BST PHARMA NEWS

FROM THE DESK OF PRINCIPAL

I am happy that the next edition of BST Pharma News is getting ready for release. At the very outset, I convey my sincere greetings and hearty congratulations to Mr. Sagnik Biswas who stood **1st** in B. PHARM in MAKAUT examination, and also congratulate Ms. Shreya Das who stood **2nd** in M. PHARM in MAKAUT examination.

This gives me an immense pleasure to share with you all, that Bengal School of Technology in the state of West Bengal during recent assessment conducted by Quality Council of India, secured a respectful position in the top 100 best Pharmacy Colleges and 3rd rank in West Bengal.

It is my immense pleasure to share that Bengal School of Technology is conferred with "AUTONOMOUS" status by UGC for a period of 10 years.

This speaks of the commitment of the institution, the visionary leadership and support of the management towards quality education of it's own kind.

I congratulate all the stakeholders for their unique achievements. We need continued support in achieving our mission to attain an all-time benchmark for a rurally based institution in the field of Pharmacy. .....Dr. P Suresh, Principal.....

FROM THE DESK OF EDITOR

Dr. Suchandra Goswami

This issue is released on the eve of National Librarian Day 2026 celebration in Prof. M.L. Schroff Memorial Library, BST College campus

EFFECTS OF ALCOHOL CONSUMPTION DURING PREGNANCY AMONG WOMEN-A PUBLIC HEALTH ISSUE

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ABSTRACT

Alcohol consumption during pregnancy can adversely affect fetal development and lead to a range of negative health outcomes, including fetal Alcohol Spectrum Disorder (FASD). Recent evidence indicates that both the prevalence of alcohol use and the amount of alcohol consumed are increasing among women of childbearing age (15–49 years). This trend is particularly concerning because increased alcohol use among women of reproductive age may result in a higher prevalence of alcohol consumption during pregnancy. Consequently, this chapter examines the prevalence of alcohol use among women of childbearing age and pregnant women, as well as the prevalence of FASD in the general population and in specific subpopulations.

Keywords: *Alcohol, pregnant women, epidemiology, health risk*

INTRODUCTION:

Alcohol consumption during pregnancy remains a significant public health concern due to its detrimental effects on maternal and fetal health. Prenatal alcohol exposure has been associated with a wide range of adverse pregnancy outcomes, including miscarriage, stillbirth, preterm birth, low birth weight, and **Fetal Alcohol Spectrum Disorders (FASD)**, a spectrum of lifelong physical, cognitive, behavioural, and developmental impairments. Scientific evidence consistently indicates that there is no known safe level of alcohol consumption during pregnancy, and the risk of adverse outcomes increases with greater frequency and quantity of alcohol intake.

The use of alcohol and other substances, particularly tobacco, during pregnancy continues to be a global health challenge, with emerging evidence suggesting that prenatal substance use also poses a considerable burden in India. Identifying the factors associated with alcohol consumption during pregnancy is therefore essential for informing public health policies and designing targeted interventions. Previous studies have demonstrated that maternal alcohol use is influenced by several sociodemographic characteristics, including age, educational attainment, parity, socioeconomic status, previous drinking behaviour, and concurrent tobacco use. However, the role of psychosocial determinants has received comparatively less attention. Factors such as women's knowledge of the harmful effects of prenatal alcohol exposure, perceptions of risk, cultural beliefs, social norms, and attitudes toward alcohol use during pregnancy may substantially influence drinking behaviour. Improving awareness of the teratogenic effects of alcohol and addressing misconceptions about its safety during pregnancy are therefore critical components of strategies aimed at preventing prenatal alcohol exposure and reducing the burden of FASD.

EPIDEMIOLOGY

This study aims to estimate the national and state-wise prevalence of alcohol use during pregnancy in India and examine associated social, demographic and health-related correlates using data from the National Family Health Survey (NFHS-5) conducted in 2019–2020. Methods Data from NFHS-5, a large-scale, nationally representative survey, were analysed. The survey included comprehensive interviews with 724,115 women aged 15–49 years, covering all 28 states and 8 union territories of India.

In India Alcohol consumption among pregnant women is a significant public health concern due to its adverse outcomes for the mother and developing fetus. The National Family Health Survey (NFHS-5) conducted in 2019-2020 estimated the national and state-wise prevalence of alcohol use during pregnancy in India, revealing a prevalence rate of 1.26% nationally.

The highest prevalence rates were observed in Arunachal Pradesh (13.03%), Chhattisgarh (5.77%), and Assam (5.62%).In U.S. The prevalence of current alcohol use, binge drinking, and heavy drinking increased among pregnant U.S. women from a low in 2011, according to a study published online July 27 in the *Journal of the American Medical Association*.
The researchers found that the adjusted prevalence of current alcohol use increased from a low of 9.1 percent in 2011-2012 to a high of 15.2 percent in 2021-2022, before decreasing slightly to 14.5 percent in 2023-2024 (prevalence ratio, 1.59).

RISK FACTORS

Most women believe that alcohol can harm the fetus, although the level of risk attributed varies depending on the amount, frequency and timing of pregnancy. While 12–40% believe some alcohol consumption is acceptable during pregnancy, nearly one-third (30%) consider any intake harmless, and around one in five underestimate the risks of low or occasional drinking.
Alcohol use during pregnancy is associated with an increased risk of :miscarriage, preterm birth, stillbirth, and sudden infant death syndrome (SIDS).
Alcohol use during pregnancy can cause a range of lifelong behavioural, intellectual, and physical disabilities known as fetal alcohol spectrum disorders (FASDs).

CONCLUSION

This is problematic, as alcohol exposure during pregnancy is harmful to both the neonate and pregnant woman. Alcohol exposure during pregnancy increases risk of delivery complications, miscarriage, preterm delivery, and sudden infant death syndrome.

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GENERATION OF TRANSFORMER-CNN BASED 2D-QSAR MODEL TO PREDICT THE FXR BINDING POTENTIAL

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INTRODUCTION: THE GROWING BURDEN OF NAFLD

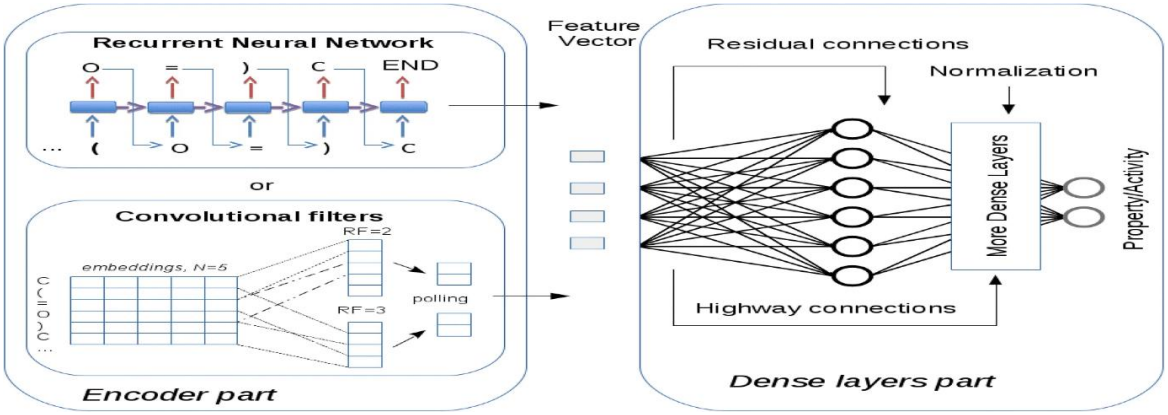
Non-Alcoholic Fatty Liver Disease (NAFLD) has emerged as one of the most common chronic liver disorders worldwide, affecting nearly one-quarter of the global population. The disease is characterized by excessive fat accumulation in liver cells and can progress to severe conditions such as cirrhosis, liver failure, and hepatocellular carcinoma. Despite its increasing prevalence, treatment options remain limited. One of the most promising therapeutic targets for NAFLD is the **Farnesoid X Receptor (FXR)**, a nuclear receptor involved in regulating bile acid metabolism, lipid homeostasis, glucose balance, and overall energy metabolism. Because of its central role in metabolic regulation, FXR has attracted significant attention from researchers seeking innovative treatments for liver diseases. Although **Obeticholic Acid (OCA)** has shown therapeutic benefits and is one of the approved medications targeting FXR pathways, concerns regarding adverse effects such as pruritus have prompted researchers to search for safer and more effective non-steroidal FXR ligands and partial agonists.

HARNESSING ARTIFICIAL INTELLIGENCE FOR DRUG DISCOVERY

To accelerate the identification of novel FXR-targeting compounds, the research team employed a state-of-the-art machine learning methodology known as **Transformer-CNN**. Unlike conventional Quantitative Structure–Activity Relationship (QSAR) approaches that rely heavily on manually generated molecular descriptors, Transformer-CNN is a descriptor-independent modelling strategy.

