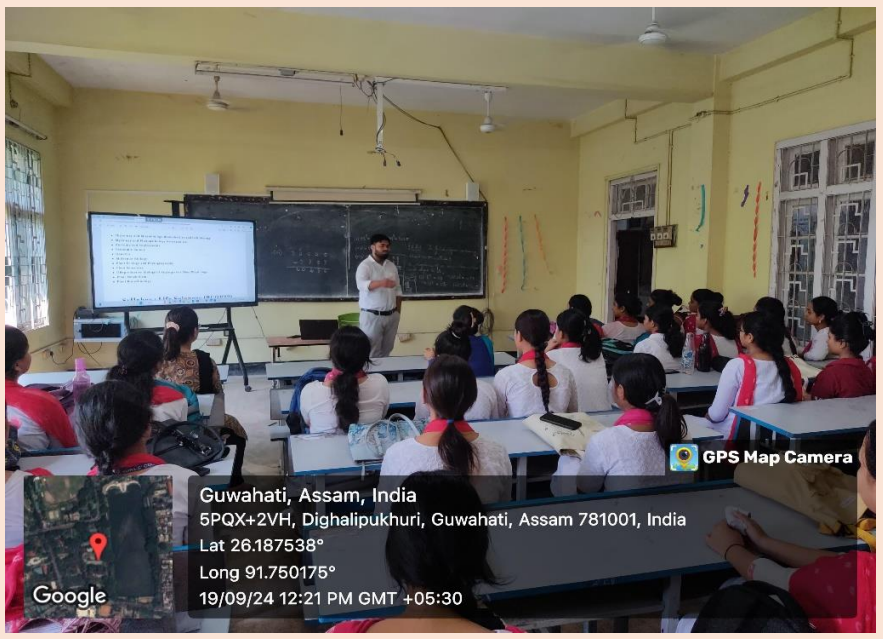
ACTIVITIES OF THE DEPARTMENT

One day field visit to ICAR and Central Agricultural University, Umiam, Meghalaya on 12th November, 2024

Interactive Session on JAM/GATE, 2025 by Prof. Swaroop Nandan Bora

Workshop on preparation for competitive examination by SPM IAS academy

Gibbon Day celebration, 2024



Career guidance counselling and preparation for competitive exams by Assistant prof. Uddipta Borthakur

Celebration of National Nutrition Week, 2024

One day field workshop on traditional knowledge and intellectual property rights at Kahua L.P School, Kulshi, Kamrup district on 14th September, 2024 under the auspices of national innovation foundation-India

Inauguration day of Departmental Wall Magazine 2024

World Environment Day, 2024

Excursion to Sikkim with B.Sc 4th Semester in March, 2024

Field trip to Manas National Park, 2023

Departmental farewell ceremony to Associate professor
Dr. Bandana Nabis Das (retired HOD, depart. of Botany)

Issue Day of Hortus Vol IV, Issue IV, October, 2023

FUTURE-READY MINDSET: THRIVING IN THE 21st CENTURY

Dr. Paramananda Saikia
Ph.D Entrepreneural Scientist
MilliporeSigma, Burlington, Massachusettes, USA
E: mail:paramasd@yahoo.com

In today's world, information is readily available to anyone with the desire to learn. For instance, if someone wants to know about a specific flower or plants, they can simply search the internet bypassing traditional textbooks or consulting teachers. This search provides comprehensive details and credible references, which is a significant advantage. Before the internet, students had no choice but to rely on textbooks or consult teachers to gain knowledge. The key takeaway is that information is now at our fingertips, opening countless opportunities for innovation across all fields to improve humanity.

Are we innovating at the same pace at which we access information? Perhaps not—there is always room for improvement. A major opportunity today is the ability to work cross disciplinary boundaries. For example, as a biologist, I can now easily access knowledge from fields like mathematics or quantum physics. Innovations don't occur in isolation; they thrive through collaboration and cross-disciplinary work. Imagine, for instance, an astrophysicist (who studies the sky) when look at plant or human cell structure under a microscope, they may offer a completely fresh perspective, spotting things a biologist might overlook.

How about when we collaborate cross functional areas to explore new ideas to solve a problem? It is very common see that researchers focus solely on their area of expertise, reluctant to engage with distantly related fields. While this focus is important for making progress and securing funding and publications, it's crucial to remember that knowledge alone isn't enough—how we apply that knowledge for the benefit of society matters even more. A great example is the rapid development of COVID-19 detection assays during the pandemic. Scientists worked tirelessly to create assays, while others developed the necessary tools to detect and analyze the data. This cross-functional collaboration was vital in identifying COVID-19 patients and preventing further spread. So, how do we foster effective cross-functional teamwork? It begins with networking. Networking is essential in today's world because it allows us to meet new people and build trust. It's a chain reaction: one connection leads to many others, expanding your circle of resources and expertise.

Ultimately, attitude is everything. We must cultivate an attitude of continuous learning and collaboration. For instance, while professionals are highly skilled in their respective domains—teachers in education, engineers in design, etc.—there are times when we must step outside our usual roles and take on tasks outside our comfort zones. The question is: do you have the attitude to learn something new and take on challenges beyond your routine responsibilities? If we embrace the right mindset, network effectively with the right people, and stay willing to learn, there is no limit to what we can achieve in pursuing our dreams.

জাতীয় ফল নেমুৰ গুৰুত্ব বাঢ়িছে

ড° মহেশ গগৈ

গুৱাহটীৰ বজাৰত নেমুৰ দাম চকুত লগা ধৰণে বৃদ্ধি পোৱা খবৰটোৱে (information) নেমু খেতিয়কসকলৰ মনত আশাৰ সঞ্চাৰ কৰিছে। লগতে এই কথাটো আলোচনা হৈছে যে মহানগৰীৰ বজাৰত প্ৰতিটো নেমু দহ টকাত বিক্ৰী হ'লেও কিন্তু কৃষকে সঠিক মূল্য পোৱা নাই। অপ্ৰিয় হ'লেও এই কথা ক'বলগীয়া যে এহাতে অনিয়ন্ত্ৰিত বজাৰ ব্যৱস্থা আৰু আনহাতে চৰকাৰে গ্ৰহণ কৰা কৃষি নীতিয়ে কৃষকক খেতি কৰিবলৈ মুঠেও উৎসাহিত কৰিব পৰা নাই। ফলত নেমুকে ধৰি আন কৃষি শস্যৰ উৎপাদন আশাব্যঞ্জক হোৱা নাই। উল্লেখ্য, ৰাজ্যখনত থলুৱাভাৱে উৎপাদিত, পুষ্টি গুণসম্পন্ন কৃষি ফচলবোৰ দেশৰ ভিন্ন প্ৰান্তলৈ ৰপ্তানি কৰাৰ বাবে চৰকাৰৰ উদ্যোগত এলানি পৰিকল্পনা (planning) যুগুত কৰাৰ কথা কাকতে-পত্ৰে পঢ়িবলৈ পাইছিলোঁ। পৰিতাপৰ কথাটো হ'ল জাতীয় ফল (state fruit) বিপননৰ বাবে কৰা সেই পৰিকল্পনা এতিয়াও ফাইলৰ মাজতে সোমাই আছে। সি যি নহওক, ক'ভিডৰ সময়তে 'পাণবাৰী বড়োফা এগ্ৰ' অৰ্গেনিক' নামৰ সংস্থাটোৰ লগতে ব্যক্তিবিশেষৰ তৎপৰতাত অসমৰ নেমুৱে লণ্ডনৰ বজাৰ শুৱনি কৰিলে। সেই দিশটোলৈ লক্ষ্য কৰিলে বুজিব পাৰি যে দেশৰ লগতে বিদেশৰ বজাৰতো আমাৰ জাতীয় ফলবিধৰ ভাল চাহিদা আছে।

