longer recovery times.

IV. Whales

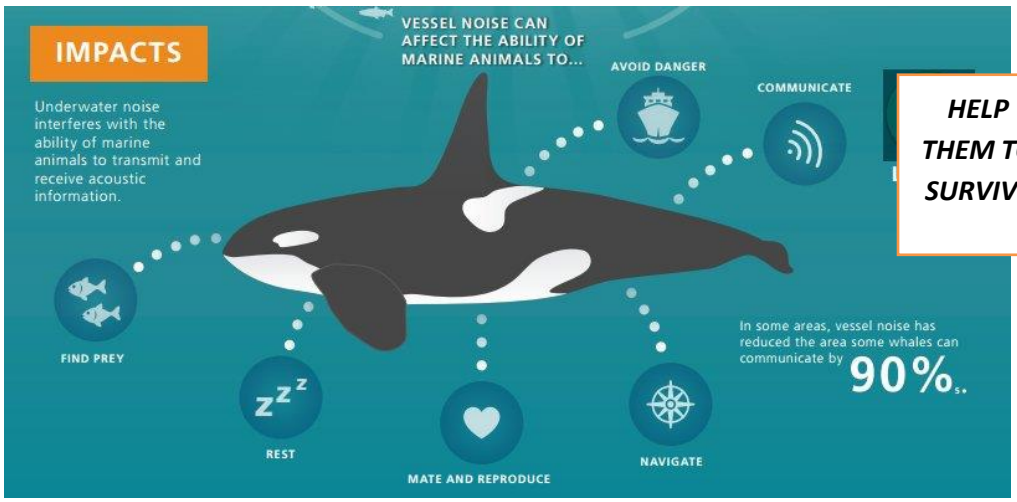
The estimated audible frequency ranges for baleen whales, including the North Atlantic right whale, are derived from vocalization frequencies, anatomical modelling, and limited anecdotal observations of spontaneous responses to tonal signals in free-ranging animals. These findings suggest that baleen whales belong to a distinct, low-frequency-oriented hearing group with a general hearing range spanning from 7 Hz to 35 kHz.Presently, data on temporary threshold shifts (TTS) exist for only four species of cetaceans (bottlenose dolphins, belugas, harbour porpoises, and Yangtze finless porpoises) and three species of pinnipeds (Northern elephant seal, harbour seal, and California sea lion). These animals were exposed to a limited range of sound sources, primarily tones and octave-band noise, in laboratory settings. However, no data on sound-induced hearing loss are available for baleen whales, as there have been no direct measurements of hearing for these species (Carroll *et al,* 2017).

V. Sea Turtles

There is a scarcity of studies investigating the physical effects of seismic airgun activity on sea turtles. It is conceivable that exposure to seismic airguns could fatally harm sea turtles in close proximity to the sound source, such as underwater explosions. Another potential physical impact on sea turtles from seismic surveys is entanglement in equipment, whether towed by a vessel or deployed on the seabed. While a review by Nelms and colleagues in 2015 found no peer-reviewed literature documenting such incidents, there were reports of anecdotal accounts of turtle entrapments in tail buoys and airgun strings during offshore seismic surveys off the west coast of Africa. Additionally, there was an incident where eight olive Kemp ridley turtles became entangled in ocean bottom cable gear off Gabon (Duffy, 2021).

Mortality: Nelms and colleagues' literature review in 2015 identified only one study that specifically investigated evidence of sea turtle mortality linked to seismic surveys. A marine and terrestrial monitoring program during a seismic survey operation documented observations of 16 turtles over an 11-day period. Eight live turtles were spotted at sea, while eight dead turtles were discovered, four of which were in the ocean and four

stranded on land. Of the deceased turtles, five showed signs of interactions with fishing activities or human consumption of turtle (Sarah, 2019).



