BENGAL SCHOOL OF TECHNOLOGY

BST PHARMA NEWS

SUGANDHA, CHINSURAH, HOOGHLY, I2TH AUGUST 2025

FROM THE DESK OF PRINCIPAL

DR. P. SURESH

I am delighted to present before the stakeholders, this edition of **BST PHARMA NEWS** on the eve of celebration of **NATIONAL LIBRARIAN'S DAY 2025** .

The BST PHARMA NEWS is rich with meaningful scientific contents of many stakeholders which makes Pharma News highly informative and impactful. This provides an opportunity amongst the staff, students and alumni, to develop the art of referring to the unique library resources and e-resources available in the **PROF. M. L. SCHROFF MEMORIAL LIBRARY** of **BENGAL SCHOOL OF TECHNOLOGY**.

The students need to underscore the importance of referring to standard textbooks by highly acclaimed authors ,reference books and standard journals for a flawless information and to keep them equipped with accurate information and will get inspired to streamline the parameters to make them competent to write a review article of high standard in reputed journals.

I from the core of my heart compliment and congratulate the Team BST in general and The Editorial Team of BST PHARMA NEWS in particular for their unwavering commitment shown in bringing out this issue of BST PHARMA NEWS.

Happy Librarian's Day to all.

FROM THE DESK OF EDITOR

DR. SUCHANDRA GOSWAMI

With great pleasure we release the second issue of **BST PHARMA NEWS.** This issue covers the write up from budding scientist as well as experienced researchers.

Inaugural session of BST-PHARMACON 2K25 held on 8th & 9th March, 2025

The write up covers a broad area of interest: education policy and it's modification, infectious disease, drug design, new targets, drug discovery from natural product. Also, it highlights different activities involving the faculties. Impressive achievement of the students has also been documented as spectrum

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BLOOM'S TAXONOMY AND ITS ESSENTIALITY IN ACADEMIC CURRICULUM: A STRATEGIC ALIGNMENT WITH NBA AND NAAC ACCREDITATION CRITERIA

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Abstract

This article explores the application of Bloom's Taxonomy in the context of academic curriculum development and its alignment with the quality assurance frameworks of India's premier accreditation bodies–the National Board of Accreditation (NBA) and the National Assessment and Accreditation Council (NAAC). It provides a scholarly analysis of how Bloom's hierarchical classification of learning objectives serves as a foundational tool for formulating learning outcomes, structuring assessments, and ensuring measurable educational attainment. The paper further discusses the implications of Bloom's Taxonomy for outcome-based education (OBE), curricular planning, and faculty training. The integration of Bloom's cognitive domain with the standards of NBA and NAAC is emphasized as a strategic approach to enhancing institutional accountability, learner engagement, and academic excellence.

Keywords

Bloom's Taxonomy, Outcome-Based Education (OBE), Curriculum Design, NBA, NAAC, Higher Education, Accreditation.

1. Introduction

The landscape of higher education in India has undergone significant transformation with the increasing focus on quality assurance and accountability. Accreditation by bodies such as NBA and NAAC serves as a benchmark for institutional performance and educational outcomes. Amid these reforms, the implementation of pedagogical frameworks like Bloom's Taxonomy has gained traction for structuring curricula and aligning instructional methodologies with expected learner competencies. Bloom's Taxonomy offers a systematic approach to designing, delivering, and evaluating education that meets both national and global standards.

2. Understanding Bloom's Taxonomy

Originally developed by Benjamin Bloom in 1956 and later revised by Anderson and Krathwohl in 2001, Bloom's Taxonomy categorizes educational objectives into three domains: cognitive, affective, and psychomotor. The cognitive domain, which is most pertinent to curriculum design, is further divided into six hierarchical levels: Remember, Understand, Apply, Analyze, Evaluate, and Create. This taxonomy not only provides clarity in articulating learning objectives but also guides the development of teaching strategies and assessment tools that promote higher-order thinking skills.

3. Bloom's Taxonomy in Academic Curriculum Design

Integrating Bloom's Taxonomy into the academic curriculum enables educators to define Course Outcomes (COs) with precision, using action verbs that correspond to cognitive levels. This hierarchy assists in differentiating between foundational knowledge and advanced intellectual engagement. By mapping Bloom's levels to specific instructional methods–such as lectures for "Remember" and case studies for "Analyze"–educators can employ targeted teaching-learning methodologies (TLMs). Furthermore, Bloom's Taxonomy aids in developing rubrics for formative and summative assessments, ensuring alignment with intended learning outcomes.

4.Alignment with the NBA Accreditation Framework

NBA's Outcome-Based Education (OBE) model mandates the formulation of Program Educational Objectives (PEOs), Program Outcomes (POs), and Course Outcomes (COs). Bloom's Taxonomy is instrumental in articulating these outcomes through measurable cognitive verbs.

The taxonomy supports CO-PO mapping, which is crucial for constructing attainment matrices that evaluate student performance relative to academic goals. Institutions can utilize Bloom's framework to identify curriculum gaps and design appropriate interventions for continuous quality improvement.Integration into NAAC's Quality Indicators

NAAC's Revised Accreditation Framework (RAF) emphasizes outcome-centric teaching and learning processes. Under Criterion I (Curricular Aspects) and Criterion II (Teaching-Learning and Evaluation), the adoption of Bloom's Taxonomy is recognized as a best practice for enhancing curriculum design and pedagogic delivery. Lesson plans structured using Bloom's levels ensure cognitive progression and student engagement. Additionally, Bloom's model is leveraged in the development of internal assessment tools and student feedback mechanisms, thereby strengthening the evidence base for NAAC accreditation.

6. Practical Applications and Institutional Case Studies

Several higher education institutions in India have successfully adopted Bloom's Taxonomy for curriculum development and accreditation readiness. For instance, in pharmacy and engineering colleges, COs are framed using Bloom-level verbs, and CO-PO mapping is conducted through clearly defined rubrics. Academic audits and curriculum reviews employ Bloom's hierarchy to evaluate instructional effectiveness. Templates for lesson planning, assessment blueprints, and attainment analysis are commonly used tools that reflect the taxonomy's practical utility.

7. Challenges and Considerations

Despite its widespread adoption, the implementation of Bloom's Taxonomy is not without challenges. Faculty members may misinterpret cognitive levels or misuse action verbs, leading to inconsistencies in CO formulation. Institutions must invest in faculty development programs to build competency in taxonomy-based curriculum design. Moreover, the integration of Bloom's framework across interdisciplinary and flexible curricula requires careful coordination to maintain coherence and alignment with national policies such as the NEP 2020.

Recommendations for Academic Institutions

To effectively leverage Bloom's Taxonomy in the accreditation process, institutions should:

Establish curriculum committees trained in taxonomy-based design.

Embed Bloom's framework into syllabus templates and academic audits.

Use Learning Management Systems (LMS) to monitor cognitive-level attainment.

Conduct regular workshops and orientation programs for faculty.

Integrate Bloom's levels into IQAC practices and quality benchmarks.

9. Conclusion

Bloom's Taxonomy is an indispensable tool for academic excellence and institutional accreditation. Its structured approach to defining learning objectives enhances curriculum clarity, instructional planning, and student assessment. By aligning the taxonomy with NBA's OBE framework and NAAC's quality indicators, institutions can ensure a robust, outcome-oriented educational experience. This alignment not only fortifies the academic ecosystem but also prepares students for lifelong learning and professional success.

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HELICOBACTER PYLORI INFECTION AND PUTATIVE THERAPEUTIC TARGET.

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Abstract:
About 7.2% of Indians have inflammatory bowel syndrome (6% have constipation, 32% have diarrhea, and 42.4% have both), 7.6% have GERD (gastroesophageal reflux disorder, 4.39/105 annually) from Crohn's disease, and celiac disease is frequently linked to FGIDs (functional gastrointestinal disorders, 4.4%). Helicobacter pylori is not linked to stomach ulcers (30:1), but it is mostly linked to duodenal ulcers and peptic ulcer disease (8:1). The prevalence of H. pylori infection in children varies from 80–90% in infancy to 22–57% in children under age 5. Mizoram has reported a maximum frequency of 30% for stomach cancer. 7–18% of cases of gastric cancer are linked to the Epstein-Barr virus. The search for alternative therapies, whether bacterial, plant, technological, or immunologically derived, is demanded by the growing worry over side effects linked to conventional medication (such as antibiotic resistance and ulcer recurrence). Here we have briefly documented H pylori-induced pathogenesis event. Further, targets such as CagA, CXCR4, ERK phosphorylation, NOTCH signalling activation, urease have been explored.

Keywords: Helicobacter pylori, CagA, CXCR4, gastric, cancer

Introduction: Three types of gastrointestinal symptoms can be identified by endoscopy: peptic ulcer, gastric cancer as well as gastritis. Both of the diffuse and intestinal type of gastric cancer, H pylori plays critical role. Endoscopy can detect 79-85% cases. Helicobacter pylori was originally discovered by Warren and Marshall by endoscopy using a fiber optic. The bacterium was isolated subsequently from culture. From that time onwards H pylori was considered pivotal for peptic ulcer disease and categorized as group I carcinogen forming gastric cancer. H pylori positivity can be easily visualized by endoscopy, urease testing, histopathology or culture.

Background: Peptic ulcer that creates a hole in the mucosa due to acid damage in the area where the mucosal defense is suppressed by H pylori, can arise after pylorus, i.e., duodenal ulcer or can remain as gastric ulcer beyond the pylorus.For 95% of the duodenal ulcer cases H pylori is the causative agent; gastric ulcer may arise from H pylori induced inflammation vis-à-vis NSAIDs exposure to the said patients. Gastritis can best be defined as abnormal inflammation (easily detected by histopathological staining), in advanced stages can be detected by endoscopy. H. pylori-induced chronic gastritis, autoimmune gastritis are critically important to study. The damage of the mucosa as well as pH changes can be monitored as a diagnosis indicator by means of both endoscopy as well as impedance spectroscopy. In histology, H. pylori organism appear 3-6 μm long and upto 0.6 μm wide, having characteristic 'seagull shaped form'. H. pylori is located in the antrum; with proton pump inhibition they locate in corpus and fundus. They are also found in the zone of gastric metaplasia in duodenal biopsy. The organism on scanning are located on the mucosal surface, individual gastric pit, in intercellular positions, or caught up in the surface mucus. The instinct character of the bacteria to colonise the duodenum is one of the main activities in duodenal ulcer disease. The basic pattern of gastritis can be classified as acute, chronic, as well as special features like granulomatous, eosinophilic etc. infiltration of neutrophilic polymorph dominates and associated with erosions and haemorrhage (but can not be detected in biopsy specimen). In H pylori-induced chronic gastritis, presence of neutrophil polymorph in a background of chronic gastritis is the main activity.

Virulence: Several recent reports have shown evidence for the involvement of CagA, endoplasmic reticulum stress, urease, chemotactic factors as factors responsible for the induction of H pylori induced pathogenesis.