অসমৰ মাটিত হোৱা নিৰ্দিষ্ট লক্ষণবিশিষ্ট নেমুবিধক ২০১৯ চনত ভৌগোলিক সূচাংক প্ৰদান কৰাৰ লগতে চলিত বৰ্ষত, অথাৎ ২০২৪ চনৰ ১৩ ফেব্ৰুৱাৰীত অসম চৰকাৰে ৰাজ্যিক ফল হিচাপে ঘোষণা কৰিলে। উক্ত ঘোষণাত ফলবিধৰ স্থানীয় নাম —'কাজি নেমু' বুলি কৈছে যদিও সেই নামটো যথাযথ হোৱা নাই যেন লাগে। আৰু নামটোৰ ক্ষেত্ৰত থকা বিসংগতি সম্পকেঁ ইতিপূৰ্বে প্ৰকাশিত লেখাত তথ্য সহকাৰে আলোচনা কৰিছোঁ। লগতে অসমৰ জাতীয় ফলবিধক 'জাতি নেমু' বুলি ক'ব পাৰি নেকি সদাশয় ৰাইজক বিচাৰ কৰি চাবলৈ অনুৰোধ কৰিছোঁ। কিয়নো কাজি (Kaji) হ'ল কাগজি (Kagzi)ৰ অসমীয়া ৰূপ আৰু এই শব্দটো পাৰ্চী (আৰবিক) ভাষাৰ 'কাগজ' (Kagaz)ৰ পৰা আহিছে, যাৰ অৰ্থ বগা-পাতল ছালৰ ফল। সচৰাচৰ যিটো Sour Lime (*Citrus aurantifolia* Swin.) ফলবিধতহে দেখা যায়, নেমুত (Sour Lemon) নহয়।

গঠনৰ ফালৰ পৰা নেমু *Citrus limon* (L.) Burm f., এবিধ সৰল-মঙহাল শ্ৰেণীৰ ফল আৰু এইবিধ ফলক 'হেছপেৰিডিয়াম' বুলি কয়। ইয়াৰ বহিস্ত্বক-মধ্যস্ত্বক লগ লাগি ফলটোৰ বাকলিখন তৈয়াৰ হয়। লক্ষণীয়ভাৱে অন্তস্ত্বকখন ভিতৰলৈ সোমাই গৈ কেইবাটাও কোঠালিৰ সৃষ্টি কৰে আৰু সেই কোঠালিবোৰত ৰসমোনা থাকে। নেমুৰ ৰসত এছকৰবিক এচিড (ভিটমিন-'চি'), চাইট্ৰিক এচিড, মেলিক এচিড, ছুক্ৰজ, চেনি, গ্লাহক'চাইড, পেকটিন, এন্থ'ছায়'নিন, বিটা-কেৰ'টিন, চৰ্বি আৰু তেল থাকে। ইফালে নেমুৰ বাকলিখনত কেইবাবিধো প্ৰতিজাৰক (antioxidant) পদাৰ্থ, যেনে- পেকটিন, এন্থ'ছায়'নিন, বিটা-কেৰ'টিন, হেছপেৰিডিন, লিম'নিন আৰু নেৰিনজিন থাকে। সেয়ে নেমুৰ ৰস খালে আমাৰ দেহৰ ৰোগ প্ৰতিৰোধ ক্ষমতা বৃদ্ধি হয়। বিচাৰ্যৰ কথাটো এয়ে যে উল্লিখিত পদাৰ্থবোৰ পূৰঠ নেমু এটাত পৰ্যাপ্ত পৰিমাণে থকাৰ বাবে ফলটো কাটিলে এক ফুৰফুৰীয়া গোন্ধ ওলায়। সেই গোন্ধটো অনন্য। একমাত্ৰ অসমৰ থলুৱা জাতৰ নেমুতহে উপলব্ধ হয় তেনেকুৱা আকৰ্ষণীয় গোন্ধ (aroma) বা সুগন্ধি।

নেমু এবিধ ঔষধি গুণসম্পন্ন ফল। নেমুৰ ৰসে হজম শক্তি বঢ়ায়। গৰম পানীৰ লগত নেমুৰ ৰস মিহলাই খালে শৰীৰৰ ওজন হ্ৰাস পায়। পুৱা শুই উঠি মুখ-হাত ধোৱাৰ পিছত খালী পেটত নেমুপানী খাব লাগে আৰু নিয়মীয়াকৈ খোৱাৰ অভ্যাস কৰিব লাগে। সেইদৰে নেমুৰ ৰস সেৱন কৰিলে দেহত উৎপন্ন হোৱা কেঞ্চাৰ কোষৰ বৃদ্ধিত বাধা দিয়ে বুলি এখন গৱেষণা পত্ৰত পঢ়িবলৈ পালোঁ। সাতে-পাঁচে মিলাই এই কথা ক'ব পাৰি যে 'জাতি নেমু' এবিধ পুষ্টি গুণেৰে সমৃদ্ধ অসাধাৰণ ফল। ই অসমৰ জলবায়ুৰ লগত খাপ খোৱা এবিধ মুল্যবান উদ্ভিদ।

Photo plate: Three distinct lemon [*Citrus limon* (L.) Burm f.] varieties of Assam

Variety: Jati nemu or Kaji nemu
Growing locality: Kokrajhar & Chirang district.

Variety: Jati nemu or Kaji nemu
Growing locality: Charaideo, Tinsukia, Sivasagar and Golaghat district.

Variety: Elachi nemu
Growing locality: Kokrajhar district.

Variety: Jora nemu
Growing locality: Assam, mainly boarder areas of Nagaland, AP and Bhutan.

ARTIFICIAL PHOTOSYNTHESIS

Dr. Manashi Kalita, Associate Professor

There is no limit to the energy requirement of mankind. Fossil fuels like petroleum and coal meet 80% of the energy requirement. Chemical energy stored in the fossil fuels is converted by the plants from sun light using photosynthesis. Thus, the most important process for providing energy to mankind has been photosynthesis. While the energy requirement is going up, the fossil fuel stored in the earth has been diminishing continuously. According to one estimate, petroleum will last for next 50 years while coal will last for next 110 years. As the conversion of plants to fossil fuel takes millions of years, it is inevitable that the fossil fuel stored in earth will be exhausted by end of 22^{nd} century.

In order to meet the ever-increasing demand for energy, researches have been going on to replicate the artificial photosynthesis for converting solar power to chemical energy. In photosynthesis, chlorophylls in plants convert solar energy, carbon di oxide and water to oxygen and carbohydrates. In artificial photosynthesis, solar energy is used to produce hydrogen from water by splitting the water molecule. There are several schemes for simulating photosynthesis artificially. Two main schemes are - Photocatalytic Water Splitting (PWS) and Photochemical Cells or Photoelectrochemical cell (PEC)

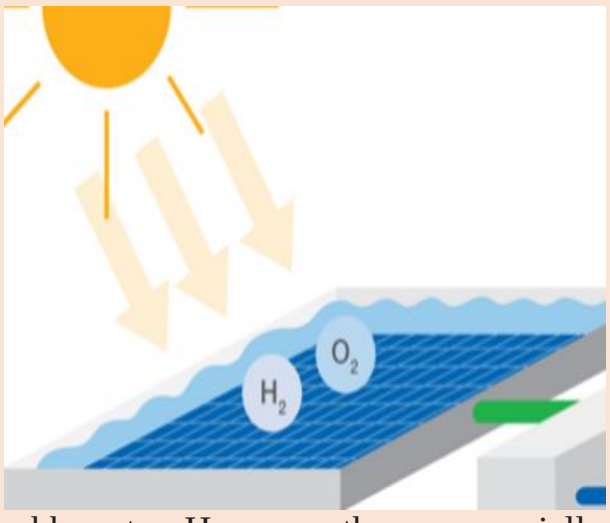
In Photocatalytic Water Splitting (PWS), photocatalyst is used to split water into hydrogen and oxygen using sun light i.e. $2\ H_2O \rightarrow 2\ H_2 + O_2$

The process involves following steps:

Step I: Production of hydrogen from water. The photocatalyst sheet is soaked in water and exposed to light.

Step II: Splitting of water molecule into hydrogen and oxygen.

Step III: A synthetic catalyst is used to produce olefins from hydrogen and carbon di oxide.