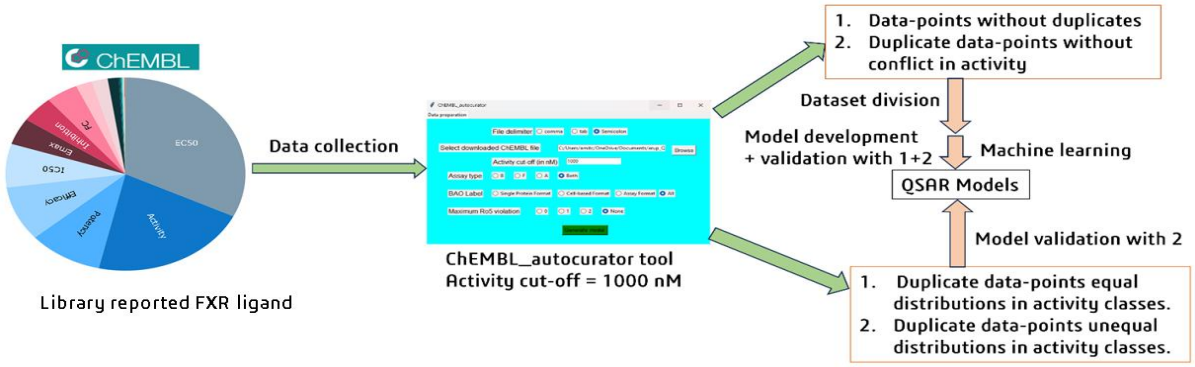
In this method, chemical structures represented by SMILES (Simplified Molecular Input Line Entry System) notations are transformed into multiple non-canonical representations. These representations are converted into binary vectors through one-hot encoding and subsequently processed using convolutional neural networks (CNNs). This enables the model to learn complex relationships between molecular structures and biological activity directly from the chemical information itself.

The approach offers several advantages, including reduced dependence on feature engineering, improved interpretability, and the ability to capture subtle structural characteristics that may influence biological activity.



BUILDING THE FXR PREDICTION MODEL

The research began with the collection of **1,950 FXR ligand data points** from the ChEMBL database. To ensure data quality and consistency, the dataset was curated using **ChEMBL_autocurator**, an open-access tool. Following the curation process, a refined dataset containing **1,270 compounds** was prepared for model development. The curated dataset was divided into training and test sets, enabling the researchers to develop and evaluate multiple Transformer-CNN models by varying parameters such as batch size and number of training epochs. The goal was to identify the optimal model capable of accurately predicting the FXR binding potential of new compounds.



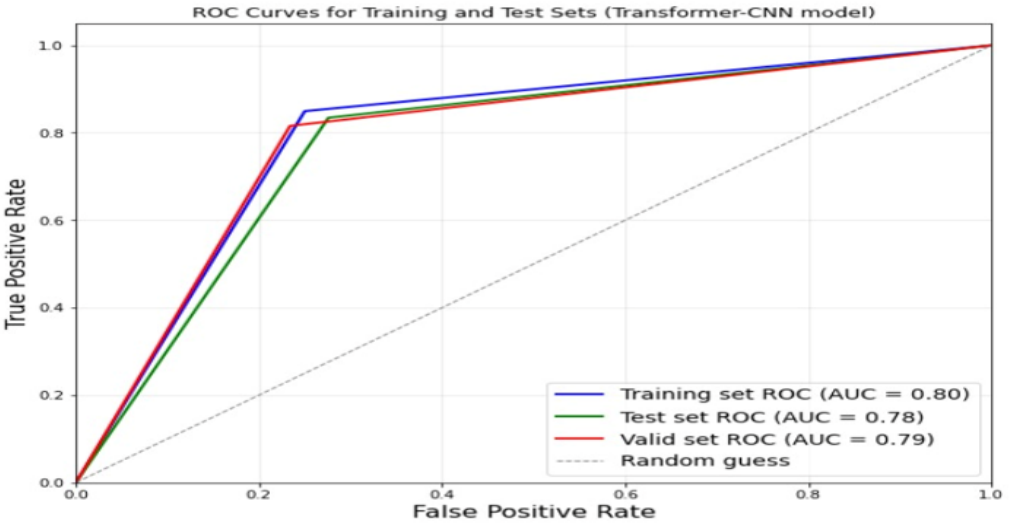
PROMISING PREDICTIVE PERFORMANCE

The final Transformer-CNN model demonstrated strong predictive capability. The model achieved:

Accuracy greater than 75%, Training MCC (5-fold cross-validation): 0.603, Test MCC: 0.556, Validation MCC: 0.579, Balanced Accuracy: approximately 79–80%

z	Transformer-CNN			
	Parameters	Training set (5-CV)	Test set	Validation set
	TP	474	131	31
	TN	312	63	36
	FP	104	24	11
	FN	84	26	7
	Sensitivity(Se)	0.85	0.83	0.82
	Specificity(Sp)	0.75	0.72	0.77
	Accuracy	0.806	0.806	0.788
	Balanced accuracy	0.8	0.78	0.79
	F1 score	0.83	0.84	0.78
	ROC_AUC score	0.8	0.78	0.79
	MCC	0.603	0.556	0.579

Roc curve result of Transformer-CNN model



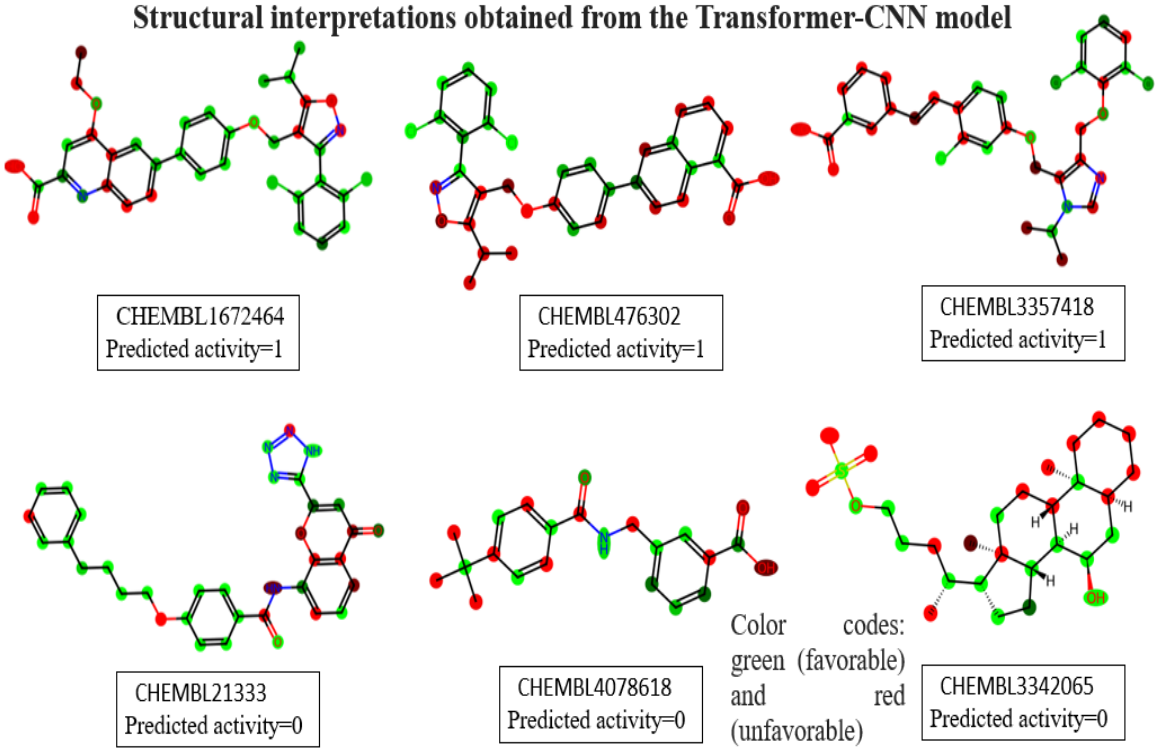
These results indicate that the model can reliably distinguish active and inactive FXR ligands while maintaining good predictive performance across independent datasets.

TESTING THE MODEL ON NEWLY DISCOVERED COMPOUNDS

To further evaluate the robustness of the model, the researchers performed an additional external validation study. Since FXR is a highly investigated target, the number of reported compounds in the ChEMBL database continued to grow over time. Several months after the original dataset collection, the database expanded from 1,950 to 2,136 compounds. Following data curation, **85 newly reported compounds** that were not included in the original model were identified and used as a completely independent validation dataset. Remarkably, the Transformer-CNN model maintained satisfactory predictive performance on these newly discovered compounds, demonstrating its potential utility in real-world drug discovery applications.

IMPLICATIONS FOR FUTURE DRUG DEVELOPMENT

Beyond predicting biological activity, the Transformer-CNN framework also offers interpretability features that help researchers identify favourable and unfavourable molecular fragments responsible for enhanced or reduced activity toward FXR. Such insights can guide medicinal chemists in designing more potent and selective therapeutic candidates. The study highlights the growing importance of AI-driven approaches in pharmaceutical sciences. By integrating machine learning with medicinal chemistry, researchers can reduce the time.



CONCLUSION

The successful development of a Transformer-CNN-based 2D-QSAR model for predicting FXR binding potential represents a significant achievement in computational drug discovery. The model demonstrated strong predictive performance, robust external validation, and valuable interpretability, making it a promising tool for identifying novel FXR-targeted therapeutics for NAFLD. As artificial intelligence continues to reshape pharmaceutical research, studies such as this illustrate how academic institutions can contribute to innovative solutions for global health challenges. The integration of machine learning, cheminformatics, and medicinal chemistry is opening new pathways toward the discovery of safer and more effective medicines, bringing the future of precision drug development closer to reality.