In the fully conserved urease active site, two Ni (II) ion are bridged by the oxygen atoms of a carbamoylated lysine residue and bound to two histidines. One Ni (II) ion is additionally bound to an aspartate carboxylated oxygen. The co-ordinated geometry of the Ni (II) ion is completed by a water molecule bound to each metal ion and by a nickel bridging hydroxide ion. Urease enzyme generates a high pH in stomach facilitating colonization of the bacteria easily. Ure has several domains to study in response to interaction with Helicobacter pylori. Nuclear factor kappa B remains in the heterodimer form with the Rel homology domain. It rests in the cytoplasm with the inhibitor IkB alpha. Upon ubiquitin mediated proteolysis, nuclear factor of kappa B translocates to the nucleus and mediates transcription of inflammatory genes. It is intimately correlated with the calcium signalling pathways. Boussioutas Alex et al has also shown the involvement of endoplasmic stress proteins that get overexpressed during H pylori infection. H pylori-induced neoplasia can be classified as mucosal neoplasia, intestinal neoplasia as well as Spasmolytic polypeptide expressing metaplasia (SPEM). ERK phosphorylation as well Notch pathway activation have also been well documented in H pylori induced infection. Also, there are several crosstalk pathways of NF kB activation, that needs to study in details in order address the inflammation. Bacterial phospholipase C (PLC) can induce NF κB activation but direct evidence is warranted PLC gamma in H pylori-induced infection is therefore a topic to probe. Phospholipase C γ1 (PLC γ1), one member of the PLC isozyme family, catalyses the hydrolysis of phosphatidylinositol-4,5-bisphosphate (PIP2), creating inositol 1,4,5-triphosphate (IP3) and diacylglycerol (DAG). These second messengers stimulate the release of Ca^{2+} from an internal store and activate protein kinase C, respectivelyultimately leading to many biological processes. PLC γ1 contains two src homology domain 2 (SH2) and one src homology domain 3 (SH3), needed for effective activationor protein-protein interactionAnother result strongly suggests that PLC γ1 enzyme activity itself is not crucial but SH2-SH3 domain of PLC γ1 is important for NF κB activation possibly through src homology mediated protein-protein interaction or protein-tyrosine phosphorylation. The involvement CXCR4, a G-protein coupled seven span transmembrane receptor, is expressed on the surface of many stem cells. The ligand for CXCR4 is the alpha chemokine stromal derived factor (SDF-1). The two members bind to each other exclusively. CXCR4 helps mobilization of normal haematopoietic stem cells to the bone marrow. CXCR4-SDF-1 basically act during embryogenesis by enhancing cell migration. Agent used to mobilize bone marrow cells need to disrupt the SDF-1/CXCR4 axis. Similar to their non-malignant stem cells counterparts, many cancer cells express CXCR4. The role of CXCR4 receptor in cancer stem cells us to mobilize, invade and metastasize. At the molecular level CXCR4 is regulated by factors related to stress and tissue damage, including NF κB, HIF-1, TGF- β, VEGF, IFN α, IL-2, IL-4, IL-7, leading to increased surface expression. Lipid rafts are being enriched with CXCR4 and the protein Rac1. Any factor affecting cholesterol content of the cell membrane, significantly affect the response of the CXCR4 receptor to SDF-1. In addition to acting as a chemotactic factor for a CXCR4 bearing cells, SDF-1 has been shown to induce adhesion, and to induce secretion of matrix metalloproteinase (MMP) and VEGFs in cell bearing CXCR4. It also increases the interaction with several integrins, thus impacting binding and migration. Houghton et al has shown elevated and sustained levels of SDF-1 in infected gastric mucosa. H pylori exhibits highly diverse genomic variability. The type IV secretion system encoding CagA (EPIYA motif) type IV machinery may export multisubunit and nucleoprotein complex. In H pylori several homologs of VirB and VirD are present. These include the ATPases VirB4 (CagE) and VirB11 (HP525), which energize the transport of CagA and possible further substrates through the putative trans envelop channel. Designing a putative inhibitor can develop new therapeutics alongwith inhibition of CagA injection.

Conclusion: The article highlights various pathogenic factors of H pylori instrumental in the pathogenesis of gastritis as well as gastric cancer Still there are many target which is beyond the limit of this article to .

to explore like riboflavin synthase inhibitor, alternate menaquinone biosynthesis inhibitors, aquaporin V inhibitor --- those will be covered in details in next issues.

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THE NEW FRONTIER: WHY AI AND COMPUTATIONAL BIOLOGY ARE REPLACING WET-LAB DRUG DISCOVERY

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Drug discovery has shifted from manual laboratory work to a mostly digital approach driven by artificial intelligence (AI) and computational biology. Modern software like Schrödinger, Auto-Dock, and MOE enables scientists to conduct computer-based drug compound analysis and virtual drug discovery, significantly minimizing the requirement for initial physical testing. Advanced technologies like Schrödinger's FEP+ offer highly accurate quantum-level estimations of drug-target interactions, while AI systems such as DeepChem utilize machine learning to predict molecular characteristics and toxicity, frequently surpassing traditional lab-based methods in efficiency and precision. The adoption of systems biology platforms like STRING DB and Cytoscape enables scientists to study complex . biological networks, mapping protein interactions and genetic pathways to identify hidden but high-value drug targets. Such approaches are particularly valuable for tackling multifactorial diseases like cancer and neurodegeneration, which have eluded conventional reductionist strategies.

Open databases like PubChem, ChEMBL, and the Protein Data Bank that supply the massive datasets needed to train these computational models, democratizing access to advanced drug discovery for institutions with minimal infrastructure. These digital methods improve precision, reproducibility, and efficiency, offer ethical advantages by reducing animal testing, and support personalized medicine by simulating drug effects across genetic backgrounds.

Despite the advances, wet labs remain essential for validating digital predictions. However, computation has shifted to become the foundation, rather than the supplement of pharmaceutical research. The integration of code, cloud, and computation in drug discovery delivers faster, more reliable, and highly scalable results, making these digital tools indispensable to the future of biomedical innovation.

DIGITAL PILLS: A NEW FRONTIER IN MODERN MEDICINE

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Introduction

Digital pills represent a significant breakthrough at the intersection of pharmaceuticals and digital technology. These ingestible sensors are designed to monitor a patient's physiological responses or confirm medication adherence, transmitting data wirelessly to external devices. As the global healthcare system increasingly prioritizes personalized treatment and data-driven decisions, digital pills are emerging as transformative tools for enhancing patient care, especially in chronic disease management and mental health [1].

How Digital Pills Work

Digital pills, also known as smart pills or ingestible sensors, combine pharmaceutical drugs with micro-electronic technology to monitor medication ingestion and/or physiological conditions inside the body. Their functioning relies on a combination of sensor technology, wireless communication, and mobile or cloud-based data platforms [1].

1. Composition of a digital pill

A digital pill typically includes:

- **Active drug:** The prescribed medication.
- Ingestible sensor: A tiny electronic sensor, usually made from materials safe for ingestion like magnesium, copper, and silicon.
- **External wearable device:** A patch or device worn on the torso that collects signals from the pill.
- **Mobile application:** An app installed on the patient's smartphone or tablet to display data.
- **Cloud platform:** For storing and sharing data with healthcare providers securely.

2. Drug release mechanism

Drugs can be administered by either passive or active mechanisms. In passive systems, the drug is released at the targeted area by diffusion or chemical reactions triggered by the temperature or pH, while in active systems, the drug is actively released from a reservoir by the capsule when triggered.

3. Ingestion and activation

Once the patient swallows the pill, the sensor activates upon contact with gastric fluids. This creates a small electrical signal powered by a chemical reaction using body fluids, similar to a battery. The signal confirms ingestion of the medication.

4. Signal transmission

The signal is picked up by the wearable patch or receiver. The patch records time of ingestion, body temperature, activity levels or heart rate, depending on the design.

5. Data transfer and display

The patch sends the data wirelessly to the patient's smartphone app via Bluetooth. The app can show real-time medication logs and reminders. With the patient's consent, the data is shared securely with doctors, family or healthcare providers via the cloud.

The Present Scenario

Currently, digital pills are primarily used for real-time medication adherence monitoring. In the 1970s, Dr. Norman H. Payson postulated digital pills, and in 2001, MIT developed the first ingestible sensor that could detect bleeding in the gastrointestinal tract. The first FDA-approved digital pill, Abilify MyCite (aripiprazole with sensor), was approved in 2017 for patients with schizophrenia, bipolar disorder, and depression [2]. Developed by Proteus Digital Health in partnership with Otsuka Pharmaceutical, the system comprises a medication tablet embedded with a tiny ingestible sensor that activates upon contact with stomach fluids. It sends a signal to a wearable patch, which transmits data to a smartphone app for patient tracking and physician review.

This innovation addresses a critical issue in healthcare: non-adherence to medication, which contributes to poor health outcomes and increased hospitalizations. According to the World Health Organization (2003), adherence among patients with chronic illnesses in developed countries averages only 50% [3]. Digital pills offer a novel way to ensure patients take medications as prescribed, helping clinicians adjust therapy based on real-time data.

Beyond adherence, researchers are exploring smart pills for diagnostics and drug delivery. For instance, the PillCam, an ingestible camera by Medtronic, allows non-invasive visualization of the gastrointestinal tract, aiding in diagnosing conditions like Crohn's disease and internal bleeding [4].

Digital pills help manage schizophrenia, bipolar I disorder, ADHD, substance abuse, smoking, pain, and insomnia by improving medication adherence. They are also being tested for cardiovascular disease, diabetes, hepatitis C, AIDS, cancer, tuberculosis, and post-surgical opioid monitoring. Advanced digital pills could monitor blood alcohol levels to avoid drunk driving. This technology is especially useful for elderly

H and neurodegenerative patients whose drug compliance is affected by patient behaviour [5].

Challenges in the Present

Despite their promise, digital pills face several challenges. Privacy and data security are major concerns; transmitting health data raises questions about consent and misuse. Cost-effectiveness is another barrier, particularly in low-resource settings [6]. Furthermore, some patients may feel discomfort with ingesting electronic devices or perceive such monitoring as invasive [7].

There are also regulatory and ethical concerns. As digital pills integrate more deeply into healthcare, questions around patient autonomy, informed consent, and physician-patient trust must be addressed. The long-term effects of these technologies on healthcare remains uncertain. Chevance et al. (2022) contend that digital pills should be considered as a complex intervention that necessitates extensive testing prior to widespread clinical usage, rather than merely as a novel pharmaceutical delivery mechanism. To ensure the responsible and proper use of these drugs, they emphasize the significance of a robust ethical and legal framework [8].

Future Prospects

The future of digital pills lies in integration with AI and IoT ecosystems, enabling predictive diagnostics and personalized treatments [9]. Researchers envision smart pills capable of sensing biomarkers (e.g., pH, temperature, enzymes) and delivering drugs only when needed, revolutionizing precision medicine [10]. Emerging technologies are exploring biodegradable sensors, energy-harvesting pills, and targeted drug delivery systems. For example, MIT researchers are developing pills that can reside in the stomach for weeks, providing controlled drug release and real-time monitoring of infections or metabolic conditions.

As healthcare shifts toward preventive care and remote monitoring, digital pills could play a central role in home-based diagnostics and therapy, especially for elderly populations and those with limited access to healthcare facilities [11].

Conclusion

Digital pills are redefining the boundaries of medicine, turning traditional therapies into intelligent, responsive systems. While challenges remain, their potential to enhance adherence, improve diagnostics, and enable precision treatment is undeniable. With robust ethical frameworks, regulatory support, and continued technological advancement, digital pills could become an essential component of future healthcare.

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DEFICIENCY OF VITAMIN D AND THE METABOLIC FUNCTION OF VIT. D RECEPTOR IN THE BRAIN ASSOCIATED WITH SCHIZOPHRENIA

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Vitamin D is a vital hormone widely recognized for its role in calcium absorption. Being a neuroprotective and dopamine-regulating steroid hormone, vitamin D produces its effect on the CNS; however, vitamin D deficiency is becoming a common problem in many countries. Many studies have highlighted hypovitaminosis D as a potential environmental risk factor for various conditions such as multiple sclerosis, asthma, cardiovascular diseases, and, more recently, psychiatric disorders such as schizophrenia/psychosis. People suffering from schizophrenia are specifically more deficient in vitamin D than patients with any other psychiatric conditions.

Gradually, the deficiency of Vitamin D was increased within human beings with emergent schizophrenia. Epidemiology proposes that the occurrence of this disorder is highly related to both genetic and environmental factors. Schizophrenia is a "neurodevelopmental" disorder that mostly arises due to low maternal vitamin D levels.

Firstly, statistics of various geographical areas suggest that people born during late winter and early spring in those final gestations during the winter months show a high chance of developing schizophrenia in the future, and the particular risk is much higher in higher latitudes experiencing more seasonal variations.