(Credits: www.safety4sea.com)

The utilization of seismic survey techniques raises significant concerns owing to the adverse consequences it entails. While these surveys offer valuable large-scale data, they also bear responsibility for causing detrimental effects on the marine ecosystem and the interconnected food chain. Consequently, this jeopardizes the delicate ecological balance that plays a pivotal role in Earth's natural cycles, essential for sustaining life forms within the natural world. Seismic surveys involve the emission of powerful sound waves deep into the ocean to map subsurface structures, often linked to offshore energy exploration and geological research. These high-energy sound waves, though effective in their purpose, have far-reaching repercussions. The acoustic energy can cause harm to marine life, particularly to sensitive creatures like whales, dolphins, and fish, by disorienting them, damaging their hearing, or even driving them away from their habitats. Furthermore, the disruption to the marine ecosystem triggered by seismic surveys can have cascading effects throughout the food chain. The dislocation of species from their habitats can lead to reduced prey availability for predators, causing imbalances and population declines in various marine organisms. These disruptions ripple through the ecosystem, potentially affecting species that rely on these organisms for sustenance, creating a domino effect that can disturb the entire ecosystem. In essence, the ecological costs of seismic surveys are not limited to the immediate environment but extend to the broader ecological framework that underpins the functioning of our planet. The intricate balance of nature, essential for the survival of countless species and the maintenance of Earth's vital processes, is put at risk by the potential damage inflicted by these surveys. Therefore, while seismic surveys provide invaluable information, their ecological consequences must be thoroughly

considered and mitigated to ensure the sustainability and harmony of the natural world (Sarah, 2019).

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COVID-19 UNMASKED: UNVEILING MENTAL HEALTH, PREVENTION AND LIFESTYLE IN THE PANDEMIC ERA

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Abstract:

The COVID-19 pandemic has had a huge influence on the general population around the world, in addition to its impacts on people's physical health. This paper provides an overview of how COVID-19 affects mental health, discusses prevention measures, emphasises the importance of maintaining a healthy lifestyle during these tough times. First off, the epidemic has increased stress levels and heightened vulnerability to mental health issues like anxiety, depression, and others. Isolation, infection dread, financial uncertainty, and changes in daily routines have all contributed to the aggravation of these psychological problems. Second, preventative strategies are essential for controlling the spread of COVID-19 and lessening its negative effects on mental health. In the study, it is addressed how important it is to follow public health recommendations including immunization, physical separation, mask wearing, and hand washing. Further, adopting a healthy lifestyle is also important if you wish to control your general welfare throughout the epidemic. The importance of consuming a balanced diet, getting regular exercise, and getting enough sleep is emphasized. The COVID-19 outbreak has brought attention to mental health problems and has prompted the need for comprehensive measures to assist the general public. By treating mental health issues, putting preventive measures in place, and embracing a healthy lifestyle, people can better manage the epidemic's psychological repercussions. Healthcare organizations, policymakers, and communities must work together to focus mental health assistance and promote resilience among the general people in this global tragedy.

Keywords: COVID-19, Mental Health, Life style, Prevention, Population

Introduction:

The COVID-19 also know as severe acute respiratory syndrome coronavirus 2 (SARSCoV-2) and middle east respiratory syndrome coronavirus (MERS-CoV), and commonly known as the novel Coronavirus is believed to have originated from a wet market in Wuhan, Hubei province, China (Wang *et al*., 2020). WHO, declared it a pandemic on March 11, 2020, first known cases occurred in late December, 2019, and has increase all

over the world, resulting in a huge number of hospitalizations and deaths (Cucinotta and Vanelli, 2020).

COVID-19 has product in an increase the risk factors for mental health problems in population. The unpredictability and improbability, lockdown and physical distancing might lead to social isolation, loneliness, inactivity, limited access to basic services, increased access to food, alcohol, and decreased family and social support, especially in older and vulnerable people, have been prominent racial and ethnic disparities in associated mortality (Hooper 2020).

The lethal effects on mental health and quality of life, because of decline in the economy caused by COVID-19 lead to unemployment, financial insecurity and poverty, which hinder the access to health services (Roca *et al*., 2013). WHO and other international organizations sponsor for incorporation of mental health and psychosocial support into the COVID-19 response, later a UN policy concise suggests that investments will reduce the mental health response. It has been severely advocate sanitizing their hands frequently, wearing a mask and maintaining social distance (Chiu *et al*., 2020).

During lockdown in India, the people affect in a different way with regards to their age, sex, profession, socioeconomic status or their residential area. Health professionals would be more distressed than some other professionals and a person who is without his family without all the necessities may be as distressed in COVID-19. In India, a report from states like Kerala where closing of outlets selling alcohol has also led to withdrawal symptoms and suicides by alcohol addicts (Jayakumar, 2020). Students hampered academic activities and people with emptying supermarkets have been also experience depression, anxiety and stress during the Covid-19 outbreak (Roy *et al*., 2020). The research is an attempt to fill this break so that potential systems adaptations, and recognize public health as an important priority that can be well planned by policy makers.