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QUALITY BY DESIGN (QBD) IN PHARMACEUTICAL DEVELOPMENT: TRANSFORMING FORMULATION FROM TRIAL-AND-ERROR TO SCIENCE-BASED APPROACH

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ABSTRACT:

The pharmaceutical industry is undergoing a significant transformation from traditional empirical formulation approaches toward systematic, science-driven development strategies. Quality by Design (QbD) has emerged as a revolutionary concept that integrates scientific understanding, risk management, and advanced statistical tools into pharmaceutical development. Unlike conventional trial-and-error methods, QbD focuses on designing quality into the product rather than testing quality into the final formulation. Through systematic identification of critical material attributes, critical process parameters, and critical quality attributes, QbD enables the development of robust, safe, and effective pharmaceutical products. This article discusses the principles, components, applications, advantages, challenges, and future perspectives of QbD in modern pharmaceutical formulation development.

INTRODUCTION:

The development of pharmaceutical formulations is a complex and highly scientific process that involves understanding the interaction between drug molecules, excipients, manufacturing conditions, and biological performance. Traditionally, pharmaceutical formulation development followed a trial-and-error approach, where researchers prepared multiple formulations by changing different variables until the desired product characteristics were achieved. Although this method has contributed to the success of many pharmaceutical products, it is often associated with longer development periods, increased cost, and limited understanding of the factors responsible for product performance. With the advancement of pharmaceutical sciences and the emergence of complex drug molecules, such as poorly soluble drugs, biologics, and novel drug delivery systems, conventional approaches have become insufficient. The pharmaceutical industry now requires a more predictive and systematic strategy that can ensure consistent quality, safety, and therapeutic effectiveness. Quality by Design (QbD) has emerged as a revolutionary concept that transforms pharmaceutical development from a traditional experimental approach into a science-based methodology. The fundamental principle of QbD is that quality should be designed into the product rather than tested only in the final stage. This approach focuses on understanding formulation variables, identifying potential risks, and controlling critical factors throughout the development process.

Concept and Importance of Quality by Design:

Quality by Design is a systematic approach to pharmaceutical development that begins with predefined objectives and emphasizes product understanding, process understanding, and risk based decision-making. The concept was introduced and promoted through the guidelines of the International Council for Harmonisation (ICH), particularly ICH Q8, Q9, and Q10 guidelines. Unlike conventional methods, where problems are identified after formulation development, QbD follows a proactive strategy. It attempts to understand why a formulation behaves in a particular way and how different variables influence the fin product. This scientific understanding allows researchers to develop robust formulation maintain quality even when small variations occur during manufacturing.

The adoption of QbD has improved pharmaceutical development by reducing uncertainty, improving efficiency, and increasing confidence in product quality.

Quality Target Product Profile (QTPP):

The first and most important step in the QbD approach is defining the Quality Target Product Profile (QTPP). QTPP describes the desired characteristics and performance requirements of the final pharmaceutical product before the actual formulation process begins. It includes important factors such as dosage form, route of administration, strength, stability requirements, and drug release characteristics. For example, while developing a sustained-release tablet, the QTPP will define the expected duration of drug release, therapeutic objective, stability requirements, and patient needs. Establishing QTPP provides a clear direction for formulation scientists and helps in selecting appropriate materials and processes.

Critical Quality Attributes (CQAs):

Critical Quality Attributes are the physical, chemical, biological, or microbiological properties that directly influence the quality, safety, and efficacy of a pharmaceutical product. Examples of CQAs include drug content, dissolution rate, stability, particle size, tablet hardness, and impurity profile. A formulation may fail to provide the desired therapeutic effect if CQAs are not properly controlled. For instance, improper dissolution behaviour in an oral dosage form can affect drug absorption and bioavailability. Therefore, identifying and controlling CQAs is essential for ensuring consistent product performance. Through QbD, formulation scientists can determine which quality characteristics are most important and focus their development efforts accordingly.

CRITICAL MATERIAL ATTRIBUTES (CMAS):

❖ The properties of raw materials used during formulation development significantly influence the final product quality. These properties are known as Critical Material Attributes. For the active pharmaceutical ingredient, important CMAs may include particle size, solubility, polymorphic form, and stability. These factors can affect dissolution, absorption, and overall drug performance.

❖ Similarly, excipients play a major role in formulation behaviour. Properties such as polymer viscosity, compatibility, and flow characteristics may influence drug release, stability, and manufacturability. Understanding CMAs helps researchers select appropriate materials and predict possible formulation challenges before large-scale production.

CRITICAL PROCESS PARAMETERS (CPPS):

Apart from formulation composition, manufacturing conditions strongly influence the quality of pharmaceutical products. Critical Process Parameters refer to processing variables that have a significant impact on product performance. Parameters such as mixing time, granulation conditions, drying temperature, compression force, and coating conditions can alter the final characteristics of dosage forms. For example, excessive compression force during tablet manufacturing may improve mechanical strength but may reduce dissolution rate. Similarly, inappropriate drying conditions may affect drug stability. By identifying an controlling CPPs, QbD ensures reproducible manufacturing and minimizes variations between different batches.

DESIGN OF EXPERIMENTS (DOE):

❖ Design of Experiments is one of the most important tools used in QbD-based formulation development.

❖ Traditional formulation methods often involve changing one variable at a time, which may not reveal interactions between different formulation factors.

❖ DoE allows researchers to study multiple variables simultaneously and understand their combined effects on product performance.

❖ For example, in a sustained-release formulation, DoE can evaluate the influence of polymer concentration, drug loading, and compression parameters on drug release behaviour. This approach reduces the number of experiments, saves resources, and provides a better understanding of formulation optimization.

APPLICATIONS OF QBD IN MODERN PHARMACEUTICS

a) QbD principles are widely applied in different areas of pharmaceutical development. In conventional dosage forms such as tablets and capsules, QbD helps optimize formulation composition and manufacturing processes.

b) In advanced drug delivery systems such as nanoparticles, liposomes, microspheres, and transdermal systems, QbD plays an even more important role because these systems involve multiple complex variables.

c) For example, in nanoparticle-based drug delivery, parameters such as particle size, surface charge, drug loading efficiency, and release profile must be carefully controlled. QbD provides a systematic approach to understand and optimize these factors.

ADVANTAGES AND CHALLENGES OF QBD IMPLEMENTATION

❖ The implementation of QbD offers several advantages to pharmaceutical industries. It improves product understanding, reduces development time, minimizes manufacturing failures, and enhances regulatory acceptance.

❖ By identifying important formulation and process variables early, QbD reduces unnecessary experimentation and improves cost-effectiveness. It also supports continuous improvement throughout the product lifecycle.

❖ However, QbD implementation requires skilled professionals with knowledge of formulation science, statistics, analytical techniques, and regulatory requirements. The generation and interpretation of large amounts of data can also be challenging.

❖ Despite these limitations, QbD provides significant long-term benefits for pharmaceutical innovation. 10. Future Perspectives of QbD in Pharmaceutical Sciences

❖ The future of QbD is closely associated with emerging technologies such as artificial intelligence, machine learning, and digital manufacturing.

❖ Artificial intelligence-based approaches can analyse large formulation datasets and predict optimal conditions, making formulation development faster and more efficient.

❖ The integration of QbD with continuous manufacturing and real-time monitoring technologies may further improve pharmaceutical production by enabling rapid decision making and improved process control.

❖ In the era of personalized medicine, QbD may also support the development of customized dosage forms designed according to individual patient requirements.

CONCLUSION:

Quality by Design has transformed pharmaceutical formulation development from a traditional trial-and-error process into a systematic and scientifically driven approach. By focusing on product understanding, risk assessment, and process optimization, QbD enables the development of safer, more effective, and consistently high-quality medicines. For modern pharmaceutical scientists, QbD represents not only a regulatory requirement but also a pathway toward innovation and improved formulation design. The integration of QbD with artificial intelligence, advanced manufacturing technologies, and personalized medicine will continue to shape the future of pharmaceutical development.

'As pharmaceutical sciences progress toward smarter and more precise therapeutic solutions, Quality by Design will remain a fundamental principle in creating the medicines of tomorrow.'

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ENTREPRENEURSHIP AND PHARMA EDUCATION

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ENTREPRENEURSHIP has emerged as a transformative and increasingly indispensable dimension of the Pharmacy curriculum in India, reflecting the rapid scientific, technological, and economic evolution of the pharmaceutical sector. Historically, graduates gravitated toward conventional career paths such as drug manufacturing, hospital pharmacy, community pharmacy, or regulatory compliance roles within established companies. However, the exponential growth of India's pharmaceutical and biotechnology industries often referred to as the "pharmacy of the world" due to its role in supplying over 50% of global vaccine demand and a significant share of generic medicines to markets like the United States, Africa, and Europe has fundamentally reshaped the opportunities available to pharmacy graduates. This shift has prompted regulatory bodies such as the Pharmacy Council of India (PCI) and the All-India Council for Technical Education (AICTE) to embed entrepreneurship development, pharmaceutical management, intellectual property rights (IPR), and Pharmacoeconomics into the Pharmacy syllabus, recognizing that scientific competence alone is no longer sufficient for sustainable career growth in a competitive global market.

From a scientific standpoint, entrepreneurship in pharmacy is deeply intertwined with emerging areas such as novel drug delivery systems (NDDS), nanotechnology-based formulations, and biosimilars. Students trained in concepts like liposomal drug delivery, nanoparticle-based targeting, transdermal patches, and controlled-release formulations are increasingly equipped to translate laboratory innovations into commercially viable products. For instance, advances in nanocarrier technology for targeted cancer therapy or sustained-release antidiabetic formulations represent areas where scientifically literate entrepreneurs can fill significant market gaps. Similarly, the growing field of pharmacogenomics and personalized medicine which tailors drug therapy based on an individual's genetic profile—offers fertile ground for startups focused on diagnostic kits, companion diagnostics, and precision dosing software. Pharmacy curricula that introduce students to bioinformatics, computational drug design, and in-silico screening techniques further empower graduates to engage with cutting-edge drug discovery startups rather than limiting themselves to manufacturing or distribution roles.