Secondly, the occurrence of this disorder is comparatively higher in people living in urban areas than in rural areas. Also, a growing possibility of schizophrenia in children can occur in dark-skinned immigrants who shift to a colder region. The extent of the photo-period is very strongly and dependably associated with vitamin D production, which is ultimately affected by season and latitude. In the city, exposure to sunlight has been reduced in the built environment compared to the country, which could increase the risk of Vitamin D deficiency. Besides, deficits in nutrients and vitamin D in long-term schizophrenia were observed from illness onset and were associated with worse symptomology. Also, adults with schizophrenia have a lower level of vitamin D in serum than normal people.

Vitamin D3 or cholecalciferol is obtained from 7-dehydrocholesterol within the skin upon contact with ultraviolet B (UVB) rays. Cholecalciferol, upon hydroxylation, produces 25-hydroxy vitamin D. D3 [25(OH)D], mostly present within the blood, which is subsequently transformed into the hormone, 1,25-dihydroxyvitamin D [1,25(OH)2D]. Both [25(OH)D] and [1,25(OH)2D] can pass the blood-brain barrier. The immunohistochemistry findings proved the cellular as well as sub-cellular availability of vitamin D receptors (VDR), metabolizing enzymes of vit. D in the human brain and the rodent brain. The vitamin D receptors, and some specific enzymes, are responsible for the synthesis as well as metabolism of vitamin D (cyt. P-450 group members CYP27B1 and CYP24A1) in adult human tissues, which can be studied with the data obtained from the Genotype-tissue expression (GTEx). In the GTEx portal, the expression of the VDR is shown in all 11 human brain regions examined, including cerebral cortex, cerebellum, amygdala, anterior cingulate cortex, caudate (basal ganglia), hippocampus, hypothalamus, nucleus accumbens (basal ganglia), putamen (basal ganglia), C-1 spinal cord, and pituitary gland. However, the abundance of VDR is relatively low compared to classic VDR organs such as the gut and kidney. Within the brain, the hypothalamus had the greatest abundance.

In other organs, a high abundance of VDR affords between 3 and 5 isoforms, whereas the brain provides a single isoform. Earlier immunohistochemistry research confirmed that the vit. D receptors are found in developing animal brains, providing a prominent study of receptor expression within the midbrain, which has further been supported by single-cell sequencing of developing mouse as well as human midbrains. With respect to various metabolic enzymes of vitamin D, the presence of CYP27B1 is less within the brain area than in other organs except the kidney. Within the brain, the level of CYP27B1 is much higher in the cerebral cortex, limbic portions of caudate putamen, and nucleus accumbens. The CYP27B1 contains 7 isoforms, providing four found in the colon and kidney, five in the testis, and one isoform in the brain. While considering CYP24A1, the expression is mostly lower in all organs except the brain. CYP24A1 provides 6 isoforms, five of which are found in the kidney, two to four isoforms in skin and bladder, whereas two isoforms are found in the brain. Many SNP variants are spotted in promoter sites, which may affect the transcription. Thus, further well-designed cohort research or randomized controlled trials are required to establish a strong connection between the Vit. D deficiency impacting the brain function and development.

IMPACT OF NEP 2020 ON PHARMACY EDUCATION SYSTEM IN INDIA- A REVIEW

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INTRODUCTION

The National Education Policy (NEP) 2020, approved by the Government of India in July 2020, is a landmark reform in the country's education landscape, aiming to make the system more holistic, flexible, multidisciplinary, and aligned with the needs of the 21st century. While NEP-2020 encompasses all levels and fields of education, its implications for Pharmacy Education–a crucial component of health science and Pharmaceutical Innovation–are particularly significant.

The policy introduces major structural, curricular, pedagogical, and regulatory reforms that are poised to impact the future of pharmacy education in India profoundly.

Pharmacy Education in India has undergone significant changes over the years, with the establishment of the Pharmacy Council of India (PCI) in 1948, which regulates pharmacy education and practice in the country. The NEP-2020 aims to revamp the Indian education system, making it more holistic, multidisciplinary, and aligned with the needs of the 21st century.

NEP 2020, Bachelor of Pharmacy (B.Pharm) and Diploma in Pharmacy (D.Pharm) programs may incorporate elective courses from diverse domains such as public health, data science, bioethics, psychology, communication skills, and even business management. This shift aims to prepare pharmacists not only as drug experts but also as active contributors to public health systems and pharmaceutical industries with a more rounded skillset.

KEY PROVISIONS OF NEP 2020 RELEVANT TO PHARMACY EDUCATION

1.Multidisciplinary Approach:

NEP-2020 promotes a multidisciplinary approach to education, encouraging institutions to offer courses across disciplines. Pharmacy education can benefit from this approach by incorporating subjects like Biotechnology, Nano Technology, and Data Science. This move is intended to broaden students' perspectives and foster critical thinking, communication, and ethical reasoning–skills that are increasingly essential for pharmacy professionals.

2.Flexibility and Choice:

The policy emphasizes flexibility and choice, allowing students to pursue courses that interest them. Pharmacy students can opt for electives from other disciplines, enhancing their knowledge and skills.

3.Focus on Research and Innovation:

NEP-2020 highlights the importance of research and innovation in education. Pharmacy institutions can focus on research in areas like drug discovery, development, and pharmacovigilance.

4.**Digital Education:**

The policy promotes digital education, including online and blended learning. Pharmacy education can leverage technology to offer online courses, webinars, and simulations.

5.Regulatory Framework:

NEP-2020 proposes a single regulatory body for higher education, which may impact the role of the Pharmacy Council of India (PCI).

IMPACT ON PHARMACY EDUCATION

1.Curriculum Reforms:

NEP-2020's emphasis on multidisciplinary education and flexibility may lead to curriculum reforms in pharmacy programs, incorporating more diverse subjects and electives.

2.Increased Focus on Research:

The policy's focus on research and innovation may lead to increased research opportunities and funding for pharmacy institutions, enhancing the quality of pharmacy education.

3.Digital Transformation:

Pharmacy education may shift towards more online and blended learning models, increasing accessibility and flexibility for students.

4.Interdisciplinary Collaborations:

NEP-2020's multidisciplinary approach may foster collaborations between pharmacy and other disciplines, like medicine, engineering, and biotechnology.

5.**Changes in Regulatory Framework:**

The proposed single regulatory body may lead to changes in the way pharmacy education is regulated, potentially impacting the role of PCI.

IMPACT ON PHARMACY INSTITUTIONS

1.Institutional Autonomy and Multidisciplinary Transformation:

One of NEP 2020's major goals is to transform higher education institutions into Multidisciplinary Education and Research Universities (MERUs). Pharmacy institutions, which traditionally operate as standalone colleges or departments, are now encouraged to integrate with or evolve into multidisciplinary frameworks. This shift aims to foster collaboration among disciplines such as medicine, biotechnology, public health, IT data science, and management, thereby promoting interdisciplinary education and research.

2.Introduction of Multiple Entry and Exit Options:

NEP 2020 introduces a flexible academic structure with multiple entry and exit points. For pharmacy institutions, especially those offering B. Pharm and D. Pharm, this has several implications:

·Institutions must redesign their curriculum to allow Modular Learning.

·Certificates, diplomas, and degrees will be awarded based on the level of completion.

·Institutions must be ready to maintain Academic Bank of Credits (ABC) accounts for each student to manage their credit accumulation and transfer across institutions.

3.**Academic Bank of Credits (ABC) and Digital Recordkeeping:**

The implementation of ABC requires pharmacy institutions to digitize and modularize their courses and ensure proper integration with national academic credit platforms. Institutions must:

·Adopt Learning Management Systems (LMS) and digital credit tracking.

·Align their curriculum with the National Higher Education Qualification Framework (NHEQF).

·Allow students to transfer credits across universities, which requires standardization of assessment and syllabi.

4.**Focus on Quality Assurance and Accreditation:**

NEP 2020 seeks to separate regulation, accreditation, and funding by establishing independent bodies like the National Higher Education Regulatory Council (NHERC) and National Assessment Accreditation Council (NAAC). For pharmacy institutions, this means:

·Regular and mandatory accreditation by NAAC or equivalent bodies.

·Increased focus on outcome-based education (OBE) and program learning outcomes (PLOs).

·Transparent ranking, evaluation, and benchmarking of institutions based on performance.

Pharmacy institutions will need to invest in infrastructure, faculty development, digital capabilities, and research output to meet new accreditation norms

and improve their standings.

IMPACT ON FACULTY OF PHARMACY INSTITUTIONS

1. Emphasis on Faculty as Key Drivers of Reform:

NEP 2020 acknowledges that "the quality of education depends on the quality of teachers." In pharmacy institutions, faculty are no longer seen just as subject experts or lecturers but as facilitators, mentors, researchers, innovators, and role models. The policy places high emphasis on faculty empowerment and development, thereby raising expectations on performance and accountability.

2.Continuous Faculty Development:

NEP 2020 recommends robust and continuous Faculty Development Programs (FDPs) to enhance teaching capabilities. For pharmacy faculty, this includes:

·Training in new pedagogical approaches such as outcome-based education (OBE), competency-based education (CBE), and flipped classrooms.

·Skill enhancement in emerging pharmaceutical technologies, including artificial intelligence in drug discovery, pharmacogenomics, nanotechnology, regulatory science, and more.

·Exposure to interdisciplinary and multidisciplinary teaching, aligning pharmaceutical science with public health, data analytics, and management.

Institutions will be required to facilitate structured, annual faculty development initiatives, supported by academic bodies and industry collaborations.

3.Increased Autonomy with Accountability:

NEP 2020 proposes granting faculty greater academic freedom in curriculum design, content delivery, assessment methods, and research directions. Pharmacy faculty will benefit from this autonomy, enabling them to:

·Design innovative and locally relevant course content.

·Engage students through project-based learning and industry-driven case studies.

·Participate in policy-making and governance within their institutions.

However, this autonomy is linked to performance metrics, meaning that faculty will also face increased expectations regarding teaching quality, student feedback, research output, and institutional participation.

4.Research Orientation and NRF Funding Opportunities:

The policy calls for the establishment of the National Research Foundation (NRF), which aims to promote a culture of research across higher education. Pharmacy faculty are expected to initiate Research Projects, Publication of articles, collaborations with Industry, Hospital & Research Institutes.

5.Shift to Digital and Blended Teaching :

NEP 2020 envisions large-scale integration of technology in teaching. Pharmacy faculty must now be proficient in online platforms for teaching, Using virtual labs and simulations & Managing Learning Management Systems (LMS).

6.Curriculum Reform and Multidisciplinary Teaching:

Pharmacy education is being reshaped into a more multidisciplinary and flexible system. Faculty is expected to participate in curriculum design, expert in teaching beyond traditional pharmaceutical subjects & should focus on collaborative teaching

7.Participation in Institutional Governance:

Faculty will be increasingly involved in institutional planning and academic leadership, with roles in academic growth and accreditation. Implementing NEP-driven reforms like multiple exit/entry points, credit systems, and international collaborations etc.

8.Challenges to be faced:

While the NEP 2020 presents tremendous opportunities, pharmacy faculty also face several challenges:

·Increased workload from teaching, research, mentoring, and administrative tasks.

·Need for rapid upskilling in digital tools and new content areas.

·Resistance to change, especially among senior faculty used to conventional methods.

·Pressure to meet research targets in institutions lacking infrastructure or funding.

These challenges must be addressed through institutional support, collaboration, and national-level faculty empowerment programs

IMPACT ON EXAMINATION SYSTEM

The NEP 2020 is reshaping the examination system across disciplines, and its impact on the Pharmacy Council of India's framework is both visible and growing. The shift from memory-based testing to outcome-driven, skill-based, and student-centric assessment models is enhancing the quality and credibility of pharmacy education in India.