PWS is the simplest of artificial photosynthesis. It can help in producing Hydrogen fuel and olefins from hydrogen. Olefins are group of hydrocarbons like ethylene, propylene etc. which are used for production of production of plastics, detergents, rubber etc. However, the commercially viable process for this is yet to be developed. Photocatalysts plays the most important role in the process. Several groups of photocatalysts are used in the process. Some of them are -

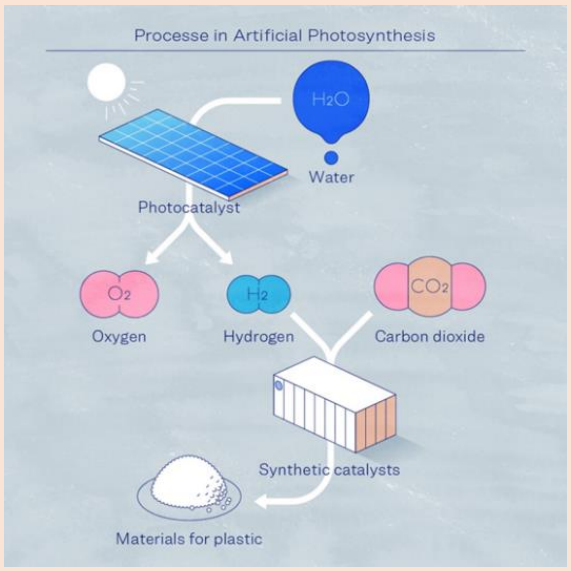
i. Semiconductor material: Silicon, Germanium, Gellium phosphide, Iridium phosphide etc.
ii. Nanomaterials: Carbon nanotubes (CNTs), Graphene, Quantum dots (CdS, CdSe) etc.
iii. Metal Sulfides: Cadmium sulphides, Zinc Sulfides etc.
iv. Pervoskites: Bismuth ferrites, Strontium titanate etc.
v. Bimetallic and Trimetallic Oxides: Titanium-zrinconium oxide, copper-zinc oxide etc.

Besides, polymeric materials like conjugated polymers, Biomimetic material (eg. Photosynthetic protein) and hybrid materials (e.g. metal organic frameworks, MOF) are also used.

The choice of the photocatalyst depends on different factors like band gap energy, stability and durability, surface area and morphology, charge carrier mobility and cost. The photoctalyst plays the most important role in the process and is responsible for utilising solar energy to split water molecules. Their main functions are as follows:

a) Light Absorption: It absorbs photon from sun light.
b) Generation of Electron-Hole pairs: The absorbed energy excites the electrons and they move to the conduction band leaving behind positively charged holes
c) Charge Separation: It prevents recombination of electron and positive holes
d) Redox Reaction: The excited electrons and the valence bond holes react with water molecules to produce oxygen and hydrogen
e) Catalysis: Photocatalysts reduces the requirement of activation energy needed for water splitting reaction

One important application of PWS is the conversion of CO_2 emitted from factories to olefin by using hydrogen, generated by this process. This helps in reducing the emission of greenhouse gases.



Photoelectrochemical cells (PEC) produce olefins like ethanol, methanol etc. which can be used as fuel. It is done by reducing carbon di oxide or by splitting water. PEC contains a semiconductor material (photo electrode). The photo electrode absorbs sunlight and drives an electro mechanical reaction that splits water into hydrogen and oxygen. The process is also used to reduce carbon di oxide to produce chemicals like methanol which can be used as fuel.

Photoelectric cells consist of -

a) Two photo electrodes *viz*. photoanode and photocathode. The electrodes are semiconductor materials. They absorb sunlight and generate electrons and holes.
b) Counter electrode - completes the electric circuit and allows flow of electron.
c) Electrolyte - a solution (normally water with a solvent) containing ions. The ions take part in the redox reactions at electrodes.
d) External Circuit - connects the electrodes to complete the circuit allowing flow of electron.

The electrochemical process is initiated by the absorption of photons by photo electrodes. This excites the valence bond electrons and makes them move to conduction of band creating holes in the valence bond. The electrons are collected at the photocathode or counter electrode for reduction reaction while the holes are collected at photoanode to participate in oxidation reaction. At photo anode, hole oxidise water molecules to form oxygen while at photocathode, electrons reduce protons (H^+) to produce hydrogen gas.

The prime utility of artificial photosynthesis is the production of hydrogen fuel, olefins etc. and to reduce the greenhouse gases. However, the use of this technology is still in nascent stage. Several researches throughout the globe are engaged on to make it commercially viable. According an estimate, artificial photosynthesis market is expected to grow to 185 million USD by 2030. The growing demand for cleaner energy and need to reduce GHG emission are likely to drive this technology in coming days reducing dependence on fossil fuels. It is presumed that the commercial feasibility of this technology will soon be established.

Large corporate like SunHydrogen, Siemens, ENEOS, Mitsubishi Chemical, Toyota, Toshiba are investing heavily in the development of this technology. In 2021, researchers from Toyota Central R&D Labs developed a large, cost-effective artificial photosynthesis system that produces formation which may be used as solvent for in spray lacquers, enamels, varnishes and latex paints. These have achieved a solar to chemical conversion efficiency of 10.5% which can be considered as quite high. Within next 10 years, Toyota plans to start commercial production of the systems.

In India, researchers are actively engaged in this field of energy tapping mechanism. Govt. of India has launched National Green Hydrogen Mission (NGHM) with an aim to increase green energy use in India. The mission supports researches in the Artificial Photosynthesis which may play a very important role towards use of Green Energy. It is expected that India will soon be able to use this technology on a commercial basis.

References:

1. Mitsubishi Chemicals Group, <*https://automotive.mcgc.com/sustainability/artificial-photosynthesis/*>
2. Wikipedia , <*https://en.wikipedia.org/wiki/Artificial_photosynthesis*>
3. National Green Hydrogen Mission, <*https://mnre.gov.in/national-green-hydrogen-mission/*>
4. A Saravanan et al, 2021, Science Direct, “Biohydrogen from organic wastes as a clean and environment-friendly energy source: Production pathways, feedstock types, and future prospects”, *Bioresource Technology, vol 342*, <*https://www.sciencedirect.com/science/article/abs/pii/S0960852421013638*>
5. Markets and Markets, *https://www.marketsandmarkets.com/Market-Reports/artificial-photosynthesis-market-94334557.html*
6. Nature Portfolio, <*https://www.nature.com/articles/d42473-021-00577-7#:~:text=In%202021%2C%20researchers%20from%20Toyota,a%20one%20metre%20squared%20cell*>

THE FUTURE PROSPECTS IN BIOLOGICAL SCIENCES IN INDIA

Mr. Sadiqul Ahmed, Assistant Professor

The biological sciences, a field encompassing a wide range of disciplines such as botany, zoology, microbiology, biotechnology, biochemistry, environmental science and more, offer an array of career paths in both the public and private sectors. This diversity of opportunities reflects the expanding role of biological research and applications in health, agriculture, environmental management, pharmaceuticals and biotechnology.

Government Job Opportunities in Biological Sciences

Government jobs in the field of biological sciences are highly valued in India due to job security, respect, structured career growth and benefits. Public sector jobs in biology are available across a range of fields, including research, healthcare, education, environmental management etc.

Key Government Employers in Biological Sciences

***Research Institutions*:** The Government of India has established numerous research institutions, such as the Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR), Indian Council of Medical Research (ICMR) and Defense Research and Development Organisation (DRDO). These funding agencies offer JRF and SRF positions to post graduate students under funding agencies like CSIR, ICMR, DBT, DST etc., where they could peruse PhD degree in biological sciences.

***Universities and Academic Institutions*:** Universities funded by central and state governments often seek teaching staff, research scholars and lab assistants in biological sciences.

***Healthcare Sector*:** Government hospitals, research centers and organizations such as the National Centre for Disease Control (NCDC) and National Institute of Virology (NIV) hire biologists, microbiologists and biotechnologists to handle laboratory testing, diagnostics and research related to public health issues.

***Environment and Forest Departments*:** For those interested in environmental science, government bodies like the Ministry of Environment, Forest and Climate Change (MoEFCC) and the State Forest Departments provide roles related to wildlife conservation, species conservation, environment or ecosystem management and biodiversity research. The Indian Forest Service (IFS) is directly aligned with environmental and conservation work, making it ideal for biology graduates interested in wildlife management, ecology and forestry.

Qualifications and Examinations:

Securing government jobs in biological sciences in India generally requires a minimum of a master's degree, with many roles preferring or mandating a PhD. Key examinations and eligibility tests include:

NET (National Eligibility Test): Conducted by the University Grants Commission (UGC) and the Council of Scientific and Industrial Research (CSIR). Qualifying NET is essential for lecturer roles in colleges and universities, for JRF positions and very recently to get admission into PhD course.