REGULATORY SCIENCE forms another critical pillar of pharma entrepreneurship education. Understanding Good Manufacturing Practices (GMP), Good Laboratory Practices (GLP), Quality by Design (QbD) principles, and bioequivalence/bioavailability studies is essential for any graduate seeking to establish a manufacturing unit or contract research organization (CRO). India's regulatory framework, governed by the Central Drugs Standard Control Organisation (CDSCO) and state licensing authorities, requires entrepreneurs to navigate complex approval pathways for new drug applications, clinical trials, and export licensing. Pharmacy programs that incorporate case studies on regulatory submissions, ANDA (Abbreviated New Drug Application) filings for the US market, and WHO-GMP certification processes give students a critical scientific and procedural advantage when launching ventures aimed at both domestic and international markets. Additionally, training in pharmacovigilance the science of monitoring drug safety post-marketing has opened entrepreneurial niches in safety database management and signal detection services for pharmaceutical companies.

The **HERBAL AND NUTRACEUTICAL SECTOR** represents another scientifically rich avenue, particularly given India's traditional knowledge base in Ayurveda, Siddha, and Unani systems. Standardization of herbal extracts using techniques like High-Performance Thin Layer Chromatography (HPTLC), High-Performance Liquid Chromatography (HPLC), and spectroscopic fingerprinting allows entrepreneurial graduates to develop quality-assured nutraceutical products that meet both Ayush Ministry guidelines and international export standards. This convergence of traditional knowledge with modern analytical pharmacy science exemplifies how scientific rigor enhances entrepreneurial credibility and market trust. On the institutional and policy front, government initiatives significantly bolster entrepreneurial ambitions among pharmacy students. The Startup India initiative, Pharma MSME schemes, the Production Linked Incentive (PLI) scheme for pharmaceuticals, and funding support through the Biotechnology Industry Research Assistance Council (BIRAC) provide critical financial and infrastructural scaffolding. Institutions like the National Institute of Pharmaceutical Education and Research (NIPER) have established dedicated technology business incubators (TBIs) that mentor pharmacy graduates through proof-of-concept development, prototype testing, and seed funding acquisition. Many Pharmacy colleges now operate Innovation and Incubation Cells under the Ministry of Education's Innovation Cell (MIC) framework, offering hands-on exposure to venture creation processes including market research, business model canvas development, and pitch deck preparation.

Despite these advancements, several **CRITICAL CHALLENGES** persist. Limited access to early-stage capital, complex and time-consuming regulatory approval processes, inadequate mentorship networks, and a curriculum that often remains theory-heavy rather than practice-oriented continue to hinder large-scale entrepreneurial conversion among pharmacy graduates. Furthermore, risk-aversion cultivated by traditional educational and family expectations often discourages students from pursuing entrepreneurial paths despite possessing the requisite scientific knowledge. Bridging this gap requires sustained efforts integrating real-world startup case studies, facilitating industry-academia partnerships, and providing structured internship-to-incubation pipelines that allow students to test entrepreneurial ideas during their academic tenure itself.

IN CONCLUSION, the intersection of entrepreneurship and Pharmacy education in India represents a scientifically grounded, economically significant, and policy-supported pathway toward self-reliance and innovation. By combining rigorous training in pharmaceutical sciences spanning drug delivery technology, regulatory affairs, pharmacovigilance, and quality control with structured entrepreneurial skill-building, India's pharmacy education system is positioning a new generation of graduates to become innovators and job creators rather than mere job seekers. This dual competency not only enhances individual employability and financial independence but also strengthens India's broader contribution to global healthcare access, affordable medicine availability, and its strategic standing as a pharmaceutical manufacturing and innovation hub on the world stage.

A NEW ERA IN DENTISTRY: THE WORLD'S FIRST TOOTH REGROWTH DRUG ENTERS HUMAN CLINICAL TRIALS

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INTRODUCTION:

For decades, the loss of permanent teeth has been considered irreversible, leaving patients with limited treatment options such as dentures, bridges, or dental implants. However, a groundbreaking development in regenerative medicine may soon transform dental care forever. Scientists in Japan have developed the world's first tooth-regrowth drug, offering hope that lost teeth could one day be replaced naturally through biological regeneration. The drug, known as **TRG035**, has been developed by **Toregem BioPharma**, a biotechnology company spun out from Kyoto University. The therapy is currently undergoing human clinical trials and represents one of the most promising advances in regenerative dentistry.

UNDERSTANDING THE SCIENCE BEHIND TOOTH REGENERATION

Human beings typically develop two sets of teeth during their lifetime: primary (baby) teeth and permanent teeth. However, research has shown that many individuals possess dormant tooth buds that never develop into functional teeth. Scientists discovered that a protein called **USAG-1 (Uterine Sensitization-Associated Gene-1)** plays a crucial role in suppressing the development of these additional teeth. The newly developed drug works by blocking the activity of USAG-1. By inhibiting this protein, researchers aim to reactivate dormant tooth buds, allowing them to grow into fully functional teeth. This innovative approach does not rely on artificial implants or prosthetics but instead stimulates the body's natural regenerative mechanisms. Preclinical studies conducted in mice and ferrets demonstrated successful tooth regeneration after administration of anti-USAG-1 antibodies. These encouraging findings paved the way for human clinical trials.

FIRST IN HUMAN CLINICAL EVALUATION OF TRG035

The first phase of human clinical trials was initiated in Japan to evaluate the safety and tolerability of the drug in healthy adults. Preliminary reports indicated that the treatment did not cause serious adverse effects, supporting further clinical development. Toregem BioPharma has now advanced into **Phase II clinical studies**, focusing on patients with **congenital tooth agenesis or severe hypodontia**, conditions characterized by the absence of multiple permanent teeth. Individuals missing six or more permanent teeth are among the primary target populations for this therapy. The company has secured substantial financial support, raising approximately **$29 million** to accelerate clinical development and bring the technology closer to commercialization. Although the therapy remains in the experimental stage, researchers anticipate that if efficacy and safety are confirmed through larger clinical trials, the treatment could become available sometime after 2030.

RECENT RESEARCH ADVANCING TOOTH REGENERATION

Anti-USAG-1 Antibody Therapy

One of the most significant studies in recent years was published by researchers from Kyoto University and associated institutions. The study demonstrated that monoclonal antibodies targeting USAG-1 successfully stimulated the formation of new teeth in animal models. Researchers observed the activation of dormant tooth germs and the development of structurally normal teeth, providing strong evidence for the therapeutic potential of USAG inhibition.

STEM CELL-BASED TOOTH REGENERATION

Beyond anti-USAG-1 therapy, scientists worldwide are investigating stem-cell-based approaches to regenerate dental tissues. Dental pulp stem cells (DPSCs), periodontal ligament stem cells, and induced pluripotent stem cells (iPSCs) have shown potential for generating tooth-like structures in laboratory settings. Recent studies suggest that combining stem cell technology with tissue engineering scaffolds may enable the reconstruction of complete tooth organs in the future.

GENE EDITING AND REGENERATIVE DENTISTRY

Researchers are also exploring the use of CRISPR-Cas9 gene-editing technology to manipulate developmental pathways involved in tooth formation. By regulating genes associated with odontogenesis, scientists hope to develop personalized regenerative treatments for patients with congenital dental disorders.

3D BIOPRINTING OF DENTAL STRUCTURES

Advances in 3D bioprinting have opened new possibilities for fabricating dental tissues. Scientists have successfully printed tooth-like scaffolds using bioactive materials capable of supporting cell growth and mineralization. Although still experimental, this technology could complement biological tooth regeneration therapies in the future.

CHALLENGES AND FUTURE PERSPECTIVES

Despite its promise, several challenges remain before tooth-regrowth therapy becomes a routine clinical treatment. Researchers must demonstrate long-term safety, effectiveness, and durability in large patient populations. Questions regarding optimal dosing, treatment timing, and the number of teeth that can be regenerated still require investigation. Furthermore, regulatory approval processes are rigorous and may take several years. Large-scale manufacturing and affordability will also influence the accessibility of the treatment. Nevertheless, the progress achieved thus far represents a remarkable milestone in regenerative medicine. What was once considered science fiction is rapidly approaching clinical reality.

CONCLUSION

The development of TRG035 marks a historic breakthrough in dental science. By targeting the USAG-1 protein and activating dormant tooth buds, researchers have introduced a novel strategy for natural tooth regeneration. Early clinical trials have demonstrated encouraging safety results, and ongoing studies will determine whether this therapy can effectively restore missing teeth in humans.

As regenerative medicine continues to advance through stem cell research, gene editing, and tissue engineering, the dream of naturally regrowing lost teeth is becoming increasingly achievable. While commercial availability may still be several years away, the emergence of tooth-regrowth therapy signals the beginning of a new era in dentistry—one in which biological tooth replacement could eventually replace conventional prosthetic solutions and transform oral healthcare worldwide

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THE LAST PRESCRIPTION: REIMAGINING HEALTHCARE IN 2050

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"The future of medicine will not be defined by smarter machines alone, but by wiser choices made by humanity."