Although PCI remains the statutory authority for designing examination norms, it is increasingly aligning with NEP 2020 through reforms in assessment patterns, credit systems, digital evaluations, and formative feedback practices. The ongoing challenge lies in effective implementation, particularly in institutions with limited resources, but the long-term impact is expected to create a more flexible, responsive, and globally competent pharmacy education system.

BENEFITS OF NEP 2020

1. **Holistic Education:**

NEP-2020's multidisciplinary approach can provide pharmacy students with a more comprehensive education, preparing them for diverse roles in the healthcare sector.

2. Increased Research Opportunities:

The policy's focus on research can lead to increased funding and opportunities for pharmacy students and faculty, enhancing the quality of pharmacy education.

3. **Digital Literacy:**

Pharmacy students can benefit from digital education, developing skills in online learning, simulations, and data analysis.

CHALLENGES OF NEP 2020

1. **Implementation Challenges:**

Implementing NEP-2020's provisions may require significant changes in pharmacy institutions, including curriculum reforms, faculty training, and infrastructure development.

2. Regulatory Uncertainty:

The proposed single regulatory body may lead to uncertainty and changes in the regulatory framework for pharmacy education.

3. Resource Constraints:

Pharmacy institutions may face resource constraints in implementing NEP-2020's provisions, including digital education and research initiatives.

CONCLUSION

The impact of NEP 2020 on pharmacy institutions is transformational. It compels a shift from traditional, exam-centric teaching models to a flexible, research-oriented, digitally enabled, and globally competitive educational framework. While the reforms demand significant restructuring and capacity building, they also offer Indian pharmacy institutions the opportunity to emerge as centers of excellence in pharmaceutical education, research, and innovation. Strategic partnerships, investments in infrastructure, and a commitment to quality and inclusiveness will determine how successfully they navigate this new educational paradigm.

The impact of NEP 2020 on the faculty of pharmacy institutions is profound and transformative. It redefines the role of educators as knowledge creators, mentors, innovators, and leaders in the academic and pharmaceutical landscape. While the transition demands effort and adaptability, it also brings enhanced recognition, professional development, and the opportunity to contribute meaningfully to the healthcare sector and national development.

The National Education Policy 2020 has the potential to transform pharmacy education in India, promoting a more holistic, multidisciplinary, and research-oriented approach. While there are benefits to this approach, there are also challenges that need to be addressed. Pharmacy institutions, regulatory bodies, and policymakers must work together to ensure a smooth transition and maximize the benefits of NEP-2020 for Pharmacy Education.

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INTERCONNECTION OF ORAL BACTERIAL INFECTION AND INCREASED RISK OF CARDIOVASCULAR EVENTS: A CLINICAL EPIDEMIOLOGICAL REVIEW

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ABSTRACT

Background: Chronic oral infection, particularly periodontitis, causes systemic inflammation and bacteremia, potentially contributing to coronary artery disease and myocardial infarction (MI). **Methods:** We synthesized epidemiologic data on periodontitis–cardiovascular risk, mechanistic studies of oral bacteria invading cardiovascular tissues, and mortality consequences. **Results:** Periodontitis was associated with a 19–33% elevated risk of cardiovascular mortality and ischemic heart disease in large cohort studies[1,2]. Meta-analysis yields relative risk ~1.19 for general CVD and ~1.44 for younger individuals (<65 years)[3–5]. Severe disease or multiple pathogens further increase the odds of MI up to 2.0–2.5[6]. In hypertensive cohorts, periodontitis raised cardiovascular mortality risk by 48% and all-cause mortality by 33%[7].**Mechanisms:** Oral pathogens such as Porphyromonasgingivalis and Treponema denticola invade gingival tissues, enter the bloodstream, and have been detected in atherosclerotic plaques, promoting systemic inflammation, endothelial dysfunction, oxidative stress, and thrombosis[8–10]. **Conclusion:** There is robust epidemiological and mechanistic evidence supporting a contributory role of oral bacterial infection–particularly chronic periodontitis –in increasing the risk of myocardial infarction and cardiovascular mortality.

Keywords: periodontitis, oral infection, cardiovascular mortality, myocardial infarction, systemic inflammation.

Ø INTRODUCTION

Oral infections–especially chronic periodontitis driven by pathogenic bacteria–are highly prevalent and often overlooked systemic contributors to cardiovascular disease (CVD)[1,3]. The chronic inflammation and periodic bacteremia can instigate vascular changes, ultimately leading to atherosclerosis and acute coronary syndromes [3, 4]. In addition to the results of interventions seen in animal models and clinical studies, the epidemiologic secondary data undoubtedly go deeper into the precise pathogenic mechanisms by which common oral bacteria–primarily Porphyromonas gingivalis, Treponema denticola, and Fusobacterium nucleatum–contribute to cardiovascular disease.[1,2,5]. Pathogen-Specific Mechanisms and Intervention Outcomes:

1. Porphyromonasgingivalis (P. gingivalis)

A Gram-negative, anaerobic, black-pigmented bacterium, P. gingivalis, is a keystone pathogen in chronic periodontitis. Its virulence and systemic effects are profound.

Mechanisms of Cardiovascular Pathogenesis[11]

a)Endothelial Dysfunction: Lipopolysaccharides (LPS) of P. gingivalis activate TLR2 and TLR4 receptors on endothelial cells, leading to upregulation of adhesion molecules (ICAM-1, VCAM-1) and monocyte recruitment to the intima, which are early steps in atherogenesis.

b) Invasion and Survival:P. gingivalis invades vascular endothelial cells, survives intracellularly, and impairs nitric oxide (NO) production, a critical vasodilator and anti-atherogenic molecule.

c)Molecular Mimicry: The bacterium expresses heat shock proteins (HSP60-like) that cross-react with human HSPs, eliciting autoimmune responses contributing to plaque instability.

d**)Induction of Foam Cells:** Its gingipains and fimbriae facilitate oxidized LDL uptake by macrophages, accelerating foam cell formation–a hallmark of atherosclerotic plaque.

e)Prothrombotic Effects: Gingipains activate platelet aggregation and clot formation via protease-activated

a)receptors (PAR-1, PAR-4), increasing the risk of thrombotic events and MI[12,13].

Experimental and Clinical Intervention Outcomes[11,14]

·**Animal Models:**

oIn ApoE-/- mice, oral or intravenous inoculation with P. gingivalis led to significantly increased atherosclerotic plaque size and inflammatory infiltration.

oAnti-P. Gingivalis vaccination (e.g., heat-shock protein–based) in rabbits and mice showed reduced atheroma burden and inflammatory cytokines.

·**Human Studies:**

oElevated P. gingivalis DNA detected in human coronary artery plaques.

oAntibiotic treatment (e.g., doxycycline) lowered systemic inflammation (CRP, IL-6) in periodontal patients with CAD, although the mortality benefit remains unproven.

2. Treponema denticola (T. denticola)[15–17]

A motile, anaerobic spirochete found in deep periodontal pockets, T. denticola often coexists with P. gingivalis and synergistically exacerbates tissue invasion and immune evasion.

Mechanisms of Cardiovascular Pathogenesis[13,18–20]

·**Proteolytic Activity:** Its Dentilisin (a major protease) degrades endothelial junction proteins, enhancing vascular permeability and bacterial invasion.

·**Toll-like Receptor Activation:** It induces persistent TLR2 activation, resulting in sustained inflammatory cytokine release (TNF-α, IL-1β) and vascular injury.

·**Matrix Metalloproteinase** (MMP) Upregulation: Dentilisin promotes MMP-2 and MMP-9 secretion, leading to vascular extracellular matrix breakdown and plaque rupture susceptibility.

·**Synergy with P. gingivalis:** Co-infection enhances virulence gene expression and atherogenesis.

Experimental Outcomes[12,13,16,18]

·In murine atherosclerosis models, T. denticola increased lesion development and lipid accumulation when introduced orally.

·Combined exposure with P. gingivalis amplified endothelial cell apoptosis and smooth muscle dysfunction.

Fusobacterium nucleatum (F. nucleatum)

A Gram-negative, spindle-shaped anaerobe involved in both periodontal and systemic diseases.

Cardiovascular Mechanisms[19–22]

a)Bacteremia and Endocarditis: Notably implicated in infective endocarditis, especially in immunocompromised hosts or post-dental procedures.

b)Invasion of Endothelial Cells: Its FadA adhesion protein binds E-cadherin, disrupting endothelial barriers and promoting transmigration.

c)Immune Activation: Triggers excessive neutrophilic response, ROS production, and systemic pro-inflammatory cytokines.

Clinical Evidence[14,23]

·F. nucleatum DNA is frequently detected in atherosclerotic plaques and infected heart valves.

·Poor oral hygiene correlates with increased incidence of bacteremia involving F. nucleatum post-extraction or even daily brushing.

Interventional Outcomes: Periodontal Therapy & Cardiovascular Impact[2,5,23–28]

Non-Surgical Periodontal Treatment (NSPT)

·Scaling and root planing (SRP), coupled with improved oral hygiene, significantly reduces systemic inflammatory markers (CRP, IL-6, TNF-α).

·Meta-analysis (Bahekar et al., J Gen Intern Med, 2007): Reduction in carotid intima-media thickness (cIMT) after SRP, indicating improved vascular health

Systemic Antibiotic Use[4,5]

·Adjunctive antibiotics (amoxicillin, metronidazole) temporarily reduce bacterial load but may not confer long-term cardiovascular protection due to microbiota rebound.

Vaccination & Probiotic Approaches

·Experimental vaccines targeting P. gingivalis gingipains, fimbriae, or HSPs show attenuated plaque growth and systemic inflammation in animals.

·Probiotics (e.g., Lactobacillus reuteri) may reduce periodontal pathogens and modestly improve endothelial function.

Cardiovascular Event Reduction[6,29]

·Randomized controlled trials such as the PAVE Study (J Periodontol, 2009) showed that periodontal treatment

·may modestly lower blood pressure and improve endothelial function in CVD patients, though direct MI/mortality reduction evidence remains limited.

Ø METHODS

We reviewed large-scale epidemiological cohort and meta-analysis studies assessing associations between oral infection markers (periodontitis, tooth loss, bacterial presence) and cardiovascular morbidity and mortality. Mechanistic evidence from in vivo/in vitro studies on periodontal pathogens and vascular tissue was also included[1,5,30].

Ø RESULTS

Epidemiological Associations

Longitudinal cohort data: In individuals aged ⩾60 years, periodontitis was associated with a hazard ratio (HR) of 1.5 for ischemic heart disease and HR 1.4 for all-cause mortality over 17 years. In hypertensive patients, similar numbers apply–48% increased risk of cardiovascular mortality, 33% higher all-cause mortality.[3,6].

Meta-analyses: A pooled RR of ~1.19 for future CVD in periodontitis subjects; higher (1.44) in those aged ⩽65 years. Case-control studies confirm ORs up to 2.5 for MI in patients with periodontitis or multiple pathogens.[4–6,26].

Tooth loss/ calculus measures: High dental calculus index (marker of chronic bacterial accumulation) is statistically associated with premature death from MI [3,4,6].

Pathophysiological Mechanisms

Bacteremia and direct invasion: Daily activities (brushing, chewing) or dental procedures allow oral pathogens into circulation; bacterial DNA from periodontal species is detected in atherosclerotic plaques[24,25].

Inflammatory cascade: Periodontitis provokes elevations in CRP, fibrinogen, proinflammatory cytokines, reactive oxygen species, and immune activation; these contribute to endothelial dysfunction and plaque progression[7,8,10].

Specific pathogens:

P. gingivalis accelerates atherothrombosis in murine models, promotes oxidative stress and matrix metalloproteinase expression that may impair myocardial stability post-MI[9].T. denticola may invade the vascular endothelium and contribute to atherosclerotic lesion formation[9,10].