ICMR JRF Exam: This examination is necessary for entry into research positions under the Indian Council of Medical Research.

GATE (Graduate Aptitude Test): Many research and technical roles consider GATE scores as part of their eligibility criteria.

Civil Services Examination and Biology as an Optional Subject: The UPSC Civil Services Examination allows candidates to choose Zoology or Botany as optional subjects, which can be advantageous for biology graduates.

State-Level Civil Services Examinations:

Many Indian states hold their own State Public Service Commission exams, similar to the UPSC. They *often* recruit candidates with a biology background for roles within state-level agricultural, forest and health services.

Private Sector Job Opportunities in Biological Sciences:

The private sector in India offers equally compelling opportunities in biological sciences, particularly due to advancements in biotechnology, pharmaceuticals, environmental services and agricultural technology.

Key Private Sector Employers in Biological Sciences:

Pharmaceutical and Biotechnology Companies: Industry leaders such as Biocon, Dr. Reddy's Laboratories, Cipla, Sun Pharmaceutical, Torrent Pharmaceuticals, Mankind Pharma, Serum Institute of India etc. are major employers of biologists and biotechnologists. They offer roles in research and development, quality control, production and regulatory affairs.

Environmental Consultancies: With increased awareness of environmental protection, private companies in environmental consultancy provide roles in ecological research, environmental impact assessment, sustainability assessments and conservation planning.

Agricultural Technology Firms: Companies like Monsanto, Bayer CropScience, and Syngenta employ professionals to innovate in the fields of genetics, plant breeding and crop management.

Food and Beverage Companies: Organizations such as Nestle, Amul and Britannia employ biotechnologists, microbiologists and quality assurance experts to oversee food safety, *quality control and new product development*.

Qualifications and Skills Required*:*

A bachelor's or master's degree in a relevant field is typically required for private sector roles, though specialized positions may necessitate a PhD. Key skills for private sector roles in biological sciences include:

***Technical Proficiency*:** Knowledge in advanced lab techniques, including PCR, chromatography and microscopy, is essential.

***Data Analysis and Bioinformatics*:** Especially in biotech and pharmaceutical roles, familiarity with data analysis software and bioinformatics is advantageous.

***Regulatory Knowledge*: An** understanding of regulations, particularly in the pharma and biotech sectors, is critical for quality control and clinical research roles.

Government Vs Private Jobs in Biological Sciences

Feature	Government Jobs	Private Jobs
Job Security	High; stable and secure	Moderate; based on performance and company status
Salary	Structured; moderate starting salary with regular increments	Variable; higher starting salary but performance-based hikes
Work Environment	Often formal and hierarchical	Flexible, with an emphasis on innovation
Growth Prospects	Steady growth based on seniority	Fast-paced; dependent on performance and skills
Benefits	Pension, health insurance, housing, and other perks	Performance bonuses, health insurance, stock options
Work-life Balance	Good, with regulated hours	Can be demanding, especially in R&D roles

Startup Opportunities:

Biology students have tremendous scopes in entrepreneurship that leverage their scientific knowledge with respect to the growing global interest in health, sustainability and technology.

***Mushroom Cultivation*:** Mushroom cultivation is increasingly popular due to its culinary and medicinal applications. This business could be expanded by offering value-added products, such as dried mushrooms or mushroom supplements.

***Floriculture*:** Floriculture is another promising field, given the constant demand for cut flowers, potted plants and decorative flowers for special events, celebrations and seasonal markets.

***Nurseries and gardening*:** Nurseries and gardening services are also flourishing, especially in urban areas where interest in home gardening and plant aesthetics is growing.

***Landscaping*:** Landscaping and green infrastructure design present another substantial opportunity. Commercial properties, residential complexes and cities increasingly seek ecologically sustainable and attractive green spaces.

***Ecotourism*:** Ecotourism and botanical walk startups offer a path for students interested in combining plant science with tourism.

***Eco-friendly Product Manufacturing*:** Botany students can start companies producing plant-based or biodegradable products, such as organic fertilizers, plant-based packaging or natural pest repellents.

***Herbal and Medicinal Plant-Based Products*:** With expertise in plant pharmacology, botany graduates can create startups focused on herbal supplements, skincare and medicinal products derived from plants.

***Wildlife Conservation and Ecotourism*:** Zoology students can create ecotourism companies that offer guided wildlife tours, organize biodiversity conservation camps or operate eco-lodges.

***Wildlife Rehabilitation Centers and Animal Rescue Services*:** Starting a wildlife rehabilitation center or mobile rescue service for injured or endangered animals can help address human-wildlife conflict and poaching.

***Sustainable Aquaculture and Fisheries*:** Developing sustainable aquaculture practices or creating a startup focused on breeding high-quality, disease-resistant fish can help meet rising global food demands.

Both government and private sectors provide diverse and promising career opportunities for the students of biological sciences in India. Government roles are ideal for those seeking job stability, structured growth and a commitment to public service, while the private sector suits those eager for a dynamic environment, higher earning potential and innovation-driven roles. Ultimately, the choice between government and private sector jobs depends on personal career goals, priorities and aspirations. Moreover, by bridging biology with business and technology, students can transform their scientific expertise into profitable and impactful ventures.

VERTICAL FARMING AND URBAN AGRICULTURE

Purabi Basumatary

M.Sc-3rd Semester

As urbanization accelerates and climate change threatens global food security, innovative approaches are needed to sustainably nourish cities. Vertical farming and urban agriculture offer promising solutions, harnessing technology and creative design to cultivate crops within urban environment. These practices can also enhance local environmental condition. The term “vertical farming” was coined in 1915 by American geologist Gilbert Ellis Bailey. Since then, architects and scientists have repeatedly looked into the idea since then, especially toward the end of the 20th century.

Urban agriculture refers to the practice of cultivating and producing food in urban areas, while vertical farming involves growing crops in vertically stacked layers, utilizing innovative technologies to optimize plant growth. Key methods include hydroponics, a soilless cultivation technique that uses nutrient-rich water and aeroponics, where plants grow in an air or mist environment without soil or water. Controlled Environment Agriculture further enhances these systems by manipulating environmental factors to create ideal conditions for growth.

These practices help bolster food security by reducing dependency on complex supply chains, making cities less vulnerable to disruptions. Efficient use of urban spaces and the potential for repurposing abandoned buildings contribute to sustainable urban development. These practices significantly reduce greenhouse gases, water consumption and soil erosion compared to traditional agriculture methods. Moreover, vertical farming has the potential for carbon sequestration and reduced greenhouse gas emissions.

Examples of successful urban agriculture initiatives include the Closed Loop Vertical Farm in Chicago, Gotham Greens’ rooftop greenhouses in urban areas, and Sky Greens’ vertical farming system in Singapore.

In conclusion, urban agriculture and vertical farming hold significant potential to revolutionize food production, making it more sustainable, efficient, and resilient. By integrating these practices into urban planning, cities can address food security challenges and contribute to a greener, more self-sufficient future.

"DARK OXYGEN: THE UNSEEN FORCE IN OUR ATMOSPHERE" – NEW DISCOVERY OF SCIENCE

Dikshita Talukdar

M.Sc-1st Semester

Imagine a world where oxygen, the most essential element for life forms, had a hidden twin! Meet dark oxygen, a lesser-known entity shrouded in mystery. The discovery of Dark Oxygen, also known as Reactive Oxygen Species (ROS), will fundamentally change our understanding about the marine ecosystem. Scientists observed an unexpected increase in oxygen concentration in some areas of the abyssal zone (where sunlight is extremely low and insufficient for photosynthesis). Researchers noted that this finding represents a new source of oxygen where photosynthesis does not occur and termed it as 'dark oxygen'.