SARS-CoV-2

Scientists have debated on the origin of the novel coronavirus and SARS-CoV-2 (Andersen *et al*., 2020). It has been hypothesized that COVID-19 is the product of laboratory manipulations from Wuhan, China. On the other hand, genetic data does not sustain this hypothesis and shows that COVID-19 did not derive from a previously known virus backbone (Almazan *et al*., 2014). The genomes analysis of earlier known coronavirus genomes indicate that COVID-19 presents unique features that differentiate it from other coronaviruses: finest affinity for angiotensin converting enzyme 2 (ACE2) receptor and a polybasic cleavage site at the S1/S2 spike junction that determines contamination (Andersen *et al*., 2020; Nao *et al*., 2017). The most recent common coronaviruses date the

epidemic to between late November 2019 and the beginning of December 2019, which were the first statement cases and there was overlooked human transmission (Huang *et al*., 2020).

Disease presentation

The mild to severe symptoms in patients with SARS-CoV-2 infection with a large portion of population being asymptomatic carriers. Most commonly reported symptoms are shortness of breathing, cough and fever, patients with pneumonia their chest X-ray shows multiple mottling (Wang *et al*., 2020; Zhu *et al*., 2019). Other gastrointestinal symptoms including abdominal pain, vomiting and diarrhea are shown in covid-19 patients, and respiratory symptoms are common (Chen *et al*., 2019).

Decrease levels of lymphocyte, eosinophils counts and hemoglobin values where as increases in WBC, neutrophil counts, and serum levels of LDH, CRP, ALT, and AST in COVID-19 patients (Lippi *et al*., 2019). Lung are the main target of coronavirus infection, ACE2 receptors is widely giving out in lungs, which lead to gastrointestinal, liver, cardiovascular, kidney and central nervous system damage in covid-19 patients (Hamming *et al*., 2004; Renu *et al*., 2020). The acute respiratory distress syndrome degenerate swiftly and die of multiple organ failure in covid-19 patients induced by "cytokine storm" (Wang *et al*., 2020).

In severe COVID-19 cases, secondary hemophagocytic lymphohistiocytosis syndrome has been illustrate, and is characterized by increased interleukin (IL)-2, IL-7, interferon-c inducible protein- 10, granulocyte colony stimulating factor, macrophage inflammatory protein 1-a, monocyte chemoattractant protein 1, and tumor necrosis factor-a (Huang *et al*., 2020).

SARS-COV-2 transmission

The transmission of SARS-CoV-2 occurs with high efficacy through the respiratory route. The main recognized route is droplet transmission and another route is aerosols transmission (Leung *et al*., 2020; Han *et al*., 2020). The virus has another route of transmission oral-fecal route, has been spot in the stool of COVID-19 patient and sewage may have a role in the transmission of virus (Holshue *et al*., 2020). In the saliva of infected individuals COVID-19 has been detected due to the presence of ACE2 receptor in salivary gland ducts (To *at al*., 2020; Liu *et al*., 2011). In the residential sites of COVID-19 confirmed patients' virus have been detect on non-living surfaces such as surface of cell phones and door handles. Therefore, the individuals who have come into get in touch with infected non-living surfaces could be infected if get in touch their mouth, eyes or nose (Han *at al*., 2020). There is no mother to child transmission of a virus into pregnant women with

confirmed COVID-19, even though virus cannot be transmitted in breast milk (Chen *et al*., 2020).

COVID-19 and mental health

The risk factors for mental health troubles increased due to COVID-19. Related to COVID-19 symptoms of depression, anxiety, and stress increased in general public, other psychosocial stressors also increased such as fear of illness, life disruption, or fear of negative economic effects (Wang *et al*., 2020). Due to worries about getting the virus, financial hardships, social isolation, and uncertainty about the future, the pandemic has increased stress and anxiety levels. Depression and mental disorders have become more prevalent as a result of the protracted period of isolation, fear, and disturbance of everyday routines (Sniadach *et al*., 2021). Physical separation and isolation requirements have led to a rise in social isolation and loneliness (Reger *et al*., 2020). There has been an increase in substance addiction, particularly alcohol and drug misuse, as a result of the pandemic's pressures (Chacon *et al*., 2021). Many people's ability to get mental health care has been hampered by the pandemic. It is difficult for people to seek and receive the support they require because there are few in-person treatment sessions available, mental health facilities are closing, and the healthcare system is overburdened.