Clinical Consequences

Mortality: Cardiovascular death is a leading outcome, consistent with global mortality burden (CVD ~32% of global deaths)[6,8,27]. Periodontal disease exacerbates risk, especially in those with hypertension or pre-existing coronary disease.[5,24].

Acute events: Patients with periodontal infection are more likely to suffer first MI and adverse cardiac events; in the PAROKRANK cohort, periodontitis is associated with an OR of 1.28 for first MI[8,24,31].

Ø DISCUSSION

This integrated evidence indicates that oral bacterial infection–notably chronic periodontitis–can significantly elevate the risk of myocardial infarction and cardiovascular death. While causation cannot be definitively proven due to observational designs, the consistency across studies, biologically plausible mechanisms, dose–response trends, and interventional improvements after periodontal treatment reinforce the link.The intricate relationship between chronic oral infections–particularly periodontitis–and cardiovascular disease (CVD) has evolved from a hypothetical association to a scientifically supported model of microbial-immune-endothelial interplay[13,18]. This discussion synthesizes pathogen-specific mechanisms and intervention outcomes, emphasizing both epidemiological relevance and mechanistic depth, while also identifying clinical and research gaps.

·Oral Pathogens as Systemic Risk Factors

Chronic periodontitis, an inflammatory condition driven by microbial dysbiosis, serves as a reservoir for systemic bacteremia and chronic immune activation. Among the diverse microbiota implicated, Porphyromonasgingivalis emerges as a critical keystone pathogen capable of subverting host immunity, promoting vascular injury, and accelerating atherosclerosis. The pathogen's virulence stems from its arsenal of lipopolysaccharides (LPS), gingipains, fimbriae, and hemagglutinins–all of which disrupt endothelial integrity, promote monocyte adhesion, and facilitate invasion into vascular tissues. Importantly,

P. gingivalis LPS triggers Toll-like receptor (TLR) pathways–specifically TLR2 and TLR4–culminating in nuclear factor-kappa B (NF-κB) activation and cytokine release (IL-1β, IL-6, TNF-α), all of which drive vascular inflammation. [17,20,21].

Experimental animal models underscore this mechanistic pathway. In ApoE knockout mice, chronic oral or systemic inoculation with P. gingivalis significantly increased atherosclerotic lesion size, accompanied by infiltration of inflammatory cells and upregulation of matrix metalloproteinases (MMPs), which degrade the vascular extracellular matrix, thereby contributing to plaque instability and rupture. [12,13,16,18,21]. Furthermore, molecular mimicry involving bacterial heat-shock proteins induces autoimmune reactions, a phenomenon increasingly implicated in chronic vascular damage.

Treponema denticola, a spirochete closely associated with late-stage periodontal disease, enhances the inflammatory burden through synergistic interaction with P. gingivalis. Its dentilisin protease facilitates endothelial transmigration and degrades host cell adhesion molecules, further compromising vascular integrity. T. denticola also promotes reactive oxygen species (ROS) production, which damages vascular smooth muscle cells and compromises nitric oxide bioavailability, contributing to hypertension and endothelial dysfunction, precursors to atherosclerosis[23,32–34]

Fusobacterium nucleatum, though classically regarded as an opportunistic pathogen, has gained attention for its systemic effects. Its FadA adhesion protein facilitates binding to endothelial cadherins, permitting deeper tissue invasion. Moreover, F. nucleatum has been identified in atherosclerotic plaques and infected endocardial valves, and it plays a known role in transient bacteremia following common dental procedures, such as scaling or extractions. Its role in thrombogenic responses and neutrophil overactivation may further exacerbate vascular injury, particularly in susceptible individuals. [24–26,31].

·Clinical and Interventional Outcomes

Intervention studies reinforce the systemic significance of periodontal infections. Non-surgical periodontal therapy (NSPT), especially when combined with improved oral hygiene and patient education, consistently reduces systemic inflammatory markers. Several trials have demonstrated significant post-treatment reductions in C-reactive protein (CRP), interleukins, and endothelial adhesion molecules. A notable observation from the PAVE (Periodontitis and Vascular Events) study was modest improvement in endothelial function and reduction in systolic blood pressure following periodontal intervention in individuals with pre-existing CVD[3,5–7,27].

Antimicrobial adjuncts, including doxycycline and metronidazole, have demonstrated temporary suppression of pathogenic load and associated inflammatory mediators. However, these pharmacologic measures often fail to produce sustained cardiovascular benefit without continuous periodontal control. Similarly, vaccine development targeting P. gingivalis virulence factors–such as gingipains or heat-shock proteins–has yielded promising results in animal studies, including reduced lesion size and systemic inflammatory responses. Despite this, human trials remain sparse, and ethical considerations limit prophylactic bacterial vaccines for non-lethal diseases like periodontitis[1,5,9,25]

Probiotics and host-modulation therapy have recently emerged as potential adjuncts. Specific strains such as Lactobacillus reuteri have shown promise in reducing P. gingivalis colonization and enhancing immune modulation, although large-scale trials are needed to validate cardiovascular endpoints. [15,17,21,25,26].

Integrative Interpretation

Taken collectively, these findings position periodontal pathogens not merely as local infectious agents but as systemic modulators of vascular health. The mechanisms–ranging from molecular mimicry, direct endothelial invasion, oxidative stress, to chronic low-grade inflammation–converge on the common pathophysiological pathway of atherogenesis. The effect size, while moderate in magnitude (risk ratios of ~

~1.2–2.0), gains public health importance due to the ubiquity of periodontitis and the high global prevalence of cardiovascular disease[17,19,20].

However, definitive causal inference remains challenged by the predominance of observational designs, potential confounding by shared risk factors (e.g., smoking, diabetes), and variability in periodontal disease definitions. Nonetheless, the Bradford Hill criteria–strength of association, consistency, biological plausibility, temporality, and dose-response relationship –are largely satisfied.

Implications for Practice and Future Research

For clinicians, particularly in cardiology and primary care, the findings underscore the need for interdisciplinary screening and management of periodontal disease as part of cardiovascular risk reduction. Integration of dental assessments into routine medical check-ups for high-risk patients (e.g., hypertensives, diabetics, post-MI) could serve as an adjunct preventive strategy.[15,16,21]. Meanwhile, future research must prioritize randomized controlled trials assessing whether sustained periodontal therapy translates into lower incidence of myocardial infarction, stroke, and cardiovascular death. [13,16,18,23,28,32].

Ø LIMITATIONS

Potential confounding from shared risk factors (smoking, socioeconomic status, diabetes), though many studies adjusted for these.Observational design precludes confirmation of causality.Variability indefinitions/grades of periodontal disease among cohorts.

Ø CLINICAL IMPLICATIONS & FUTURE DIRECTIONS

a)Integrated healthcare: Medical and dental practitioners should collaborate to identify and manage at-risk patients, particularly those with hypertension, diabetes, or established coronary disease.

b**)Preventive oral hygiene**: Regular professional periodontal care, brushing, and flossing can substantially reduce cardiovascular mortality risk (~50% reduction in one cohort).

c)Research: Randomized controlled trials evaluating whether periodontal treatment reduces cardiovascular events are needed for definitive causal inference.

Ø CONCLUSION

Bacterial infection in the oral cavity, especially chronic periodontitis, is associated with significant increases in the risk of myocardial infarction and cardiovascular mortality. The interconnection arises via systemic inflammation, pathogenic bacteria entering circulation, and endothelial dysfunction–all contributing to atherosclerosis. Proactive oral health maintenance could play an important role in cardiovascular disease prevention. The mechanisms through which specific oral pathogens contribute to cardiovascular morbidity and mortality are both diverse and potent. P. gingivalis remains the central instigator, while co-pathogens like T. denticola and F. nucleatum enhance disease synergy. Though intervention via periodontal therapy shows promise in reducing systemic inflammation and improving surrogate cardiovascular markers, large-scale trials targeting hard endpoints (MI, stroke, cardiac death) are urgently required to substantiate the therapeutic linkage.

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PHYTO-ANTIBIOTICS: BRIDGING TRADITIONAL KNOWLEDGE WITH MODERN ANTIMICROBIAL THERAPY

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1. Introduction

Antibiotics have revolutionized modern medicine, playing a critical role in treating bacterial infections, preventing complications in surgeries, and supporting immunocompromised patients. However, the widespread and often inappropriate use of antibiotics has led to the emergence of multidrug-resistant pathogens, posing a serious global health threat. The World Health Organization has identified antibiotic resistance as one of the top ten public health challenges of our time. This alarming trend has intensified the need for new and effective antimicrobial agents. In this context, medicinal plants have garnered increasing attention as a rich source of bioactive compounds with potent antibacterial, antifungal, and antiviral properties. This article aims to explore the potential of plant-derived antibiotics, highlight key medicinal plant families, and examine their role as sustainable alternatives against infectious diseases and resistance.

"Let food be thy medicine and medicine be thy food." – Hippocrates

2.The Scientific Basis of Phyto-antibiotics and Rationality

Plants have evolved sophisticated defence mechanisms to survive microbial attacks, among which the production of secondary metabolites plays a central role. These compounds—distinct from primary metabolic products—include alkaloids, flavonoids, tannins, terpenoids, phenolics, and essential oils, many of which possess potent antimicrobial, antifungal, and antiviral properties. Functioning as natural antibiotics, these phytochemicals can inhibit microbial growth by disrupting cell walls, interfering with protein synthesis, or altering membrane permeability [1].

Alkaloids such as berberine have demonstrated broad-spectrum antibacterial activity, particularly against multidrug-resistant organisms. Flavonoids and phenolic acids, like quercetin, exhibit strong bacteriostatic and viricidal properties through enzyme inhibition and oxidative stress induction. Tannins can precipitate microbial proteins, while essential oils containing thymol and eugenol have shown significant membrane-disruptive and anti-inflammatory effects. Together, these plant-derived compounds form the biochemical basis for phytoantibiotics, offering diverse modes of action that could modulate modern antimicrobial therapies [2-5].

Fig. 1: Primary and secondary metabolites of medicinal plants.

Table 1: Family, Active compounds and Key plants with Antibiotic Properties

Family	Key Plants	Active Compounds
Lamiaceae	*Ocimum sanctum, Thymus vulgaris*	Thymol, Eugenol
Zingiberaceae	*Zingiber officinale, Curcuma longa*	Gingerol, Curcumin
Myrtaceae	*Eucalyptus globulus, Syzygium aromaticum*	Eucalyptol, Eugenol
Rutaceae	*Citrus spp., Ruta graveolens*	Limonene, Coumarins
Asteraceae	*Artemisia annua, Calendula officinalis*	Artemisinin, Flavonoids
Fabaceae	*Glycyrrhiza glabra*	Glycyrrhizin
Berberidaceae	*Berberis vulgaris, Berberis aristata*	Berberine
Meliaceae	*Azadirachta indica*	Nimbidin, Azadirachtin
Moraceae	*Morus alba, Ficus religiose*	Kuwanon G, Moracin, Flavonoids
Liliaceae	*Allium sativum*	Allicin, diallyl sulfide, diallyl disulfide

3.Prominent Plant Families with Antibiotic Potential: Key Species and Their Mechanisms of Action

Several plant families are well-recognized for their rich repository of antimicrobial compounds. These families include medicinal plants traditionally used in various systems like Ayurveda, Traditional Chinese Medicine, and ethnomedicine, and are now being explored scientifically for their antibiotic potential.

Ø The **Lamiaceae** family, known for its aromatic herbs such as Ocimum sanctum (Holy Basil) and Thymus vulgaris (Thyme), produces essential oils rich in thymol and eugenol, known to disrupt microbial membranes.

Ø The **Zingiberaceae** family includes Zingiber officinale (Ginger) and Curcuma longa (Turmeric), whose active compounds gingerol and curcumin exhibit antimicrobial and anti-inflammatory properties.