Oxygen is a critical component of marine ecosystem not just for the creature that live there but also for the chemical reaction that sustain all life on earth. Before this discovery, it was considered that oxygen in the deep sea primarily originated from the surface ocean where it is produced by photosynthetic organisms like Phytoplankton. This oxygen rich water then sinks and is transported to the deep ocean through a process called Thermohaline circulation also known as the Global conveyor belt. The deep -sea oxygen was largely a balance between the influx of oxygen and its consumption. But in an attempt to better understand the oxygen consumption in the deep sea, researchers stumbled upon something extremely exciting. Over several years a team of researchers set out to measure oxygen consumption in the Clarion-Clipperton Zone, a remote region of the Pacific Ocean known for its Rich deposits of Poly metallic nodules. The team used Advanced Benthic Chamber Landers and placed these chambers over different patches of sea floor. Inside the chambers they added inorganic Carbon and dead algae to stimulate different environmental conditions. The researchers measured the level of oxygen and unexpectedly found that the increase in oxygen level inside the chambers. After getting the same result over several experiments, in 2021 they verified their findings with an additional oxygen measuring method known as the Winkler titration but they get the same results and they called it as "Dark Oxygen" since it is produced in the absence of light. This discovery raises concerns about potential damage to ecosystems that rely on this oxygen source. A study released in November 2023 revealed that deep-sea mining could negatively impact deep-sea jellyfish by generating mud plumes in the ocean, which disrupt the nutrient and reproductive cycles of various marine species.

The discovery of dark oxygen has far-reaching implications for science and challenges the assumption that only photosynthetic organisms, such as plants and algae, produce oxygen on Earth. It could mean that Earth has a new source of oxygen that could support life.

HYDROPONICS-A PROMISING AGRICULTURAL SYSTEM

Chayanika Das
M.Sc-3rd Semester

Continuous change of land use due to population growth, rapid urbanization and industrialization are the main reasons behind the shrinkage of agricultural land in highly populated and developing country like India. Besides, climate change, unavailability of labour etc. possess major limitations against the growth of the present-day agriculture. Moreover, there is shortage of sufficient food to feed the growing population in the country. In order to meet the current and future food demand, there is a need to create and use alternate farming strategies. Among, many such new agricultural practices, hydroponics is one, which is gaining popularity among the farmers now-a-days. In hydroponic system, growing of crops using vertical space can also be realized in case of land limitations/soil health issues with the aim to ensure food security.

In Hydroponics technique of growing crops nutrient solutions or an inert medium, such as perlite, vermiculite, gravel, coir, or mineral wool etc. are used to provide mechanical support to bear the plant's weight and anchor its root structure. According to Giro et al. (2016), hydroponics system is a suitable technique to produce vegetables in urban areas to enhance food security. The basic idea behind this technology is to allow the plant roots to come in contact with the nutrient solution. Hydroponics used for the production of vegetables (tomatoes, lettuce, cucumbers and peppers), fruits (strawberry), ornamental crops (carnations, rose and marigold) and medicinal crops (Aloe vera and coleus) etc. Plants grown by hydroponics have shown high yield, rapid harvest and high nutrient content.

The hydroponic system is classified and modified according to availability of space and other resources such as growing medium and supporting media. Generally used systems in hydroponics are - wicked system, ebb and flow system, drip system, deep water culture system and nutrient film technique. In a hydroponics system, frequency and amount of application of the nutrients depend on the substrate type, crop type, container size, irrigation systems and the existing environmental conditions. Generally nutrient is applied early in the morning in between 6.00 to 8.00 am and should be given to the roots zone to keep away from disease. Control of pH is also very essential in a hydroponic system as it changes continuously according to the growth of the plants. For most nutrient solutions, the optimum range of pH is 5.5 to 6.5 for the accessibility of nutrients for the majority of species.

In this system, nutrient solutions are provided directly to the root of plant consequently plants grow faster as compared to field crop. The main advantages of this technique are - efficient nutrient management, higher planting density, better quality, clean product and increased yield of the produce. As compared to soil-based culture, 1/5th of total area and 1/20th of overall water is requiring to growing of plants under hydroponics system. The possibility of infestation of soil-borne disease, pest or weed is very less in this system thereby reducing the use of insecticide, pesticides, fungicide and herbicide. For the area under cold, heat stress and dessert etc. This technique of cultivation is very useful. Crops grown hydroponically are less vulnerable to climate change thus offseason cultivation of produce is possible. For an efficient and economically viable hydroponics system, technical knowledge, experience and the high initial investment are essential. For plant health, great care and water quality are also required to be maintained.

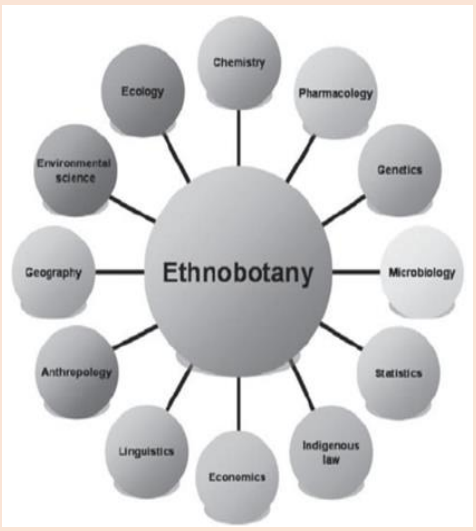
Hydroponics is seen as a promising technique for growing different vegetables round the year in limited spaces with improved yield and quality products. It can contribute greatly in areas with limitations of land, water even for the poorer and landless people. Even urban farming may get a new dimension through this system. In India, it is projected that hydroponic industries grow exponentially in coming years. There is a need to develop low-cost hydroponic technologies that can reduce the dependence on labour and lower overall operational costs to encourage commercial hydroponic farm, as a future farming option, it holds very good prospects as many start-ups are flourishing with it and provides local food security and quality of the food.

References:

1. Giro, A., Capellino, S., Ferrante, A. (2016). Vegetable production using a simplified hydroponics system inside City of Dead (Cairo). Adv. Hort. Sci., 30(1), 23-29.
2. Sardari, M.D. and Adman, S.V. (2013). A review on plant without soil – hydroponics, IJRET 2(3), 299-304.
3. Sinha Anuradha, Singh Digvijay and Swapnil Hydroponic - A New Method of Growing Crops Without Soil. Agriallis 2(3): 35-39

ETHANOBOTANY-A MULTIFARIOUS SUBJECT

Yougasmita Choudhury
B.Sc-5th Semester



Ethnobotany is the study of use of plants indigenous people. It provides details on the traditional uses of plant resources that can be practiced for integrated development of the ethnic communities.

The knowledge of ethnobotany is not so recent. Stephen Powers (1873) first coined the word “Aboriginal Botany” and explained in the form of simple definition as the “study of vegetation used by aboriginals for their various commodities such as food, shelter, medicine, textiles, ornaments, etc.”. Based on this concept, the term "ethnobotany" was first used in 1895 by John William Harshberger, a botanist at the University of Pennsylvania, to refer to the use of plants by indigenous people. Since then, it has been defined as the traditional knowledge of indigenous communities, about plant diversity and their uses. The word is derived from the terms "ethno" the study of people and "botany" for the study of plants. Ethnobotany deals with the direct relationship of plants with man. Dr. Sudhanshu Kumar Jain is known as the “father of Indian Ethnobotany.

Ethnobotany is the scientific study of cultural practices and traditional knowledge in relation to religious, medicinal, and other uses of plants. It primarily focuses on the study of native plants as well as their practical application using the customs and traditional knowledge of the local populations, which can be used towards the development of societies. It broadly deals with the investigations, observations, and identifications of botanical diversity used for the prevention and treatment of human and livestock ailments. One gains knowledge about using plants in curing of various ailments through years of consistent practice. The ethnic people are the main repositories of traditional knowledge of various uses of plants and this knowledge are transmitted to generation after generation.

The terms ethnobotany and traditional medicine are not similar. Traditional medicine's early roots must have been in ethnobotanical folklore, but it now includes a number of well-organized, unique systems of diagnosis and treatment. Ayurveda, Siddha, and Unani are the three traditional medical systems that are acknowledged in India. The study of foods, fibres, dyes, tans, other beneficial and harmful plants, taboos, avoidances, and even magico-religious beliefs about plants are all included in ethnobotany.