It is a quiet morning in the year 2050. A young woman walks into a hospital, not carrying a thick file of medical reports, but wearing a lightweight health sensor on her wrist. Before she speaks, an artificial intelligence system has already analysed her heartbeat, blood chemistry, sleep pattern, and genetic profile. A digital replica of her body—known as a *digital twin*—predicts how her disease may progress over the next five years. Within minutes, a treatment plan is prepared, a medicine is adapted to her DNA, and microscopic nanoparticles are programmed to deliver the drug only to the affected cells. The doctor reviews the recommendations, smiles reassuringly, and makes the final decision.

This scene may sound like science fiction today, but many of its foundations are already being built. As medicine enters an era shaped by artificial intelligence, biotechnology, and precision healthcare, one question becomes increasingly important: **what will the last prescription of the future look like?**

For centuries, healthcare has largely been reactive. Patients became ill, visited a doctor, received a diagnosis, and were prescribed treatment. By 2050, this sequence may be transformed. Advances in wearable technology, biosensors, and continuous health monitoring are enabling healthcare to become predictive rather than reactive. Smart devices are already capable of tracking heart rhythm, blood oxygen levels, sleep quality, and physical activity. In the coming decades, these technologies may identify diseases long before noticeable symptoms appear, allowing doctors to prevent illness instead of merely treating it.

Another remarkable transformation lies in the concept of personalized medicine. Traditionally, two patients with the same disease often receive the same medication, even though their bodies may respond very differently. Future healthcare will move away from this "one-size-fits-all" approach. By analysing an individual's genetic makeup, lifestyle, and metabolism, physicians may prescribe treatments specifically designed for that person. Such precision could improve treatment success while reducing adverse drug reactions. In this future, prescriptions will no longer be written for a disease alone—they will be written for the individual.

Artificial intelligence is expected to become one of the greatest partners in modern medicine. AI systems are already assisting researchers in discovering new drug molecules, interpreting medical images, predicting disease risks, and supporting clinical decisions. Hospitals of the future may rely on intelligent systems to reduce diagnostic errors, monitor intensive care patients continuously, and automate routine administrative tasks. Yet, despite these extraordinary capabilities, AI should remain an assistant rather than a replacement.

Compassion, ethicPal PDFal judgment, empathy, and trust are qualities that no algorithm can truly replicate. Technology may enhance healthcare, but healing will always remain a profoundly human responsibility

Equally revolutionary is the emergence of nanotechnology and regenerative medicine. Scientists are developing nanoparticles capable of carrying medicines directly to diseased tissues while minimising damage to healthy cells. Researchers are exploring 3D bioprinting to create skin, cartilage, blood vessels, and, perhaps one day, fully functional organs for transplantation.

Stem cell therapies may repair damaged tissues instead of simply managing symptoms. These innovations represent a shift from treating disease to restoring the body's natural function.
However, every technological breakthrough brings important ethical questions. If our genetic information becomes part of routine healthcare, who will protect that data? If AI helps determine treatment priorities, who will be accountable for mistakes? Will advanced medical technologies be available to everyone, or only to those who can afford them? Could gene editing eventually extend beyond curing diseases to enhancing human abilities? The future of medicine will not depend solely on scientific progress but also on our ability to use these discoveries responsibly, fairly, and with respect for human dignity.
The role of healthcare professionals will also evolve. Doctors, pharmacists, nurses, and researchers will need to understand not only biology and medicine but also artificial intelligence, data science, genomics, and digital ethics. Tomorrow's pharmacist may analyse genetic reports before dispensing medicines. Tomorrow's physician may work alongside intelligent machines that process millions of medical records in seconds. Lifelong learning will become one of the most valuable skills in healthcare.
As we imagine the hospital of 2050, it is tempting to focus only on intelligent machines, advanced robotics, and futuristic medicines. Yet the true heart of healthcare has never been technology—it has always been people. Every innovation, whether powered by artificial intelligence or engineered at the nanoscale, must ultimately serve a single purpose: improving the quality of human life.
Perhaps the last prescription written in 2050 will not simply contain the name of a medicine. It will represent something far greater—a partnership between science and compassion, between innovation and ethics, and between human intelligence and artificial intelligence. The future of healthcare is not merely about living longer; it is about living healthier, wiser, and with greater dignity. The greatest breakthrough of tomorrow may not be a new drug or a new machine, but a healthcare system that remembers that every patient is, above all else, a human being.

"The future of healthcare is not a destination waiting for us—it is a responsibility we are building today."

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ANTIBACTERIAL RESISTANCE: A GROWING GLOBAL HEALTH THREAT

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ABSTRACT

Antibacterial resistance (ABR) has emerged as one of the most serious global public health challenges, threatening the effectiveness of antibiotics that have transformed modern medicine. The inappropriate and excessive use of antibiotics in healthcare, agriculture, and animal husbandry has accelerated the development of resistant bacterial strains, making common infections increasingly difficult to treat. As a result, healthcare systems face prolonged hospitalizations, increased treatment costs, and higher mortality rates. Effective control of antibacterial resistance requires antimicrobial stewardship, rational antibiotic prescribing, infection prevention, surveillance, research into new antimicrobial therapies, and public awareness. Pharmacists play a crucial role by optimizing antibiotic therapy and educating patients on responsible antibiotic use. This newsletter highlights the causes, consequences, and preventive strategies associated with antibacterial resistance while emphasizing the collective responsibility needed to preserve the effectiveness of antibiotics for future generations.

Keywords: *Antibacterial resistance, antibiotics, antimicrobial stewardship, pharmacists, global health.*

INTRODUCTION

The discovery of antibiotics revolutionized medicine by making previously fatal bacterial infections curable and enabling complex medical procedures such as surgery, organ transplantation, and chemotherapy. However, decades of antibiotic misuse and overuse have led to the emergence of antibacterial resistance (ABR), where bacteria evolve mechanisms that reduce or eliminate the effectiveness of antibiotics. This growing problem has become a major threat to global healthcare because resistant bacteria spread rapidly through hospitals, communities, food chains, and the environment. Without immediate action, antibacterial resistance could reverse many of the medical advances achieved over the past century.

UNDERSTANDING ANTIBACTERIAL RESISTANCE

Antibacterial resistance develops when bacteria adapt to survive exposure to antibiotics. Although resistance is a natural evolutionary process, human activities have greatly accelerated its development. Excessive antibiotic prescriptions, self-medication, failure to complete prescribed treatment courses, and widespread antibiotic use in agriculture and livestock production create selective pressure that favors resistant bacterial strains. Once established, these bacteria spread easily between individuals and across healthcare settings, making infections progressively harder to control.

HEALTH AND ECONOMIC CONSEQUENCES

The impact of antibacterial resistance extends beyond individual patients. Common infections such as pneumonia, tuberculosis, urinary tract infections, and bloodstream infections are becoming increasingly resistant to standard antibiotic therapies. These infections often require prolonged hospitalization, expensive second-line drugs, and intensive medical care, resulting in significantly higher healthcare costs.

---Continued (Mainak Mukherjee)---

Furthermore, many modern medical procedures rely on effective antibiotics to prevent or treat infections. Surgical operations, cancer chemotherapy, intensive care, and organ transplantation all become considerably more hazardous when antibiotics lose their effectiveness. Consequently, antibacterial resistance threatens not only infectious disease management but also the overall success of modern healthcare

THE ROLE OF ANTIMICROBIAL STEWARDSHIP

Combating antibacterial resistance requires coordinated antimicrobial stewardship programs that promote the responsible use of antibiotics. Stewardship involves prescribing antibiotics only when necessary, selecting the most appropriate antimicrobial agent, optimizing dosage and treatment duration, and avoiding unnecessary use of broad-spectrum antibiotics. These measures reduce the selective pressure responsible for resistance while improving patient outcomes.

Infection prevention strategies, strengthened surveillance systems, public awareness campaigns, and continued investment in antibiotic research are equally important components of a comprehensive response to antibacterial resistance.

PHARMACISTS: KEY PARTNERS IN COMBATING RESISTANCE

Pharmacists play a vital role in preserving antibiotic effectiveness through antimicrobial stewardship. They ensure appropriate antibiotic selection, verify correct dosing schedules, identify potential drug interactions, monitor therapy, and counsel patients on completing prescribed treatment courses. By applying pharmacokinetic and pharmacodynamic (PK/PD) principles, pharmacists help maximize treatment success while minimizing the emergence of resistant bacteria.

In addition, pharmacists educate patients about avoiding self-medication and unnecessary antibiotic use, thereby improving public awareness and supporting rational antimicrobial therapy.

FUTURE PERSPECTIVES

Addressing antibacterial resistance requires sustained collaboration among healthcare professionals, researchers, governments, policymakers, and the public. Continued research into novel antibiotics, alternative antimicrobial therapies, improved diagnostics, and enhanced surveillance systems will be essential for managing resistant infections. Equally important is promoting responsible antibiotic use across human healthcare, veterinary medicine, and agriculture to slow the emergence of resistance.

CONCLUSION

Antibacterial resistance is one of the defining healthcare challenges of the twenty-first century. Driven primarily by inappropriate antibiotic use, it threatens the successful treatment of infectious diseases and jeopardizes many life-saving medical procedures. Through antimicrobial stewardship, rational prescribing, patient education, infection prevention, and continued scientific innovation, healthcare professionals can help preserve the effectiveness of antibiotics. Pharmacists, in particular, play an indispensable role in ensuring the safe and appropriate use of antimicrobial agents. Protecting antibiotics is a shared global responsibility, and timely collective action is essential to prevent the world from entering a post-antibiotic era in which common bacterial infections once again become difficult to treat.