Ø In the **Myrtaceae** family, Syzygium aromaticum (Clove) and Eucalyptus globulus yield eugenol and eucalyptol, potent against oral and respiratory pathogens

Ø The **Berberidaceae** family is represented by Berberis species (includes Berberis aristate), which produce berberine, which intercalates DNA and inhibits bacterial topoisomerase, effective against Staphylococcus aureus and Escherichia coli.

Ø The **Meliaceae** family (e.g., Azadirachta indica, Neem) produces nimbidin, interfering with microbial replication.

Ø The **Fabaceae** family (Glycyrrhiza glabra) yields glycyrrhizin, with antiviral and antibacterial effects via modulation of inflammatory pathways.

Ø The **Liliaceae** family features Allium sativum (Garlic), rich in allicin, which inhibits sulfhydryl-containing enzymes essential for microbial metabolism and exhibits strong broad-spectrum activity.

Ø The **Moraceae** family includes Ficus religiosa and Morus alba, which produce flavonoids and phenolic acids that damage microbial cell walls and inhibit nucleic acid synthesis.

Other notable families include Rutaceae (Citrus species), and Asteraceae (Artemisia annua) all rich in diverse antimicrobial phytochemicals. These families serve as critical sources in the ongoing search for plant-based antibiotics with novel mechanisms of action[6].

4. Mechanism of Action of Plant-Based Antibiotics

Plant-derived antibiotics exhibit diverse mechanisms of action that target essential microbial structures and processes.

· Many phytochemicals, such as thymol (from Thymus vulgaris) and eugenol (from Syzygium aromaticum), disrupt bacterial cell walls and membranes, leading to leakage of intracellular contents and cell death.

· Others, such as allicin from garlic, interfere with quorum sensing, thereby inhibiting microbial communication and biofilm formation, which are critical for pathogenicity and resistance[7].

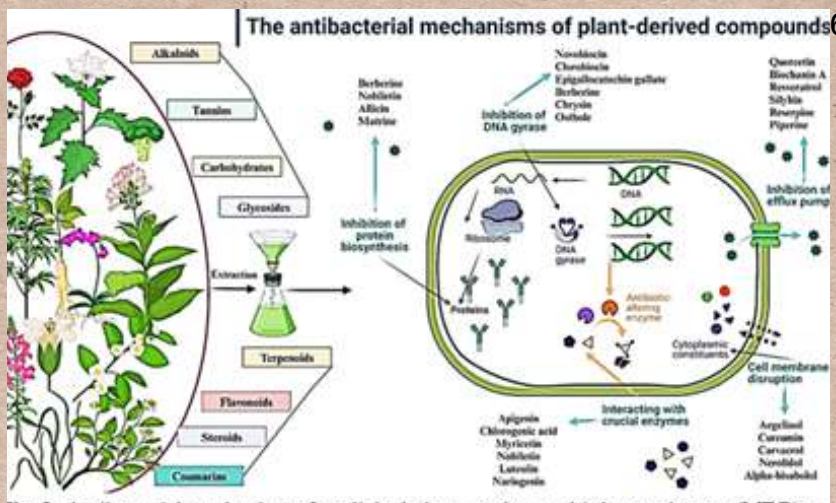

Fig. 2: Antibacterial mechanism of medicinal plants against multi-drug resistance (MDR) as natural alternatives to antibiotics

Table 2: Comparison: Phytoantibiotics vs Synthetic Antibiotics

Parameter	Phytoantibiotics (Plant-Based)	Synthetic Antibiotics
Source	Derived from medicinal plants and their secondary metabolites	Chemically synthesized or semi-synthetic compounds
Chemical Complexity	Contain complex mixtures of bioactive compounds (e.g., alkaloids, flavonoids, terpenes)	Usually single active pharmaceutical ingredients with defined structure
Mechanism of Action	Multi-targeted: disrupt membranes, inhibit enzymes, affect quorum sensing	Often single-targeted: inhibit cell wall synthesis, DNA replication, or protein synthesis
Resistance Development	Slower resistance development due to multi-target action	Higher risk of resistance due to specific molecular targets
Toxicity & Side Effects	Generally lower toxicity with immunomodulatory benefits	May cause organ toxicity, allergic reactions, or gut flora imbalance
Bioavailability	Often lower; requires enhancement via nanoformulation or encapsulation	Typically optimized for absorption and systemic circulation
Synergistic Potential	High synergy with conventional antibiotics, enhancing efficacy and overcoming resistance	May require adjunctive therapy for resistant strains

5. Applications and Formulation Strategies

Ø Herbal Extracts are used in:

o Topical antiseptics

o Mouthwashes

o Ayurvedic polyherbal formulations for systemic infections and immune support

o Synergistic therapies combined with modern antibiotics

Ø Advanced Drug Delivery Systems:

o Nanoparticle-based delivery for targeted action and enhanced potency

o Encapsulation techniques to improve:

§ Stability

§ Solubility

§ Bioavailability

§ Controlled release of active phytochemicals[8].

6. Challenges in Plant-Derived Antibiotics

- Phytochemical Variability: The concentration and composition of active compounds can vary widely due to:
  - Geographical origin
  - Seasonal changes
  - Extraction and processing methods
- **Pharmaceutical Limitations:**
  - Poor solubility, stability, and bioavailability limit clinical efficacy.
  - Difficulty in standardizing extracts and controlling dosage.
- **Regulatory and Scientific Barriers:**
  - Limited clinical trials and lack of regulatory frameworks for approval.
  - Inadequate toxicological and pharmacokinetic data.
- **Environmental and Ethical Concerns:**
  - Risk of overharvesting threatens biodiversity.
  - Urgent need for sustainable cultivation and conservation of medicinal plants[9-10].

7. Conclusion

In the era of rising antibiotic resistance, phytoantibiotics offer a promising, sustainable alternative with diverse mechanisms of action. Their integration into personalized and integrative medicine holds potential for safer, more effective infection management. Bridging traditional ethnobotanical knowledge with modern pharmacological validation is crucial for advancing these therapies.

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GASTRORETENTIVE DRUG DELIVERY FOR HELICOBACTER PYLORI INFECTION : A NOVEL STRATEGY TO IMPROVE ERADICATION

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Helicobacter pylori (H. pylori) is a Gram-negative bacterium that colonizes the human stomach and is implicated in various gastrointestinal diseases, including chronic gastritis, peptic ulcers, and gastric cancer. Eradication of H. pylori has become a global health priority due to its widespread prevalence and serious clinical implications. Standard treatment regimens typically involve a combination of antibiotics and acid-suppressing drugs; however, eradication rates are declining due to increasing antibiotic resistance, poor patient compliance, and inadequate local drug concentrations. In this context, Gastro Retentive Drug Delivery Systems (GRDDS) have emerged as promising platforms for enhancing the efficacy of anti-H. pylori therapy by prolonging gastric residence time and improving localized drug delivery.Conventional oral therapies for H. pylori face several limitations.The bacterium resides in the gastric mucus layer, close to the epithelial surface, where it is partially protected from systemic circulation and conventional antibiotics. Furthermore, gastric emptying rapidly removes drugs from the stomach, reducing the time available for them to act directly at the site of infection. This necessitates frequent dosing and often leads to incomplete eradication. GRDDS address these limitations by providing prolonged retention in the stomach, enhancing local drug concentration, and potentially improving the efficacy of the antibiotics used.

Several types of GRDDS have been developed, including floating systems, bioadhesive systems, expanding systems, high-density systems, and superporous hydrogels. Among these, floating drug delivery systems are the most extensively researched for H. pylori treatment. These formulations have a

lower density than gastric fluids and can float on the stomach contents, thereby remaining in the stomach for extended periods. Drugs such as metronidazole, clarithromycin, and amoxicillin have been successfully incorporated into floating tablets or capsules, ensuring prolonged drug release and better targeting of the bacteria. Mucoadhesive systems rely on polymers that adhere to the gastric mucosa, thereby resisting gastric emptying and maintaining the drug at the site of infection. Polymers like carbopol, chitosan, and polycarbophil are commonly used for their ability to bind to the mucus lining and provide sustained drug delivery. These systems not only increase the gastric residence time but also create a close contact between the drug and the infected mucosa, improving antimicrobial efficacy. Expanding or swelling systems are designed to increase in size upon contact with gastric fluids, preventing their passage through the pylorus. These systems can offer both immediate and sustained drug release, and their large size allows for drug loading and longer gastric retention. Similarly, high-density systems, which sink to the bottom of the stomach, have also been studied for targeted delivery, though their practical application is more limited due to variability in gastric motility and contents.

In addition to these, nanotechnology-based approaches have been gaining attention for H. pylori treatment. Nanoparticles, liposomes, and microspheres can encapsulate antibiotics, protect them from gastric degradation, and deliver them directly to the site of infection. Some nanoparticles can even penetrate the mucus layer and bind to the bacteria, offering a highly localized therapeutic effect. Incorporating these systems into gastroretentive formulations may further improve targeting efficiency.The choice of GRDDS formulation depends on various factors, including the physicochemical properties of the drug, the nature of the polymer used, and the patient's gastric physiology. For example, floating systems are best suited for drugs that are stable in acidic pH and have higher solubility in gastric fluid. On the other hand, mucoadhesive systems may be preferable for drugs that require close mucosal contact to exert their action.

Several studies have shown that GRDDS can significantly enhance the bioavailability and therapeutic efficacy of anti-H. pylori drugs. For instance, floating tablets of amoxicillin and clarithromycin have demonstrated prolonged gastric retention and improved eradication rates in preclinical and clinical trials. Furthermore, combining GRDDS with proton pump inhibitors or bismuth compounds in triple or quadruple therapy regimens may further enhance treatment outcomes.However, the development and commercialization of GRDDS face certain challenges. Formulation stability, manufacturing complexity, variability in gastric emptying time among individuals, and the influence of food and motility patterns can affect the performance of these systems. Additionally, patient-related factors such as adherence to the dosage regimen and tolerability of prolonged-release formulations must be considered.

In conclusion, Gastro Retentive Drug Delivery Systems offer a promising advancement in the treatment of H. pylori infection, particularly in overcoming the limitations of conventional therapy. By extending gastric residence time and ensuring localized, sustained drug release, GRDDS can potentially improve eradication rates, reduce dosing frequency, and combat antibiotic resistance. Continued research and clinical validation of these systems are essential to optimize their design and ensure their effectiveness in real-world settings.

PLANTIBODIES: GREEN FRONTIER IN IMMUNOTHERAPY AND VACCINE DEVELOPMENT

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Plantibodies are plant-derived monoclonal antibodies (mAbs) produced through recombinant biotechnology. They represent a revolutionary paradigm shift in biopharmaceutical manufacturing, offering a sustainable, scalable, and cost-effective alternative to traditional production in mammalian cell cultures.