The importance of ethnobotany is multifarious. The ethnobotanical studies shed light on several unidentified useful plants as well as novel applications for many well-known plants that can be used to create new markets for certain plant-based products and agro-based industries. The direct or natural relationship between man and plants is universally acknowledged. This includes the use of plants by both tribal and non-tribal people without any reference to developing or primitive societies. A multidisciplinary field of study, ethnobotany has applications in sociology, anthropology, taxonomy, photochemistry, archaeology, ecology, agriculture, medicine, linguistics, and other fields. In the modern era, ethnobotany has grown to be an important and essential area of study and development in resource management, sustainable use, biodiversity conservation, and socioeconomic development. Medicinal plants also provide a source of drugs to defeat various diseases for the majority of the global population today. During last few decades, some drugs such as quinine, cocaine, taxol, digoxin have been discovered from plants, due to the knowledge of ethnobotany. It also encourages awareness for establishing a link between biodiversity and cultural diversity as well as the mutual influence of plants and humans. Botanists, social scientists, anthropologists, and practitioners of traditional medicines from all over the world are currently researching how people interact with plants in their natural environments.

References:

a) Jain S.K., 1987. A manual of Ethnobotany by published by Scientific publishers Jodhpur.
b) Jain Vartika and Jain S K., 2016. Compendium of Indian Folk Medicine and Ethnobotany. Deep Publications, New Delhi, India.

ELEPHANT APPLE-A TRADITIONAL REMEDY

Akansha Boruah
B.Sc 5th semester

Dillenia indica, commonly known as Elephant Apple, is a large acidic flavoured fruit and belongs to the family Dilleniaceae. The plant is a tropical evergreen tree that is native to Indonesia, but some may expand its origin to encompass India, Sri Lanka, Bangladesh, Southwestern China, Vietnam, Thailand & Malaysia. It is popularly known as elephant apple for Its knobby shape which looks like an elephant's toe. It is noteworthy to be mentioned that it serves as the main food source for wild elephants. The genus Dillenia has two important species, i.e., D. indica and D. pentagyna, which are widely distributed in many Asian countries. The pulp is enclosed by greenish yellowish husk which is hard and very leathery containing numerous seeds. Fruits emit a sourish smell at the time of ripening. The fruits are rich source of nutrients. The ripe fruits are eaten as raw and could be processed to make commercial products such as pickle, curries, jams and jellies.

In Assam, elephant apple is known as 'Ou tenga'', which is a popular fruit and is widely used in the state. Elephant apple is a staple ingredient in Assamese cuisine and has been used since ancient times. It is a common ingredient in fish recipes, and is used to make sour and tangy curries.

Besides being used as an ingredient in Assamese traditional recipes, elephant apple also has notable potential medicinal uses. A few of them have been listed below-

1. Beneficial for stomach and helps in curing constipation. Increases digestion ability.

2. Helps in reducing and controlling high blood pressure or hypertension.

3. It has large amounts of vitamin A which is beneficial for the eyes. It also helps to protect us from eye conditions like cataract, glaucoma, and macular degeneration which occurs due to aging.

4. Its inner glutinous pulp is beneficial for hair which makes it strong and smooth, provides nutrition to hair follicles, reduces dandruff.

5. It has the ability to control diseases like Leukemia.

6. Though diseases like stomach pain, diarrhea, etc., needs medical consultation, the elephant apple can also cure to some extent.

7. The leaves of elephant apple when scattered in the storehouse of harvested paddy crops, plays a vital role in keeping insects and reptiles away from damaging the harvested crops.

8. According to Assamese folklore, it is believed that if "Ou tenga" and its leaves are kept under the beds of the bedroom, it controls increase in diseases like chicken pox due to its antiseptic and antiviral properties.

9. "Ou tenga" is also known as 'Cardio tonic'. Its juice is very much beneficial for the people with heart diseases. It controls the regulation of heartbeat. It is beneficial for the people who are suffering from high triglycerides and high cholesterol.

10. It acts as an antiaging agent because of the presence of large amounts of vitamin C, vitamin E, flavonoids and antioxidants. This helps in increase in amount of collagen which improves the elasticity of our skin.

11. It is very much good for kidney function which helps in removing various toxins from it during filtration process in our body.

12. It plays a vital role in controlling diabetes and is also considered as a No. 1 medicine for patients with diabetes. It controls the blood sugar level along with regulation of pancreas function which produces insulin.

13. It also works as a medicine for the people suffering from cold, cough, fever and Pharyngitis.

BOTANY IN SPACE: GROWING PLANTS BEYOND EARTH

Aditi Gogoi
B.Sc-5th semester

Growing plants in space is more than a fascinating scientific endeavor—it is a crucial step toward sustainable human exploration and habitation beyond Earth. Plants are essential for life support, providing fresh oxygen, absorbing carbon dioxide, and serving as a renewable food source. As we look to establish human presence in space, cultivating plants has moved from science fiction into a necessary part of future missions. Not only can space-grown plants supply food, but they also contribute to oxygen production, water recycling, and mental well-being, making them indispensable for long-term space exploration and potential settlements on other planets.

As extended missions to the Moon, Mars, and beyond become a reality, space botany has emerged as an essential area of research with the potential to reshape life in space. Space environments present unique agricultural challenges: no soil, limited sunlight, and a lack of gravity. On Earth, gravity directs roots downward, and helps plants in absorbing water and nutrients; however, in the weightlessness of space, plants must find alternative ways to grow. To support them, scientists have developed innovative systems, such as hydroponics and aeroponics, where plants grow in water or nutrient-rich air, eliminating the need for soil.

On the International Space Station (ISS), NASA's "Veggie" project has shown that leafy greens, mustard, and even flowers like zinnias can thrive in microgravity using carefully calibrated light, temperature, and humidity. Veggie was built by ORBITEC in Madison, Wis- consin (Sierra Nevada Corporation acquired OR- BITEC in 2014) under the NASA Small Business Innovation Research (SBIR) program.

Experiments in space botany offer critical insights for developing sustainable agriculture in Earth’s most challenging environments—from arid deserts to dense urban areas where traditional farming is impractical. As we set our sights on Mars, space agriculture could pave the way for self-sustaining colonies by creating controlled environments that shield plants from extreme temperatures and radiation. Recent experiments with simulated Martian soil indicate that, with specific adjustments, certain plants can indeed thrive on Mars, expanding the possibilities for life beyond Earth.Research in space botany also influences agriculture on our planet, advancing innovative techniques like vertical farming and water-efficient systems essential for urban food production. By addressing the unique challenges of growing plants in space, we discover new paths toward sustainable agriculture here on Earth. Ultimately, the quest to grow plants in space is more than just science; it symbolizes hope and adaptability.

As we venture farther from Earth, plants will be essential in creating self-sustaining life systems, showing us that wherever humanity travels, nature can come along. In this journey to explore new worlds, plants are not merely companions; they are vital partners in our survival and a testament to resilience, growth, and the essence of life.

References:

a) https://www.nasa.gov/exploration-research-and-technology/growing-plants-in-space/
b) https://science.nasa.gov/biological-physical/focus-areas/plant-biology/focus-areas/

CLIMATE CHANGE AND PLANT MIGRATION

Debasmita Deka

B.Sc-5th semester

Climate change poses significant threats to ecosystems worldwide by altering weather patterns, temperature and precipitation. One of the lesser discussed but crucial impacts of the climate change is plant migration. For plants, migration is a way to survive in response to climate change.

As human-generated greenhouse gas emission causes the world to rapidly warm, scientists have observed that plants are shifting towards the poles and upslope. They also noted that old ecosystems are being suddenly replaced by new ones due to disturbances in the environment. Plants around the world are now forced to find new homes because of shifting climate condition in their original habitats.

Change in the climate can alter plant's seed dispersal methods by affecting the wind strength and direction. As a result, direction and distance travel by seeds are also changed.

Climate change also affects some biological events like flowering and fruiting. Many plants are beginning to bloom earlier in the year due to warmer temperature. This shifting of biological events can lead to mismatch with pollinators and other organisms, promoting plants to migrate to areas where their reproductive timing aligns better with the environmental conditions.

In response to climate change, some plants have evolved to produce seeds with different traits such as - different size and weight, which can influence their dispersal methods. Lighter seeds are able to travel further while heavier seeds may rely on animals for dispersal.

Plant migration is a critical response to climate change. Understanding these patterns is essential for conservation efforts and future prediction of ecological changes. Plant migration can alter ecosystems, species interaction and can lead to biodiversity loss.