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LACTOPEROXIDASE: THE WHOLESOME NATURAL ANTIMICROBIAL

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ABSTRACT

Lactoperoxidase is a peroxidase antimicrobial enzyme which is secreted from various glands like mammary, salivary and also mucosal gland. Lactoperoxidase helps in innate Immune system also play first line of defense mechanism by killing bacteria in milk. Lactoperoxidase is a milk protein which helps in growing immune system. It catalyzes oxidation of various organic and inorganic substrates by Hydrogen peroxide (H_2O_2) which makes a bacteria free environment. Substrates are like Bromide, Iodide and Thiocyanate. These oxidized products have bactericidal and antiviral activities. This non-mutagenic lactoperoxidase system is effective in killing both the aerobic and non-aerobic microorganisms. It may be helpful in case of initiation of breast cancer by oxidizing estrogenic hormones which produce free radical intermediates. Furthermore, by using ion exchange mechanism lactoperoxidase can be isolated from milk or whey. Functions of lactoperoxidase are being found in preservation of food, cosmetics, and also the ophthalmic solution. This is also beneficial in killing of tumor cells in vitro and also eradication of micro-organisms from fresh meat.

Keywords: *Enzyme, Immune system, Non-aerobic, Organism.*

INTRODUCTION

Lactoperoxidase is an enzyme that occurs in raw milk, colostrum and other natural concealment. Bovine milk naturally contains 10 to 60 mg of lactoperoxidase per liter. It's a member of the peroxidase- cyclooxygenase superfamily and one of the most abundant enzymes in bovine milk, constituting about 1 of whey proteins. There's an imperative need to apply approaches to control the noted microbial growth in the foods. lately, consumers have a tendency to use natural preservative/ antimicrobials due to new enterprises about the safety & health knowledge of synthetic preservatives. Now-a-days, experimenters have concentrated on using antimicrobial agents as an effective approach to drop down the growth and proliferation of corruption and pathogenic microorganisms in different foodstuffs, in addition to save nutritive quality and increase the shelf- life of food products.

STABILITY

During pasteurization, whole milk loses about 75 of its LPO activity, whereas the purified LPO was rendered unstable after 15 minutes of exposure. LPO deactivated during storage at pH 3 with partial denaturation at pH 4 and no deactivation at pH 10. The optimum pH for LPO lies between 5 and 6.

WHY NATURAL PRESERVATIVES

- These are non-toxic
- Acceptable at various recognized authorities such as USFDA
- Financially viable
- More Stable
- Ease of source

ISOLATION & PURIFICATION

The most essential steps involved with isolation of Lactoperoxidase include casein precipitation with rennet, adsorption of whey proteins through ion exchange method, elution, fractionation and final purification.

ACTIVITY

LPO is a type of enzyme with a primary function to oxidize thiocyanate at the expense of H2O2 to generate products that kill or inhibit the growth of many species of microorganism. The oxidation of sulfhydryl groups of microbial proteins by hypothiocyanite and hypothiocyanous acid is considered to be the

APPLICATION

Oral care:

- Used in toothpastes, mouthwashes, and oral gels.
- Helps reduce harmful oral bacteria responsible for plaque, gingivitis, and bad breath.
- Supports the natural antimicrobial defense of saliva.
- Often combined with enzymes such as glucose oxidase and lysozyme to enhance oral hygiene.

CANCER CURE:

- Current research explores its antimicrobial and antioxidant properties and whether it may have supportive roles in reducing oxidative stress or assisting certain therapies.

COSMETICS:

- Added to skincare and personal care products as a natural preservative system.
- Helps control microbial contamination, extending product shelf life.
- Used in creams, lotions, facial cleansers, and deodorants.

IMMUNE DEFENSE:

- Produces antimicrobial molecules that help protect mucosal surfaces from pathogenic microorganisms.
- Contributes to maintaining a healthy balance of microorganisms in the mouth and upper respiratory tract.

CONCLUSION

Although the LP system was primarily meant for preservation of raw milk in warm tropical climates where cooling facilities are not available, now its application is growing beyond raw milk preservation and it is finding its way to commercial applications

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BEYOND THE GREEN LABEL: ENSURING THE SAFE AND RATIONAL USE OF HERBAL MEDICINES

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ABSTRACT

Herbal medicines have gained widespread acceptance worldwide owing to their long-standing traditional use, accessibility, and growing preference for natural healthcare approaches. However, the widespread belief that natural products are inherently safe has contributed to their indiscriminate use, increasing the risk of adverse health outcomes. Like conventional medicines, herbal products contain pharmacologically active constituents capable of producing therapeutic as well as undesirable effects, particularly when used inappropriately or alongside prescription medications. This report highlights the major safety concerns associated with herbal medicine use, including herb-drug interactions, adverse effects, toxicity, allergic reactions, incorrect dosage, adulteration, contamination, and misidentification of medicinal plants. It also emphasizes the importance of scientific validation, quality assurance, standardization, pharmacovigilance, and evidence-based practice in ensuring the safe and rational use of herbal products. Furthermore, the report outlines the pivotal role of pharmacists in patient counselling, monitoring adverse reactions, and promoting informed healthcare decisions. Responsible integration of traditional knowledge with modern scientific principles is essential to maximize therapeutic benefits while safeguarding public health.

Keywords: *Herbal medicines; Herb-drug interactions; Pharmacovigilance; Quality assurance; Evidence-based healthcare.*

INTRODUCTION

Herbal medicines have been an integral part of traditional healthcare systems for centuries and continue to gain widespread acceptance across the globe. Driven by growing interest in natural therapies, preventive healthcare, and holistic wellness, the use of herbal products has expanded significantly in recent years. From dietary supplements and herbal teas to standardized botanical formulations, these products are increasingly incorporated into modern healthcare practices alongside conventional medicines.

Despite their widespread use, a common misconception persists that products derived from natural sources are inherently safe and free from adverse effects. In reality, medicinal plants contain biologically active compounds capable of producing both therapeutic and harmful effects, depending on factors such as dosage, quality, individual health status, and concurrent use with prescription medications. Cases of herb-drug interactions, contamination, adulteration, and improper self-medication underscore the need for greater awareness regarding their safe use.

Scientific evaluation and quality assurance are therefore essential to ensure the efficacy, safety, and consistency of herbal medicines. Through rigorous pharmacognostic studies, standardization, toxicological assessment, and evidence-based clinical research, healthcare professionals can promote the rational use of herbal products while minimizing potential risk. Understanding both the benefits and limitations of herbal medicines is fundamental to achieving safe, effective, and responsible healthcare.

---Continued (Rohit Pal)---

WHY ARE HERBAL MEDICINES SO POPULAR?

The widespread use of herbal medicines can be attributed to their deep-rooted presence in traditional healthcare systems and their continued relevance in modern society. For centuries, medicinal plants have formed the foundation of systems such as Ayurveda, Traditional Chinese Medicine (TCM), Unani, and other indigenous healing practices. Their long history of use has fostered public confidence and cultural acceptance, making herbal remedies a preferred choice for managing various health conditions.

Another key factor driving their popularity is their accessibility and affordability. Herbal products are often readily available through pharmacies, health stores, and local markets, making them an economical alternative or complementary option to conventional medicines. In many developing countries, medicinal plants remain an important component of primary healthcare due to their cost-effectiveness and widespread availability.

The growing preference for natural therapies has also contributed significantly to the increasing demand for herbal medicines. Many individuals perceive plant-based products as gentler and more compatible with the body's natural processes, often choosing them to support general well-being or manage chronic health concerns.

Furthermore, rising awareness of preventive healthcare and healthy lifestyles has encouraged consumers to seek herbal supplements, functional foods, and botanical products that promote immunity, vitality, and overall wellness. This global shift toward holistic health has positioned herbal medicines as an important component of contemporary healthcare, emphasizing prevention alongside treatment.

Potential Safety Concerns

Although herbal medicines offer numerous therapeutic benefits, their indiscriminate use can pose significant health risks if appropriate precautions are not followed. One of the most important concerns is **herb-drug interactions**, where herbal products may alter the effectiveness or safety of prescription medications. Such interactions can lead to reduced therapeutic efficacy or increase the likelihood of adverse effects, particularly in patients receiving treatment for chronic conditions.

Herbal medicines may also produce adverse effects and toxicity, especially when consumed in excessive amounts, used for prolonged periods, or prepared improperly. Individual allergic reactions to certain plant constituents can range from mild skin irritation to severe hypersensitivity responses. Furthermore, incorrect dosage, self-medication, and the misconception that higher doses provide greater benefits can increase the risk of harmful outcomes.

Quality-related issues present another major challenge. Herbal products may become adulterated or contaminated with heavy metals, pesticide residues, microbial contaminants, or synthetic pharmaceutical substances during cultivation, processing, or storage, compromising both their safety and efficacy. In addition, misidentification or substitution of medicinal plants can result in the use of toxic or ineffective species, leading to serious health consequences.