Emerging from the foundational concept of molecular farming pioneered in the late 1980s, this field leverages genetically engineered plants as bioreactors to synthesize complex therapeutic proteins (1). Significant advancements in transient expression systems, particularly Agrobacterium-mediated agroinfiltration into rapid-growth hosts like Nicotiana benthamiana and BY-2 tobacco cells, have been pivotal (2). These systems enable remarkably swift production timelines (often within days) and offer unparalleled scalability, a critical advantage dramatically demonstrated during the COVID-19 pandemic for the rapid deployment of potential countermeasures (3). Beyond speed, plant platforms possess a unique and powerful advantage: sophisticated glycoengineering potential. Unlike mammalian cells or microbes, plants can be genetically tailored to eliminate immunogenic plant-specific glycans (such as β1,2-xylose and α1,3-fucose) and instead produce humanized N-glycan structures (1). This precise control over post-translational modification is not merely cosmetic; it directly enhances crucial therapeutic functions like antibody-dependent cell-mediated cytotoxicity (ADCC), thereby boosting the efficacy of plantibodies in demanding clinical applications, particularly oncology and viral neutralization, where specific glycan profiles dictate biological activity and safety. Furthermore, the inherent biology of plants unlocks innovative delivery strategies largely inaccessible to conventional biologics. A particularly compelling application is in oral and mucosal passive immunization. Plantibodies, including formats like Fc-fused nanobodies (VHHs) or secretory IgA (sIgA) constructs, can be expressed directly within edible plant tissues (e.g., lettuce, rice seeds) or formulated into stable, lyophilized powders. This facilitates non-invasive administration routes – oral, nasal, or sublingual – bypassing the need for injections and stringent cold-chain logistics. Proof-of-concept studies underscore this potential, demonstrating successful passive protection using plantibodies against enterotoxigenic E. coli (ETEC) in piglets via oral delivery and against periodontal pathogens through nasal application (4,5). This positions plantibodies as exceptionally promising candidates for global health initiatives and deployment in low-resource settings, where infrastructure limitations often hinder traditional vaccine and therapeutic antibody distribution. However, despite these significant advantages and promising applications, the path to widespread clinical adoption faces hurdles. Technical challenges include ensuring consistent batch-to-batch homogeneity, developing efficient and cost-effective large-scale purification protocols for complex plant tissues, and optimizing expression levels for diverse protein formats. Regulatory frameworks specifically governing plant-made pharmaceuticals are still evolving and require greater international harmonization to facilitate global approval and commercialization. Public perception and acceptance of genetically modified organisms (GMOs), especially in the context of food-associated production systems, also remain a significant consideration requiring proactive communication and education. Addressing these challenges demands continued innovation in synthetic biology tools for precise genome editing and glycan control, alongside rigorous process standardization and optimization (6). In conclusion, plantibodies embody a highly versatile and adaptable platform technology poised to reshape biopharmaceuticals. Their modular design, rapid and flexible production capacity, unique delivery potential, and inherent cost-effectiveness make them ideal candidates not only for pandemic preparedness and responsive therapeutics but also for next-generation cancer immunotherapies and novel mucosal vaccines. Overcoming the existing technical and regulatory barriers holds the key to unlocking their full potential, paving the way for a new era of more affordable, accessible, and sustainable health solutions on a global.

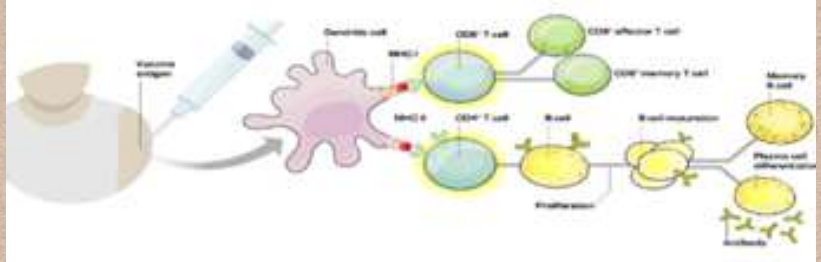

Figure : Vaccine-mediated immune response

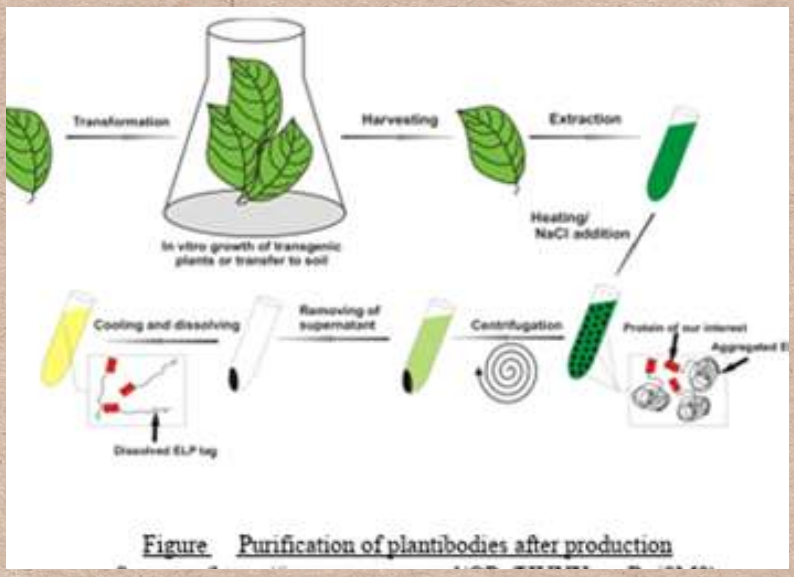

Figure Purification of plantibodies after production

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CO-PO ATTAINMENT PROCESS THROUGH BLOOM'S TAXONOMY IN THE ACADEMIC EXAMINATION FRAMEWORK: IMPLEMENTATION WITH APPLIED EXAMPLES

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Abstract

This article presents a structured narrative on the Course Outcome–Program Outcome (CO–PO) attainment process through the application of Bloom's Taxonomy within the academic examination framework. Recognized as a cornerstone of Outcome-Based Education (OBE), this methodology facilitates the alignment of teaching, learning, and assessment strategies with institutional accreditation norms set by the NBA and NAAC. The manuscript elucidates how cognitive-level mapping through Bloom's Taxonomy supports measurable attainment analysis, contributes to quality benchmarks, and enhances curriculum delivery. Real-world academic examples are provided to demonstrate the practical utility of this framework in higher education institutions.

Keywords

CO-PO Mapping, Bloom's Taxonomy, Outcome-Based Education (OBE), Assessment Design, NBA, NAAC, Academic Quality, Cognitive Levels.

1. Introduction

Modern accreditation systems, especially those governed by the National Board of Accreditation (NBA) and the National Assessment and Accreditation Council (NAAC), mandate institutions to shift from input-based education to outcome-based education (OBE). Central to this paradigm is the process of mapping and assessing Course Outcomes (COs) against Program Outcomes (POs). This article introduces the essential role of Bloom's Taxonomy in strengthening this linkage, ensuring that examinations, teaching methods, and curriculum content are appropriately scaffolded for progressive learning.

2. **Understanding COs, POs, and Their Relevance**

Course Outcomes (COs) are specific, measurable statements detailing what a student is expected to learn upon completing a course. Program Outcomes (POs) define the competencies a graduate is expected to exhibit upon program completion. Mapping COs to POs ensures that the cumulative learning objectives across courses contribute to holistic program goals.

3. **Role of Bloom's Taxonomy in CO-PO Mapping**

Bloom's Taxonomy, particularly its cognitive domain, categorizes learning into six hierarchical levels: Remember, Understand, Apply, Analyze, Evaluate, and Create. These levels provide a clear mechanism for:

Designing COs with appropriate action verbs.

Aligning assessments with targeted learning levels.

Ensuring consistency and clarity in outcome evaluation.

4. **Steps in the CO-PO Attainment Process Using Bloom's Taxonomy**

1. **Define COs:** Use Bloom's action verbs to draft outcome statements aligned with course objectives.

2. **CO-PO Mapping:** Create a matrix showing the relevance level (Low: 1, Medium: 2, High: 3) between each CO and the corresponding PO.

3. **Assessment Design:** Structure examination questions and internal evaluations across various Bloom levels to test learning depth.

4. **Attainment Calculation:**

Assign marks or grades to each question according to Bloom's level.

Aggregate student performance data against COs.

Calculate attainment based on set benchmarks (e.g., 60% students scoring above 60% marks).

5.**Indirect Attainment:** Use student feedback surveys mapped to COs to supplement direct data.

6. **Final PO Attainment**: Use the weighted average of CO-PO mapping values to compute PO attainment levels.

5. **Applied Example: Implementation in a Pharmaceutical Science Course**

Course: Pharmacognosy I

- CO1: Recall sources and classification of crude drugs (Bloom's Level: Remember)
- CO2: Explain the methods of adulteration in crude drugs (Understand)
- CO3: Apply macroscopical and microscopical evaluation of natural products (Apply)

Assessment Mapping:

- Q1: Define crude drugs – CO1 – Remember – 5 marks
- Q4: Explain types of adulteration – CO2 – Understand – 10 marks
- Q6: Analyze a plant part sample under microscope – CO3 – Apply – 15 marks

CO-PO MAPPING MATRIX:

CO \ PO	PO1	PO2	PO3
CO1	3	1	-
CO2	2	3	-
CO3	1	2	3

Attainment:

Based on exam results, 70% of students achieved CO1, 65% achieved CO2, and 60% achieved CO3. This data is used to calculate PO attainment.

6. **Benefits of This Model**

- Ensures objective-based teaching and evaluation
- Enhances transparency and traceability in curriculum planning
- Supports data-driven decision-making for quality improvement
- Aids in NBA/NAAC documentation and continuous improvement cycles

7.**Challenges in Implementation**

- Initial resistance or unfamiliarity among faculty
- Requirement of data analytics tools or software (e.g., Excel, LMS)
- Alignment across interdisciplinary subjects

8. Recommendations

- Conduct regular faculty development programs on Bloom's Taxonomy and CO-PO mapping
- Standardize templates for CO definition and assessment matrices
- Use digital tools for tracking and visualization of attainment metrics

Conclusion

The integration of Bloom's Taxonomy into the CO-PO attainment process offers a robust mechanism for outcome evaluation and academic accountability.

Through structured examination practices and measurable learning benchmarks, institutions can foster academic excellence and achieve accreditation compliance. This framework, when institutionally adopted and refined, becomes a cornerstone of sustainable academic quality.

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RECENT PhD AWARDS OF OUR FACULTY MEMBER

We are pleased to announce that one of our esteemed faculty member have recently been awarded Doctor of Philosophy (PhD) degrees.

Dr. Sasmita Dash, Assistant Professor
Department of Pharmaceutical Chemistry
From- Centurion University of Technology and Management, Bhubaneswar, Odisha

RECENT PATENT OF BST

Sl No	Faculty Name	Title of the Patent	Nature of Patent	Patent No /Design No / Application No. (Country)	Year of Grant/ Published	Application Status
1	Dr. Raja Majumder	AI-Based Non-Invasive Brain Scanning Device for Neuro Defects Identification	Design	418985-001 (India)	July, 2024	Granted
2	Dr. Raja Majumder	Digital Ocular Drug Delivery Device for Diabetic Retinopathy Control	Design	427795-001 (India)	Oct, 2024	Granted
3	Dr. Raja Majumder, Mr. Gouranga Sundar Roy	Microfluidic SGPT Detection Apparatus With IOT Integration	Design	433141-001 (India)	Dec, 2024	Granted
4	Dr. Aniruddha Mukherjee	Instruments used for detection of Neurodegenerative Disorder	Design	6377777 (UK)	July, 2024	Granted
5	Dr. Aniruddha Mukherjee	Medical device used for non-invasive measurement of Haemoglobin	Design	423454-001 (India)	Aug, 2024	Granted

Session 2023-24

Sl No	Faculty Name	Title of the Patent	Nature of Patent	Patent No /Design No / Application No. (Country)	Year of Grant/Published	Application Status
1	Dr. Saumya Das	Portable Autoclave for Sterilization of small equipments	Design	391502-001 (India)	July, 2023	Granted
2	Dr. Saumya Das	Tablet Coating Machine for Enteric Coated Tablets	Design	6300386 (UK)	Aug, 2023	Granted
3	Dr. Dharmajit Pattanayak	Rotating cylinder type Dissolution Testing apparatus for Gastro-retentive Drug	Design	410286-001 (India)	Mar, 2024	Granted
4	Mr. Shaibal Chandra	Evaluation of Antioxidant and Antibacterial properties of *Azadirachta indica* - mediated green silver nanoparticles synthesis	Utility	202341046462 (India)	Sep, 2023	Published