STUDENT ART WORK

NEW SPECIES: THREE NEW 'DANCING GIRLS' GINGER SPECIES DISCOVERED IN NORTH EAST INDIA

Annysha Choudhury and Farhana Akhtar
B.Sc-5th semester

Globba tyrnaensis *Globba janakiae* *Globba yadaviana*

Researchers from the Indian Institute of Science, Education and Research (IISER), Bhopal have made an exciting discovery by uncovering three new species of ginger in the Eastern parts of India, in the states of Mizoram and Meghalaya. These new types of ginger are special because of their unique flower shapes, and together, they are called the "dancing girls" ginger species.

The discovery was made by two scientists, Ritu Yadav and Vinita Gowda, during their field explorations. Their work is important because it highlights the rich variety of plant life in these regions and adds to our knowledge about botany.

The newly discovered species belong to a group of plants known as the Globba genus. This genus is known for its beautiful, ornamental flowers, and it includes about 136 different species. The Globba genus belongs to Zingiberaceae family, and it is the fourth largest group in that family.

The three new species of ginger are:

1. *Globba tyrnaensis*: It was found near the famous Double Decker Living Root Bridge in Meghalaya. This species grows mainly in the forest at an elevation of around 731 meters. It attracts many bee species, which help with pollination.

2. *Globba janakiae*: It was named in the honor of Dr. E.K. Janaki Ammal, a well-known Indian botanist. This species was also discovered in Meghalaya, in the same area as G. tyrnaensis.

3. *Globba yadaviana*: It was discovered along Reiek Tlang Road in Mizoram. This species is named after Rajesh Yadav, father of Ritu Yadav.

Floral Characteristics and Habitat:

Each of these new ginger species has distinct floral characteristics, which is why they have earned names like weeping goldsmith and white dragon. They grow in specific habitats, with G. tyrnaensis thriving in the lower parts of forests, known as the understory.

Conservation Status:

One of the new species, G. Yadaviana, is only found in small populations. Only about 30 individual plants have been seen along Reiek Tlang Road in Mizoram. Because these species are rare, conservation efforts will be important to protect them and their natural habitats.

This discovery shows how vital it is to continue exploring and researching the biodiversity of India, especially in regions that are still not fully explored. It also highlights the rich botanical heritage of the country.

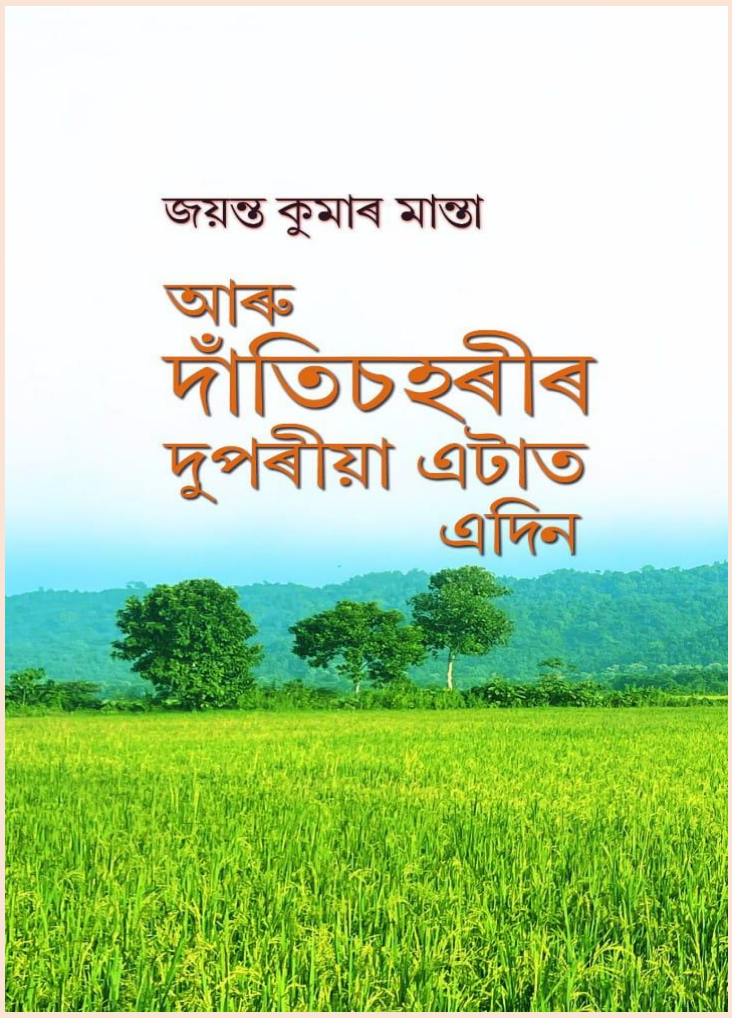
References:

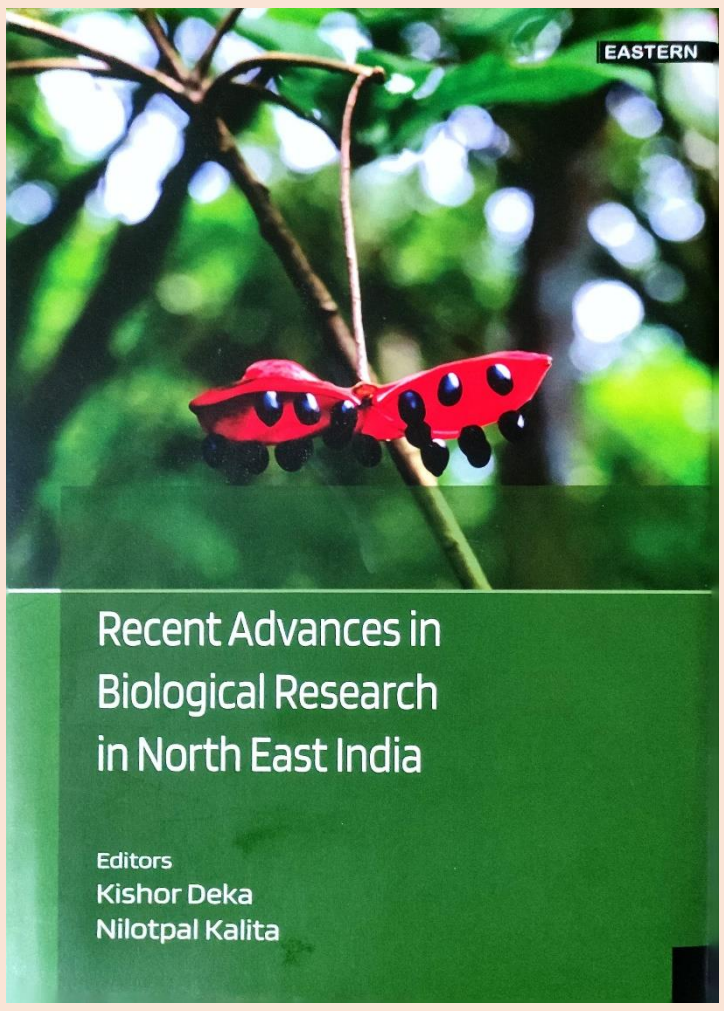
1. https://www.gktoday.in/researchers-discover-new-dancing-girls-ginger-species-in-india/

2. https://www.thehindu.com/sci-tech/energy-and-environment/ginger-family-gets-six-new-dancing-members-from-india/article68618140.ece

3. https://www.news9live.com/knowledge/new-species-found-three-dancing-girls-ginger-species-discovered-in-northeast-india-2688560

TEACHER'S ACHIEVEMENTS





14

Anticancer Potential of Lichen Secondary Metabolites: A Review

Sadiqul Ahmed, Subham Roy, Rupjyoti Gogoi
Manashi Kalita, Prabhali Doley

Abstract

This review comprises the literature from 1968 to the present (end 2023), on lichen metabolites and their impact on different cancer cell lines. It focuses primarily on classes of metabolites obtained from a variety of lichens involved in cell cycle arrest, apoptosis, and inhibition of proliferation as an anticancer agent. The review reports a brief overview of human cancer and its continental outbreak in the recent past, including India. We have reviewed various publications from scientific databases to summarize results on lichen compounds with promising aspects in oncology. The summary includes a brief account of lichens with their metabolite profile and key findings of each publication concerning the anticancer potential of those metabolites. We found that crude extracts and isolated metabolites of lichen(s) exhibit considerable inhibitory effects against numerous cancer cell lines, mostly in a time and dose-dependent manner.

