THE TECHNOCRACY
STUDENTS' TECHNICAL COMMITTEE, NIT RAIPUR

AAVARTAN 24-25

VIGYAAN
DEPARTMENT OF BIOTECHNOLOGY ENGINEERING

PROBLEM STATEMENTS

<u>BIT01</u>: <u>Enhance the expression and stability of therapeutic proteins in microbial hosts for cost-effective pharmaceutical production.</u>

A cost-effectiveness ratio is the net cost divided by changes in health outcomes. Examples include cost per case of disease prevented or cost per death averted. However, if the net costs are negative (which means a more effective intervention is less costly), the results are reported as net cost savings. As the tools of pharmacy continue to evolve, so too will the role of the pharmacist. Pharmacy automation is expected to more than double by 2030. This use of automation will allow pharmacists to spend more time on virtual and physical patient care.

<u>Current issues and limitations</u>:

- The pharmaceutical industry has a number of unusual characteristics, both in its structure and in the nature of its business operations, which are little known outside the industry but that materially affect the process of bringing the safest and quality pharmaceutical drug products to the patient.
- The development and manufacturing of pharmaceutical drug products is very time-consuming, extremely costly and high risk, with very little chance of a successful outcome.
- The process of pharmaceutical manufacturing operations with respect to cost factors is described, together with all its challenges, including talent procurement.

Future scope and impact:

- With advancements in biotechnology, scientists have been able to produce therapeutic proteins in large quantities, making them more accessible and affordable for patients. These proteins have shown remarkable success in treating conditions such as cancer, autoimmune disorders, and genetic diseases.
- Therapeutic proteins can be used to replace a protein that is abnormal or deficient in a particular disease. They can also augment the body's supply of a beneficial protein to help reduce the impact of disease or chemotherapy.

Expectation from the team:(Overcoming the current issues)

The task involves designing an innovative biotechnological strategy to improve both the expression and stability of therapeutic proteins within microbial hosts, with the ultimate goal of achieving cost-effective pharmaceutical production

BIT02: Address the challenges of microbial contamination in large-scale fermentation processes.

Microbial contamination is a pervasive problem in any large scale (ethanol)fermentation system. These infections can at minimum affect the efficiency of the fermentation and at their worst lead to stuck fermentations causing plants to shut down for cleaning before beginning anew.

Current issues and limitations:

- Factors that majorly affect the process of microbial fermentation are(Aeration, temperature,pH,substrate's type and concentration,fermentation time,chemical attributes.)basically due the unwanted changes in their parameters.
- One of the key challenges for fermentation scale up is the flow field difference between lab-scale and industrial-scale bioreactors.
- The constraint of specific power input in large-scale bioreactors always results in heterogeneous environments in the large bioreactors.

Future scope and impact:

- Fermentation technology can be applied to alter the metabolic pathways using cultivation-based or molecular approaches.
- Production of recombinant products: Recombinant proteins, vaccines and hormones can be produced by fermentation that are used widely by pharmaceutical companies.

Expectation from the team:(Overcoming the current issues)

Proposing innovative solutions to maintain product quality and yield of the products.The task involves integrating technological innovations, stringent aseptic practices, and genetic enhancements to create a more resilient and contamination-resistant large-scale fermentation process. The solution should be aiming not only to mitigate the challenges posed by microbial contamination but also to ensure sustained product quality and yield in biotechnological production processes.

BIT03: Tackling antibiotic resistance through innovative biotechnological approaches.

The problem statement underscores the importance of developing alternative strategies to combat infectious diseases. This could involve exploring non-traditional methods for treating infections, such as using bacteriophages, immune system modulators, or innovative drug delivery systems.

Current issues and limitations:

- As a result of drug resistance, antibiotics and other antimicrobial medicines become ineffective and infections become difficult or impossible to treat, increasing the risk of disease spread, severe illness, disability and death.
- AMR is a natural process that happens over time through genetic changes in pathogens.While resistance is a natural phenomenon and not just a health issue, from a human healthcare perspective it is accelerated by: inappropriate use of antimicrobial drugs.
- Poor infection prevention and control practices and a lack of new antimicrobial drugs being developed.The main cause of antibiotic resistance is antibiotic use. When we use antibiotics, some bacteria die but resistant bacteria can survive and even multiply. The overuse of antibiotics makes resistant bacteria more common.

Future scope and impact:

- Projections by the Organization for Economic Cooperation and Development (OECD) indicate an anticipated twofold surge in resistance to last-resort antibiotics by 2035, compared to 2005 levels, underscoring the urgent need for robust antimicrobial stewardship practices and enhanced surveillance coverage worldwide.
- In the future, more people may also die from secondary bacterial infections that are resistant to antibiotics.
  (Such as during the Great Influenza or the Spanish Flu, viral and bacterial infections combined to create a much bigger problem. Most of the Spanish Flu deaths were not actually caused by a virus.)