RECENT PUBLICATIONS OF BST

Name of the Author	Title of Paper	Name of Journal
Dr. Anandamoy Rudra	Mucoadhesive Buccal Drug Delivery: A Review	International Journal of Pharmaceutical Sciences
Dr. Anandamoy Rudra	Emulgel: A Comprehensive Review for Topical Delivery of Anti-Fungal drugs	American Journal of Pharmacy and Health Research
Dr. Anandamoy Rudra	A Comprehensive Review on Ophthalmic in situ gelling system	American Journal of Pharmtech Research
Dr.Paramita Dey	Novel approaches in Pediatric Drug Delivery System	International Journal of Pharmaceutical Sciences and Drug Research
Dr.Paramita Dey	*In vitro* efficacy of poly-gama-glutamic acid loaded nano-formulation of Levofloxacin and Moxifloxacin against Brucellosis.	Revista Electronica de Veterinaria
Dr.Raja Majumder	Design, Synthesis and Pharmacological Evaluation of Some Novel Quinoxalines Derivatives	Nanotechnology Perceptions
Arunima Nag, Bommana Sweety Dhar, Dishari Dutta	Water for Pharmaceutical Use- A Mini Review	World Journal of Pharmaceutical Research
Arunima Nag, Suman Dutta, Toumica Ghosh, Annesha Chakraborty, Sanjita Rani Maiti, Riya Sarkar	Research & Development of Thyroquinone Drug-Conjugated Porous Chitosan Sponges for Wound Healing	International Journal of Research Publication and Reviews
Dr.Aniruddha Mukherjee	Evaluating the Neuropsychopharmacolog-ical Profiling of a Calcium Channel Blocker Verapamil on Sleep, Depression, and Locomotion in Mice	Frontiers in Health Informatics
Dr.Aniruddha Mukherjee	A Comparative Evaluation and Pharmacological Assessment of Abelmoschus Manihot Leaves Extract in Vitro Antidiabetic, Neuroprotective Activities, and their Effects on Glucose Uptake and DPP-4 Inhibition	The Bioscan

Arghya Bhattacharya	Innovative approaches in stem cell therapy: revolutionizing cancer treatment and advancing neurobiology - a comprehensive review	International Journal of Surgery
Suman Dutta, Arunima Nag, Riya Sarkar, Annesha Chakraborty, Toumica Ghosh	Herbal Drug Kali Phosporicum Therapeutic Effect on Neuropathy	International Journal of Research Publication and Reviews
Dr.Atanu Chatterjee	Comprehensive Analysis of Antidiabetic Properties in Raphanus sativus Leaves: A Synergistic In-Silico and In-Vitro Approach	Chemistry Africa
Dr.Atanu Chatterjee	Antimicrobial activity, Phytochemical screening by HPTLC, FTIR and GC-MS of the extracts of Cissus quadrangularis (L.)	African Journal of Biomedical Research
Dr.Atanu Chatterjee, Shaibal Chandra	Pharmacological and Antioxidant Activities of Cyperaceae Rhizomes: A Review of Current Research and Traditional Uses	African Journal of Biomedical Research
Sayani Paul	Phyto-nanotechnology: A novel beneficial strategy for Alzheimer's disease therapy	Neurochemistry International
Gouranga Sundar Roy	The irreversible, towards fatalic neuropathy: from the genesis of diabetes	Acta Diabetologica
Dishari Dutta	Design and development of solid lipid nanoparticles containing rosuvastatin using central composite design	International Journal of Applied Pharmaceutics
Dr.Paramita Dey	Nanorobots-The Future of Medicine	International Journal of Pharmaceutical Sciences
Dr. Paramita Dey	An overview on nanofibres: their whereabouts and applications in the pharmaceutical field	International Journal of Research in Pharmaceutical Sciences
Shaibal Chandra, Dr. Atanu Chatterjee	Exploration of antiurolithiatic properties of methanolic extract of rhizome of *CyperusTegetumRoxb* in ethylene glycol-induced urolithiatic rats	Pharmacological Research - Natural Products (https://www.sciencedirect.com/journal/pharmacological-research-natural-products)
Arghya Bhattacharya	Exosome isolation and characterization for advanced diagnostic and therapeutic applications	Materials Today Bio

RECENT EVENTS

NATIONAL PHARMACOVIGILANCE WEEK 2024

Celebration of 4th National Pharmacovigilance Week at Bengal School of Technology. at BENGAL SCHOOL OF TECHNOLOGY on 19.09.2024 & 20.09.2024.

WORLD PHARMACISTS DAY CELEBRATIONS 2024

"Pharmacists play a key role in helping patients get well and feel better as quickly as possible. They are medication specialists who improve medication adherence and are a vital part of healthcare teams" World Pharmacists Day Celebrations 2024 at BENGAL SCHOOL OF TECHNOLOGY on 25.09.2024.

SPANDAN 2024

Reunion organized by BST Pharma Alumni Association of Bengal School of Technology on 05.10.2024.

BLOOD DONATION CAMP & FREE HEALTH CHECK-UP CAMP

Organized by NSS unit of Bengal School of Technology & Bengal School of Technology and Management in association with Belur Sramajibi Swasthya Prakalpa Samity & Chinsurah Sramajibi Swasthya Prakalpa Samity on 29.10.2024.

SAPLING OF THE PLANTS

Organized by NSS unit of Bengal School of Technology & Bengal School of Technology on 29.10.2024.

FOOTBALL TOURNAMENT 2024

Organised by Bengal School of Technology & Bengal School of Technology and Management on 15.11.2024 & 17.11.2024

PHARMA RALLY

Organised by Bengal School of Technology on the Occasion of National Pharmacy Week 2024 to spread the awareness among the Public about the role and responsibilities of Pharma Professionals in Health Care System on 21.11.2024

ESSAY WRITING COMPETITION 2024

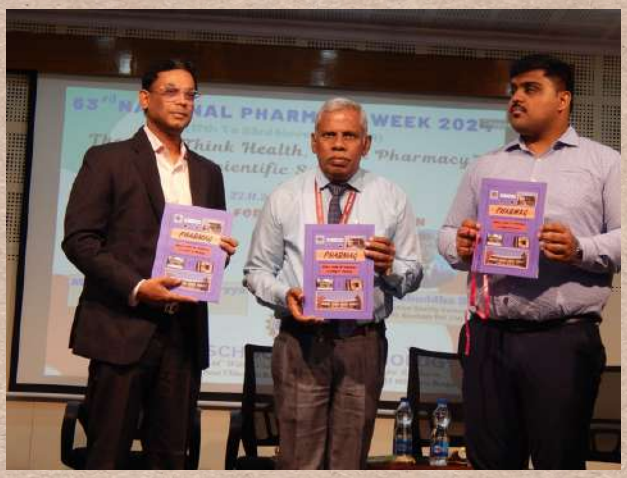
Bengal School of Technology organised an Essay Writing Competition for the students of Class 7 to 12 of Sugandha Higher Secondary School on the topic "Role of Pharmacists in Health Care" to percolate the knowledge of the roles and responsibilities of Pharma Professionals on 21.11.2024

SCIENTIFIC SESSION ON NPW 2024

Organised by Bengal School of Technology on 22.11.2024

INAUGURATION OF PHARMAMAG

A Pharma Magazine published by Bengal School of Technology



REPUBLIC DAY CELEBRATIONS

at Bengal School of Technology

Award of Appreciation for Academic Excellence 2023-2024

INFERNO 2K25

Annual fest organised by Bengal School of Technology & Bengal School of Technology and Management on 07.02.2025 & 08.02.2025

ANNUAL SPORTS MEET

Organised by Bengal School of Technology & Bengal School of Technology and Management on 15.02.2025

ENVIRONMENTAL AWARNESS CAMP

Organised by Women's Cell of Bengal School of Technology on 28.02.2025

BST-PHARMACON 2K25

Innovations in Pharmaceutical Sciences: Reshaping the healthcare system

Bengal School of Technology has organized First National Level conference BST Pharmacon2K25 during March 8-9, 2025 in the college campus. BST-PHARMACON 2K25 aims to foster the advancement of the pharmacy profession by providing a platform for education, collaboration, networking, and the exchange of knowledge.

The objective of the conference has been: 1. The interplay between pharmaceutical sciences with the biochemistry, biology, physiology, and electronic engineering brings innovations and their beneficial effect on healthcare systems improves the quality of life. 2. With the evolution of innovation only deadly diseases can be handled. 3.Innovation helps in economic growth of the society.4. Opening the new marketing window we can improve the product portfolio. 5. Innovation in pharmaceutical sciences will lead India to become a pharmaceutical hub globally.6. Opportunity of employability. 7. Increase the productivity and logistic distribution domain. 8. Increase the purchasing capacity of the customer and consumer. 9. Increasing the per capital income of the nation. 10. Invention of biological vaccines, sera, monoclonal antibody also help to prevent the pandemic situation. 11. Invention of new diagnostic kits also help to detect the different types of disease. 12. Optimization of new formulation development helps in fast release, targeted delivery of the essential medicaments. 13. Discussion on barriers to innovations.14. Optimization of new formulation development for strengthening of pharmaceutical manufacturing units. 15. Discussion on waste management, renewable energy. 16. Discussion on the risk management of the Quality management system (QMS). 17. Compliance to the regulatory activities of both domestic and international guidelines. 18. Comprehensive understanding of current good manufacturing practices (cGMP) and Good Clinical practices (GCP) and also good laboratory practices (GLP). 19. Good monitoring of the pharmacovigilance activity. 20. Detailed understanding of drug pharmacokinetic and pharmacodynamic pathway. 21. Maintaining of the clinical trials protocol. 22. Understanding the Computer aided drug design. 23. Discussion on traditional use of medicinal plants. 24. Herb used as healthy food. 25. Development of modern medicine by using traditional plant. 26. Discussion on 3D printing techniques of drug formulation. 27. Discussion on micropropagation and plants tissue culture. 28. Discussion on phenotype, genotype based drug discovery preclinical model. 29. Discussion on cloning, transgenic animal, gene expression, antisense oligonucleotide, microarray in clinical study. 30. Development and implementation of new pharmaceutical analytical techniques. 31. Synthesis of new active biomolecules through modern organic chemistry, combinatorial chemistry and green chemistry technologies.

The conference was graced in the presence of distinguished guests from all over India.


Welcome
to

CAMPUS PLACEMENTS

Campus Placements by **Alembic Limited**
at Bengal School of Technology
on 17.02.2025

TATA 1MG Pool Campus at Bengal School of Technology
More than 200 students from different Pharmacy Institutes of West Bengal appeared for the same.
on 12.03.2025

Campus Placements by **Macleods Pharmaceuticals**
at Bengal School of Technology
on 21.03.2025

Pool Campus Placement by **Eris Life Sciences** at Bengal School of Technology on 24.03.2025

Campus Placements by **Apollo Hospitals**
at Bengal School of Technology
on 09.04.2025

ACHIEVEMENT BY THE STUDENTS

Remarkable achievement by the students in **GPAT & NIPER JEE**. This achievement is a testament to the education, hard work, and commitment of everyone involved in creating an outstanding educational environment. The relentless pursuit of excellence, innovative teaching methodologies, and unwavering focus on student success have truly set a benchmark in the field of pharmaceutical quality education.

Congratulations to all achievers.

ALUMNI LECTURE SERIES

BST PHARMA NEWS 2024

Glimpses of NATIONAL LIBRARIAN'S DAY 2024

BST PHOTOGRAPHY CLUB

Picture by Nikita Kumari Singh, B.Pharm 3rd Year

Picture by Kiron Pal , B.Pharm 4th Year

Picture by Sandeep Pal , D.Pharm 1st Year

Picture by Shoubhik Halder , B.Pharm 4th Year

BENGAL SCHOOL OF TECHNOLOGY

Approved by Pharmacy Council of India, New Delhi

Affiliated to: Maulana Abul Kalam Azad University of Technology (MAKAUT) (Formerly known as West Bengal University of Technology) &

West Bengal State Council of Technical and Vocational Education and Skill Development (WBSCT&VE&SD)

Accredited by NAAC with Grade "A", Accredited by NBA for B. Pharm

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