Viral testing

One of the most important steps in the diagnostic process is the COVID-19 viral testing. For diagnosing COVID-19, polymerase chain reaction testing is the most popular and reliable approach. These tests look for the virus' genetic material (RNA) in a person's respiratory sample, which is commonly taken from the nose or throat. Rapid diagnostic techniques that identify specific viral antigens from respiratory samples are known as antigen assays (Kevadiya *et al*., 2021). Antigen testing are performed using nasal or throat swabs, similar to PCR tests (Pavia *et al*., 2021). For the purpose of detecting infected people, putting in place the necessary public health measures, and delivering essential medical care, COVID-19 testing is essential.

Viral load in respiratory

The amount of virus presents in a person's respiratory sample, such as a nasal or throat swab, is referred to as viral load, and it is a crucial component in assessing the contagiousness and severity of COVID-19 (Pavia *et al*., 2021). The viral load in respiratory sample is directly correlated with an individual's infectiousness. Higher viral loads denote the presence of more virus, increasing the likelihood that the individual may spread the infection to others (Dadras *et al*., 2022). High viral loads make people more infectious, especially if they are coughing, sneezing, or talking while exhaling respiratory droplets that

contain the virus. Implementing public health interventions like isolation, quarantine, and contact tracing requires careful assessment of the virus load in respiratory samples (Ashcroft *et al*., 2022). Health care providers that are able to offer the right advice and treatment based on each patient's unique needs should conduct the viral load testing.

Serology

The main purpose of serology tests is to establish whether a person has ever had SARS-CoV-2 infection. These tests search for particular antibodies that the immune system creates in reaction to the virus, such as IgM and IgG (Hou *et al*., 2020). Serology tests are most useful a few weeks after the onset of symptoms or exposure since antibodies take time to form. Although the presence of antibodies suggests prior virus contact, immunity or full protection from reinfection are not guaranteed (West et al., 2021; Cromer *et al*., 2021). Following COVID-19 infection, the degree and persistence of immunity are still being researched. It is crucial to remember that serology tests by themselves should not be used to assess a person's level of immunity or their capacity to spread the virus.

Prevention and vaccination

The management of COVID-19 transmission and the protection of persons and communities depend heavily on COVID-19 prevention and immunization. Many nations have developed and approved COVID-19 vaccines for use in emergency situations. One of the best strategies to avoid a COVID-19-related serious illness, hospitalization, and death is through vaccination (Cocciat *et al*., 2022). Face masks can help prevent the spread of respiratory droplets that can contain the virus, especially in busy indoor situations and when social seclusion is impossible. Masks should be worn in conjunction with other preventive measures and should properly cover the mouth and nose (Kisielinski *et al*., 2021). It is advised to stay away from busy areas and huge gatherings. Regarding COVID-19 prevention strategies and vaccine advice unique to your area, it's critical to rely on reliable and recent information from reputable health organizations, such as the World Health Organization or the Centres for Disease Control and Prevention.

Lifestyle after COVID-19 pandemic

Our lives have been significantly impacted by the COVID-19 pandemic, and as we move into a post-pandemic environment, a number of facets of our way of life might continue to change. Here are some things to think about when making lifestyle changes following the COVID-19 epidemic. Beyond the pandemic, improved hygiene practices might endure. To stop the spread of COVID-19 and other respiratory infections, regular hand washing, the use of hand sanitizers, and respiratory etiquette can become ingrained habits (Chiu *et al*., 2020). The epidemic brought attention to the value of good mental health and

wellbeing. It's likely that mental health will continue to receive more attention. It has posed enormous challenges to economies, healthcare systems, civilizations, and people as a whole (Chakraborty and Maity, 2020). A global response has been launched in an effort to stop the virus's rapid spread, lessen its effects, and ultimately end the pandemic due to the virus' considerable impact on public health and wellbeing.

Conclusion:

The connection between physical and mental health has come into focus as a result of the COVID-19 pandemic. The general public's wellbeing depends on comprehensive initiatives that address mental health issues, support preventive actions, and promote a healthy lifestyle. To adequately support mental health and promote resilience in the midst of this global catastrophe, cooperation across healthcare systems, policymakers, and communities is crucial. We can better manage the issues raised by COVID-19 and create a more resilient society by giving mental health the same priority as physical health.

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