<u>Expectation from the team</u>:(Overcoming the current issues)

The task is to diversify the arsenal of tools available for healthcare professionals, reducing reliance on traditional antibiotics and minimizing the risk of resistance development.Overall, the statement highlights the proactive role that biotechnology can play in finding sustainable solutions to antibiotic resistance, safeguarding the effectiveness of antimicrobial treatments, and ensuring continued success in managing infectious diseases on a global scale. Such as the discovery of new antimicrobial agents and the development of alternative strategies to combat infectious diseases.

<u>BIT04</u>: <u>Investigating the potential of synthetic biology in creating bioengineered organisms with specific functionalities.</u>

The focus is on designing organisms with specific functionalities, which could include producing biofuels, synthesizing valuable chemicals, or serving as biological sensors. This approach allows for the customization of biological systems to meet particular needs or solve specific challenges.However, the statement also highlights the importance of addressing safety and ethical considerations associated with manipulating biological systems.

<u>Current issues and limitations:</u>

- Organisms made using synthetic biology and released into the environment could have unknown ,unintended and potentially irreversible effects on ecosystems.Such effects could be widespread if, for example, these organisms negatively affected food or water systems.
- Currently, it is argued that insufficient work has been conducted to identify or assess related biosafety risks in the synthetic-biology field. A comparative approach is a common method for evaluation of risks; however, risk assessment based on a comparison is difficult due to the complexity of synthetic biology.
- Traditional genetic modification approaches usually involve manipulation of known genes in a donor organism; therefore, it is easy to find an appropriate comparator.
- In contrast, designs and procedures in synthetic biology are usually more complex and typically involve construction of a new pathway consisting of multiple genes or involve a gene with an unknown function.
- In addition, an important branch of synthetic biology, xenobiology, deals with construction of life by means of non canonical base pairs or amino acids. These components do not exist in nature; therefore, no comparator can be found naturally for these cases.

Future scope and impact:

- Synthetic biology aims to design and modify cellular functions to engineer cells to perform specific and well-defined functions. This control over the capabilities of the cell is dependent on the knowledge of cellular behavior and its regulatory control.
- Towards this end, synthetic biology has resulted in the creation of genetic circuits to help visualize and standardize the various modules employed to modify cellular functions.
- Computational tools are being developed to aid in the complexity ,prediction and analysis of possible synthetic biology strategies for modifying the cell. In this chapter, computational tools developed for designing genetic components and strategies are presented.

Expectation from the team:(Overcoming the current issues)

The task involves implementing rigorous safety protocols to prevent unintended consequences, such as environmental impact or unintended consequences in the organisms themselves. Ethical considerations involve ensuring responsible and transparent practices in research and development to avoid misuse or unintended consequences.

BIT05: Develop advanced and accessible insulin pump solutions focusing on Type 1 diabetes patients.

Automated insulin delivery systems,also called artificial pancreas or closed-loop control systems, track a person's blood glucose levels using a CGM (Continuous Glucose Monitor)and automatically deliver the hormone insulin when needed using an insulin pump. These systems replace reliance on testing glucose level by fingerstick, continuous glucose monitor with separate insulin delivery through multiple daily injections, or a pump without automation.

Current issues and limitations:

- It is estimated that the number of people affected by diabetes will rise to 783 million by 2045. This has led the World Health Organization to consider diabetes an epidemic. Despite its huge impact on the global population, there is still no cure for any type of diabetes
- Facing challenges in achieving optimal blood glucose control and maintaining their quality of life due to the limitations and barriers associated with traditional insulin administration methods.

- Conventional insulin injection regimens can lead to inconsistent blood sugar levels, frequent hypoglycemia or hyperglycemia episodes, and the need for strict adherence to complex dosing schedules.

<u>Future scope and impacts</u>:

- Advanced and accessible insulin pump solutions that provide precise and personalized insulin delivery, minimize glycemic fluctuations, and improve overall diabetes management while addressing concerns related to affordability, usability, and integration into daily life for individuals living with type 1 diabetes.
- This pump would combine the continuous glucose monitoring (CGM) and insulin pump into one device, so it can continuously monitor a person's blood glucose and remove the patient's involvement in calculating the insulin dosage they need the pump to provide.
- Aid the burden of frequent injections can have a negative impact on the emotional well-being of individuals with type 1 diabetes.
- Would reduce the risk of heart diseases,stroke and circulation problems. In addition, it would also prevent sight problems and blindness,pain and loss of feeling (nerve damage).

<u>Expectation from the team</u>:(Overcoming the current issues)

The task involves development of a pump that can give you the right amount of insulin at the times you need it. There's less risk of low and high blood glucose.The device releases insulin almost the way your body naturally would: a steady flow throughout the day and night, called basal insulin, and an extra dose at mealtime, called a bolus, to handle rising blood sugar from the food you eat. You program the pump for both basal and bolus doses.