These concerns underscore the importance of stringent quality control, scientific standardization, regulatory oversight, and professional guidance to ensure the safe and responsible use of herbal medicines

COMMON EXAMPLES OF HERBAL MEDICINE SAFETY CONCERNS

Several commonly used medicinal plants demonstrate that, despite their well-established therapeutic benefits, herbal medicines should be used judiciously and under appropriate guidance

Herbal Medicine	Therapeutic Use	Potential Safety Concern
Ashwagandha (*Withania somnifera*)	Adaptogen, stress relief, immunomodulator	May enhance the effects of sedatives and anxiolytics, interfere with thyroid hormone regulation, and should be used cautiously in individuals receiving immunosuppressive therapy or those with autoimmune disorders.
Ginkgo (*Ginkgo biloba*)	Cognitive enhancement, memory support	Possesses antiplatelet activity that may increase the risk of bleeding, particularly when taken with anticoagulants or antiplatelet drugs such as warfarin, aspirin, or clopidogrel. It is generally advised to discontinue its use before surgical procedures.
St. John's Wort (*Hypericum perforatum*)	Mild to moderate depression	Induces hepatic CYP3A4 enzymes and P-glycoprotein, reducing the effectiveness of several medications including oral contraceptives, anticoagulants, immunosuppressants, antiretroviral drugs, and certain anticancer agents.
Liquorice (*Glycyrrhiza glabra*)	Cough, gastric ulcers, sore throat	Excessive or prolonged consumption of glycyrrhizin-containing liquorice may lead to hypertension, hypokalemia, edema, and cardiac rhythm disturbances. It should be used cautiously in individuals with cardiovascular or renal disorders.
Aloe Latex (*Aloe barbadensis* Miller)	Laxative	Prolonged use may cause abdominal cramps, diarrhea, dehydration, electrolyte imbalance, and potassium depletion. Chronic misuse can also reduce the effectiveness of certain cardiovascular medications and diuretics.
Garlic (*Allium sativum*)	Cardiovascular health, antimicrobial Page No. 25activity	High doses may increase bleeding tendency when combined with anticoagulants or antiplatelet medications. It may also lower blood pressure and blood glucose, necessitating caution in patients receiving antihypertensive or antidiabetic drugs.

Turmeric (*Curcuma longa*)	**Anti-inflammatory and antioxidant**	**Although generally considered safe, concentrated curcumin supplements may increase bleeding risk, interact with anticoagulants, and cause gastrointestinal discomfort in susceptible individuals. High doses may also interfere with iron absorption.**
Ginseng (*Panax ginseng*)	Fatigue, cognitive performance, immune support	May alter blood glucose levels, interact with antidiabetic medications, anticoagulants, and stimulants, and occasionally cause insomnia, nervousness, or elevated blood pressure when consumed excessively.
Kava (*Piper methysticum*)	Anxiety and relaxation	Long-term or excessive consumption has been associated with hepatotoxicity. Concurrent use with alcohol or central nervous system depressants may further increase the risk of liver injury and excessive sedation.
Ephedra (*Ephedra sinica*)	Traditionally used for respiratory ailments (restricted in many countries)	Contains ephedrine alkaloids that may cause hypertension, tachycardia, stroke, myocardial infarction, and other serious cardiovascular events. Its use is prohibited or heavily regulated in several countries.

These examples emphasize that herbal medicines, like conventional pharmaceuticals, contain biologically active compounds capable of producing both therapeutic and adverse effects. Their safety depends on appropriate dosage, duration of use, product quality, patient-specific factors, and potential interactions with other medications. Therefore, consultation with qualified healthcare professionals and the use of standardized, quality-assured herbal products are essential to maximize therapeutic benefits while minimizing avoidable risks.

THE PHARMACIST'S ROLE

Pharmacists play a crucial role in ensuring the safe and rational use of herbal medicines by:

- Providing patient counselling on the appropriate use, dosage, duration, and possible adverse effects of herbal products.
- Identifying potential herb-drug interactions to prevent reduced therapeutic efficacy or harmful reactions in patients receiving conventional medications.
- Promoting evidence-based use by recommending herbal medicines supported by scientific research and established clinical evidence.
- Reporting adverse reactions through pharmacovigilance systems to improve the safety monitoring of herbal products.

Encouraging the use of quality-assured herbal products manufactured according to recognized standards and regulatory guidelines

TIPS FOR SAFE HERBAL MEDICINE USE

To maximize the therapeutic benefits of herbal medicines while minimizing potential risks, the following precautions should always be observed:

- Consult healthcare professionals before initiating any herbal product, particularly if you have existing medical conditions or are taking prescription medications.
- Inform your physician or pharmacist about all herbal supplements, vitamins, and over-the-counter products you are using to avoid potential herb-drug interactions.
- Purchase herbal products from reputable manufacturers that adhere to recognized quality standards and regulatory guidelines to ensure authenticity, purity, and safety.
- Avoid self-medication during pregnancy, lactation, and chronic illnesses unless specifically recommended by a qualified healthcare professional.
- Follow the recommended dosage and duration of use, as excessive consumption may lead to toxicity or other adverse health effects.
- Remain vigilant for adverse reactions, such as allergic responses, gastrointestinal disturbances, or unusual symptoms, and discontinue use while seeking medical advice if necessary.

CONCLUSION

Herbal medicines continue to serve as valuable therapeutic resources, offering diverse health benefits and complementing modern healthcare practices. However, their safe and effective use depends on proper identification of medicinal plants, scientific standardization, stringent quality control, appropriate dosage, and professional guidance. By integrating traditional knowledge with evidence-based research and responsible healthcare practices, herbal medicines can be utilized safely and effectively. Promoting awareness, informed decision-making, and pharmacovigilance will help bridge the gap between ancient healing traditions and contemporary scientific medicine, ensuring that the benefits of herbal therapies are realized without compromising patient safety.

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Campylobacter jejuni infection status in India

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INTRODUCTION

Campylobacter is a leading cause of bacterial gastroenteritis globally, and surveillance indicates it is endemic in India, especially among children. Reported prevalence in India varies widely by region and study: for example, hospitalized patients in Kolkata showed ≈7% of diarrheal stools with *Campylobacter* (mostly *C. jejuni*), whereas a community study in Chandigarh found only 2.6% of diarrheal cases positive. Children bear the brunt of infection: in Kolkata the isolation rate was 10% in <5-year-olds versus 3.7% in older patients. A 2022 review of South Asia similarly noted detection rates from <1% up to ~30% depending on setting, with an average around 7%. Overall, young age, environmental and food exposures are risk factors, and infection is frequently acquired early in life (e.g. >80% of children in MAL-ED study had evidence of *Campylobacter* by age 1).
Geographically, studies from across India – including the northeast, east (Kolkata), north (Chandigarh, Delhi), south (Vellore, Chennai), and west (Mumbai) – have detected *Campylobacter* in human diarrheal illness, though systematic national data are lacking. For instance, reports note 16% prevalence in rural Mumbai and 14.8% in Vellore (southern India) versus 8.6% in Ranchi (eastern India). Heterogeneity is high, reflecting differences in surveillance and diagnostics.

Campylobacter spp. are zoonotic; common reservoirs in India include poultry (especially broiler chickens), cattle, and other livestock and pets. Major transmission routes are foodborne (undercooked poultry, meat), unpasteurized milk, and contaminated water. For example, *Campylobacter* was detected in up to 82% of poultry isolates in India, and a 2025 Pune outbreak of Guillain–Barré Syndrome (GBS) (an autoimmune sequela) was traced to *Campylobacter*-contaminated drinking water. This outbreak (over 200 GBS cases) underscored water as a critical vehicle. Overall, food handling, sanitation, and animal contact are key risk factors (e.g. hygiene, breastfeeding, safe water use reduce risk in children).

Clinically, *C. jejuni* causes acute gastroenteritis (often bloody diarrhea, fever, abdominal pain). Most Indian cases are mild to moderate, but significant illness and hospitalization do occur, especially in young children or with complications. Hospitalization data are sparse, but diarrheal illness from *Campylobacter* adds to the burden of acute gastroenteritis in hospitals. Mortality is rare; WHO notes deaths mostly in very young or immunocompromised. Major complications include bacteremia (in ~1% of cases) and post-infectious sequelae: reactive arthritis and neurologic syndromes (e.g. GBS). The Pune 2025 outbreak vividly demonstrated severe outcomes (GBS required prolonged hospitalization in many). Overall, *Campylobacter* contributes substantially to diarrheal disease burden, growth impairment in children (MAL-ED study found higher enteropathy and stunting with high *Campylobacter* exposure), and costs, but is under-recognized in routine surveillance.

---Continued (External Author Dr Jaweed Ahmed)...

ANTIMICROBIAL RESISTANCE (AMR)

Multidrug resistance in *Campylobacter* is rising in India. Multiple studies report very high fluoroquinolone resistance: e.g. >80% of isolates (humans or poultry) are ciprofloxacin-resistant. In Kolkata, 97% of *C. jejuni* isolates were ciprofloxacin-resistant. Resistance to tetracycline is also common (17–74% in different reports). Conversely, macrolide (erythromycin/azithromycin) resistance has remained low: Kolkata isolates were >97% susceptible, and older studies found erythromycin resistance in the single digits. However, azithromycin-resistant *C. coli* have emerged globally. Recent poultry-focused data show 82.4% of isolates resistant to ≥1 drug and 82.4% resistant to ciprofloxacin. MDR (resistance to ≥3 classes) was estimated ~41.5% in animal isolates in Asia by 2021. In summary, *C. jejuni* in India is typically resistant to quinolones and tetracyclines, largely susceptible to macrolides/gentamicin, but local data are sparse. This necessitates empirical use of macrolides for severe cases.