Keywords: *Lichen metabolites, Anticancer agent, Scientific databases*

Introduction

Lichen metabolites have been traditionally utilized in medicine for a wide range of ailments since ancient times (Ahmed *et al.*, 2020). They are obligate symbiotic associations, mostly between a fungus (mycobiont) and

STUDENTS' ACHIEVEMENTS

Parlita Kalita secured 1st prize in group song competition in college week-2024

Elisha Boro secured 3rd prize in Boro dance competition in college week-2024

Diya Hazarika secured Younger Achiever's Award on Women's Day-2024

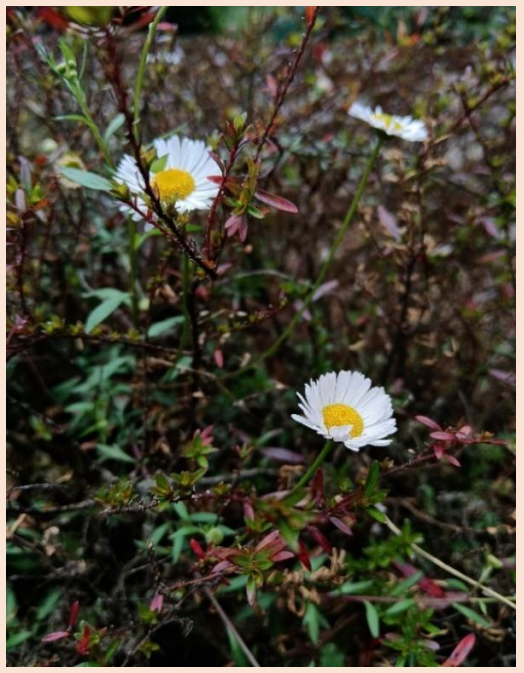
Annysha Choudhury secured 3rd prize in chess competition in college week 2023

Afreen Mazid for securing highest marks in Botany for the session 2023-2024

PHOTOGRAPHY

Zingiber rubens
Priya Basumatary-M.Sc 3rd sem

Rhododendron arboreum
Akansha Boruah-B.Sc 5th sem



Erigeron karvinskianus
Aditi Gogoi-B.Sc 5th sem

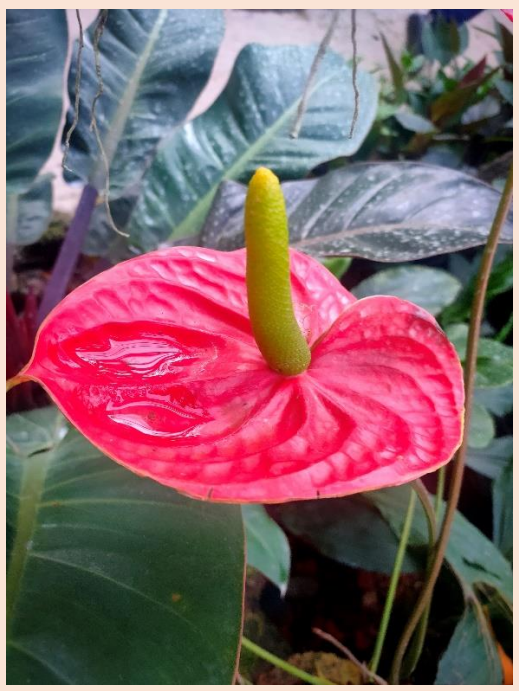
Calendula officinalis
Prishtha Gogoi-B.Sc 5th sem

Dendrobium infundibulum
Namrata Sarma-B.Sc 5th sem

Coelogyne nitida
Purabi Basumatary-M.Sc 3rd sem

Syngonium podophyllum
Geetanjali Basumatary-B.Sc 3rd sem

Kroenleinia grusonii
Apeksha Sarmah-B.Sc 5th sem

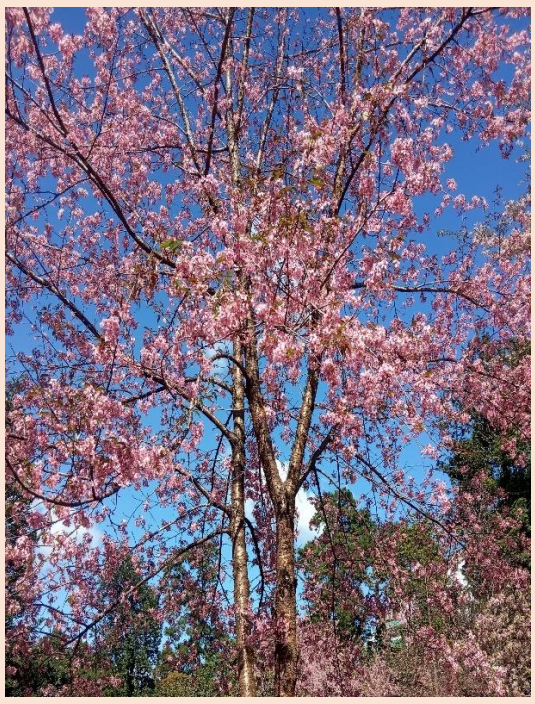


Anthurium andraeanum
Manjima Bhuyan-M.Sc 3rdsem

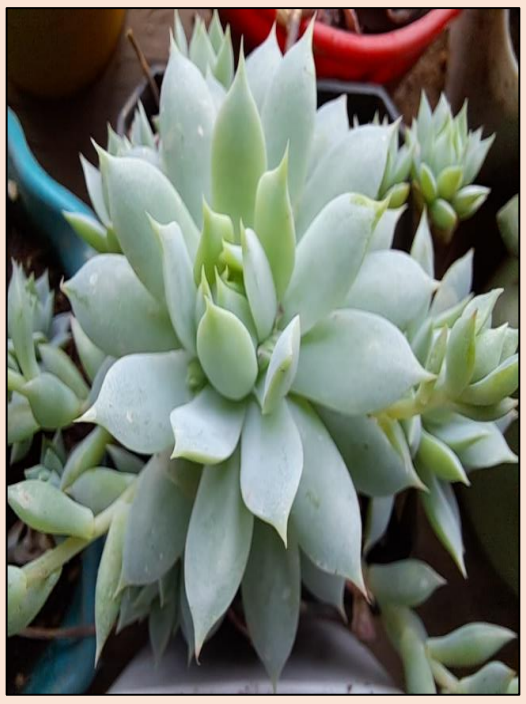
Abutilon pictum
Biniska Mallick-B.Sc 3rd sem

Florist Kalanchoe
Bhabana Sarma-B.Sc 3rd sem

Nepenthes khasiana
Priya Basumatary-M.Sc 3rd sem



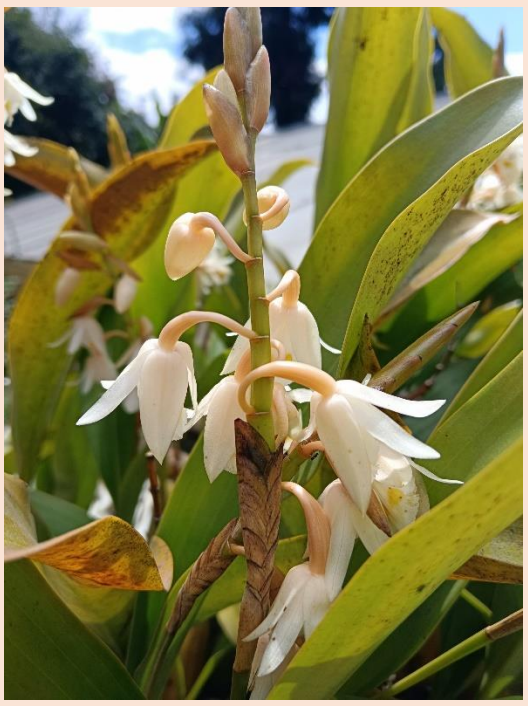
Prunus cerasoides
Shahana Ahmed-B.Sc 3rd sem



x*Sedeveria* 'Fanfare'
Ayushi Dey-B.Sc 5th sem

Alstroemeria ligty
Rashmita-B.Sc 3rd sem

Spathiphyllum wallisii
Akansha Boruah-B.Sc 5th sem



Pinalia ovata
Aditi Gogoi-B.Sc 5th sem

Clerodendrum Fragrans
Apeksha Sarmah-B.Sc 5th sem