SURVEILLANCE & DIAGNOSIS

India lacks dedicated surveillance for Campylobacter. It is not a notifiable pathogen, and routine labs seldom test for it. Campylobacteriosis is often subsumed under "acute diarrheal disease" reporting. Research studies have used culture on selective media and molecular methods (PCR). Culture remains the standard but under-detects cases; PCR/antigen tests are more sensitive. For example, routine labs in Kolkata found 7% via culture, but molecular screening in research indicates higher mixed infections. Improved diagnostics (culture plus PCR or copro-antigen assays) would reveal a higher true prevalence. The Pune GBS incident exposed surveillance gaps: it was only identified by retrospective testing of stored samples. India's Integrated Disease Surveillance Programme (IDSP) does not specifically capture Campylobacter, which leads to underestimation of its burden.

OUTBREAKS

Outbreaks of campylobacteriosis are infrequently reported in India. The notable exception is the 2025 Pune outbreak of Guillain–Barré Syndrome, traced to contaminated municipal water containing *C. jejuni* (and norovirus). Over 200 GBS cases were linked to a preceding diarrheal illness; nearly 50% of GBS patients tested positive for *C. jejuni*. This event highlighted both the potential for large-scale outbreaks and deficiencies in rapid outbreak detection, clinical management, and laboratory capacity. No major foodborne outbreaks (e.g. raw milk) have been documented publicly in India in recent years, but sporadic clusters may go unrecognized due to limited testing.

Research Gaps & Recommendations: Despite evidence that *C. jejuni* is endemic in India, systematic epidemiological data are limited. Key gaps include national incidence estimates, standardized age-stratified prevalence, and sources attribution. There are no large, population-based studies or integrated surveillance linking human, animal, and environmental data. We lack time-trend analyses of AMR within India. Diagnostic capacity needs strengthening: molecular or antigen tests should supplement culture in sentinel labs. Government surveillance should explicitly monitor *Campylobacter* as part of enteric disease reporting.

Control measures are needed on the "One Health" front: reducing *Campylobacter* in poultry (biosecurity, slaughter hygiene), regulating antibiotic use in livestock (to curb AMR), and improving water and sanitation. Clinically, use macrolides for empirical therapy when campylobacteriosis is suspected, given high fluoroquinolone resistance. Finally, public health education on safe food handling and water treatment is vital. Future Indian research should focus on nationwide prevalence studies, outbreaks investigation, and AMR surveillance, to inform policy and interventions.

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Table: Key Indian Campylobacter Studies

ER*Y=erythromycin (macrolide); CIP=ciprofloxacin; TET=tetracycline; MDR=multidrug-resistant (≥1 drug here).

Author (Year)	Location (State)	Population	N (samples)	Prevalence (%)	Findings (major)	Ref (PMID/DOI)
Mukherjee *et al.* (2013)	Kolkata, West Bengal (East India)	Hospitalized diarrhea	3,186	**7.0%** (222/3186)	*C. jejuni* in 10% of <5y vs 3.7% older; 97% CIP-resistant; macrolide-susceptible. Mixed infections common.	Emerg Infect Dis (Jul 2013), doi:10.3201/eid1907.121278 (PMID: 23780630)
Vaishnavi *et al.* (2015)	Chandigarh (Northern India)	Community diarrhea	1,145	**2.6%** (30/1145)	Low regional prevalence; *C. jejuni* most frequent; higher in summer; moderate CIP resistance.	Adv Microbiol (2015), doi:10.4236/aim.2015.53015 (PMID: not found)
Borkakoty *et al.* (2020)	Northeast India (Assam, etc.)	<5y hospitalized diarrhea	407	**10.1%** (41/407)	Campylobacter endemic; risk factors = rural, livestock contact. (Endemic in NE India).	Indian J Med Microbiol 2020;38:32-36 (DOI:10.4103/IJMM.IJMM_19_498)
MAL-ED Consortium (2016)	Multisite (incl. India, S Asia)	Birth cohort, 0–24 mo	1,892	**84.9% by 1 yr** (diarrheal or not)	Infection very common; associated with poor growth; breastfeeding and clean water protective	Clin Infect Dis 63(9):1171–79 (PMID: 27504561)

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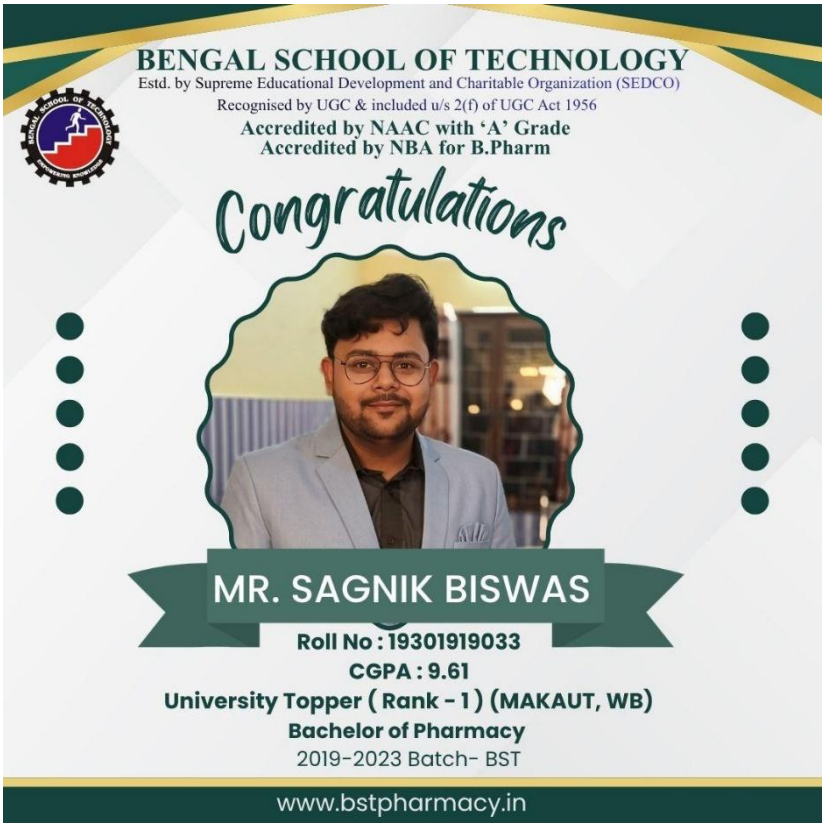
Author (Year)	Location (State)	Population	N (samples)	Prevalence (%)	Findings (major)	Ref (PMID/DOI)
Saleem & Haq (2024)	Poultry	Poultry meat samples	245 isolates	82.4% CIP, 74.3% TET, 0% ERY (drug resistance)	82.4% isolates MDR (≥1 drug); poultry is reservoir; calls for antibiotic regulation.	Infect Chemother 2024;56(3):423-425 (doi:10.3947/ic.2024.0061)
Tandale *et al.* (2026)	Pune, Maharashtra (West India)	GBS patients (from diarrheal outbreak)	~230 GBS cases	~50% (Campy+) in GBS	*C. jejuni* found in ~50% of GBS outbreak cases; contaminated water (and poultry) implicated; major gaps in surveillance highlighted.	J Neurol Sci 480:125696 (2026) (DOI:10.1016/j.jns.2025.125696)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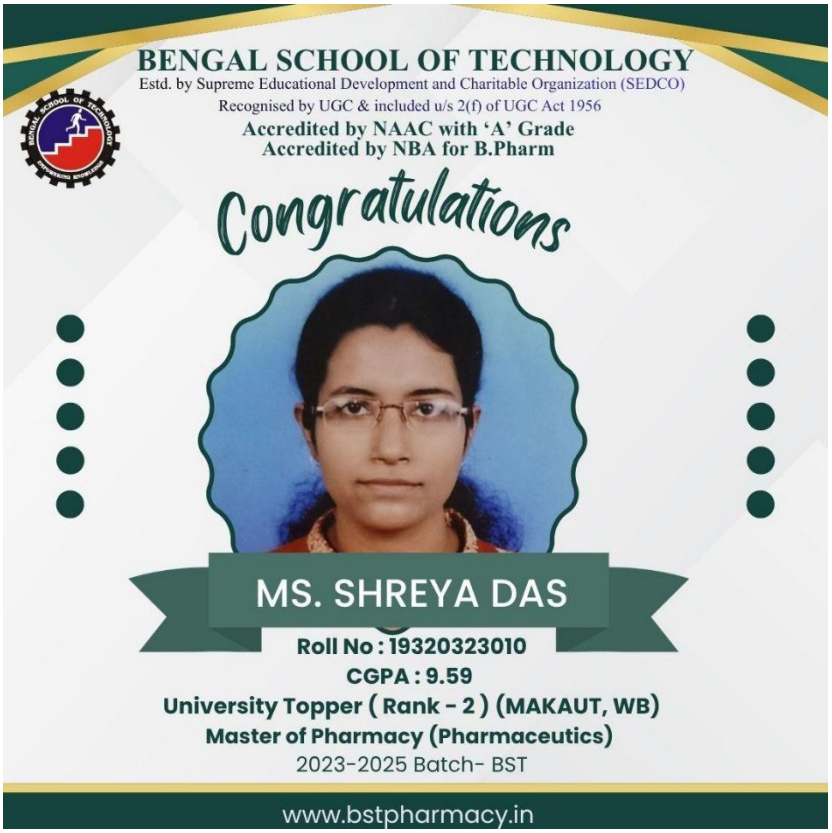
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