Manipal BioTech Hackathon '21

Manipal - Government of Karnataka BioIncubator & Manipal School of Life Sciences, Manipal Academy of Higher Education (MAHE), Karnataka

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Problem statement

1. **Neglect of Crop rotation or cropping pattern – alternate C3 and C4 plants**

Food crops such as food grains, sugarcane and other beverages and non-food crops such as fibres and oilseeds make an array of cropping patterns. Depletion of nutrients of one crop can be made up by alternating growing other crops at the same place on a rotational basis. Knowledge of specific crop rotation may help to maintain the fertility of the soil with minimum efforts and consistent yield. Another strategy is to grow C3 and C4 plants alternatively to contribute to control climate change.

2. **Seed quality analysis**

Post-harvesting seeds and their optimum germination in another cycle is key to success in farming. Seed quality can change due to several reasons. These can be physical or physiological. Identifying these and mitigating the same can improve the success of farming, including overcoming seed infections.

3. **Soil nutrient analysis**

Soil nutrient analysis is key determine the use of natural or artificial fertilizers for farming. Soil nutrient analysis can also determine the extent of the crop yield. A systematic evaluation of all the factors and identifying solutions with new technologies will help in the successful agricultural practices.

4. **Programing plants for Tolerance to Abiotic Stresses**

Abiotic stresses is one of the factors that significantly limit crop production worldwide with an average 70% reduction, mainly drought, salinity, etc. Programing plants to improved stress tolerance to improve agricultural production using the unutilized lands where soils are nutrient-rich and shift in rainfall patterns.

5. **Increase the shelf life of fruits and vegetables & Postharvest Processing.**

Food waste and loss is an important issue worldwide with 20% of dairy products, 30% of cereals, 20% of oilseed and pulses, 20% of meat, 45% of fruits and vegetables, 35% of fish and seafood, 45% of roots and tubers are lost or wasted. Biotech intervention to decreasing postharvest losses to ensure food supply, the efforts without losing the natural benefits of fruits and vegetables through innovative solutions focused on the real problems of Ethylene exposure, Temperature changes Humidity/moisture, Microbial growth, Physical harm, respiratory rate control and Packing materials.

6. **Rapid detection of bacterial and fungal infections in plants.**

Infections are detrimental for successful cropping practices. Infections can differ during various stages of growth and at different parts of the plants. These will have a significant impact on the crop yield. Identification of microbial infection early that can destroy the plants will facilitate its eradication for better yield.

7. **Identification of food adulterants.**

The current estimate of more than two million people, including children, face fatality due to the consumption of unsafe food and impure water annually. The different forms of food adulteration with diverse forms and chemical combinations without direct tracing affect the food integrity and authenticity in developing countries. The need for proper identification of all sort of food adulterants qualitatively or quantitatively becoming a global challenge today with at least a gold standard. Many technologies currently using are below slandered and false positives cases. The global consumers are waiting for the high throughput technologies for accurate identification of food adulterants, through biotech Innovation.

8. **Vaccine candidates.**

The development of vaccines by conventional methods for a specific pathogen is labor intensive, time consuming, poor immune responses, need of adjuvants, and susceptibility to enzymatic degradation and expensive. It also has high failure rate and becomes trickier for those organisms that cannot be cultured in the laboratories. Novel vaccine development strategies to overcome the shortcomings of traditional vaccines candidate through advancement in computational biology for screening vaccine candidates from the genome of a pathogen for the prediction of antigenic peptides for successful development is to develop vaccines.

9. **Drugs from plants for infectious microorganisms.**

The microbial resistance to classical antibiotics and its rapid progression has raised serious concern in the treatment of infectious diseases. The phyto compounds have exerted potential antimicrobial activities against a large number of pathogens via different mechanisms of action. Plants hold great promise as a source of novel antimicrobial agents, currently large number of database available for phytochemicas, but the limitation is developing a novel therapeutic screening platform to predict the antimicrobial activity of phytochemicals.

10. **Targeting microorganisms as antifouling agents**

The problem of biofouling by the undesirable colonization of surfaces by fouling organisms, including micro-organisms and macro-organisms cause huge material and economic loss. Currently, other toxic and non-targeted chemicals are used as coatings. Microorganisms are identified as a novel source for antifoulants mainly by its bioactive secondary metabolites.

11. **Microorganisms for bioremediation**

Today, environmental pollutants are one of the primary concerns all over the Globe, which in turn affects human health. The Domestic and industrial waste generated with non-degradable pollutants progressively deteriorate the environment, and current technologies are insufficient to clean up the vast mass of trash. The individual or consortia of microorganisms are considered to remediate the pollutants at the lab scale using their biochemical and enzymatic interaction. The development of innovative technology, with programmable microbial process potentiality for rapid biodegradation, need to develop with big data of biology (microbial genomics, proteomics, systems biology, computational biology, and bioinformatics) with controlled bio-degradative pathways.

12. Cell factories –The single-cell programmed differentiation artificial red blood cell

The demand for blood transfusion remains high in surgical interventions and other hematologic malignancies, and there is an imbalance in blood demand and supply. Can we create a roadmap for how specific features of genomic architecture determine the programmed differentiation of stem cells to RBC. The possibility of utilizing pluripotent stem cells to transform into RBC for therapeutic purposes with less ethical concerns.

13. Nanobubbles application for plant and human cells – take an example

Micro- and nanobubble (MNB) technology is an emerging technology to solve multi domain problems, an effective alternative for current treatment technologies. It proves a wide level of applications in agriculture, Industry, environmental, water recycling, the therapeutic potential of the nanobubbles in reverting hypoxic tumour regions, targeted drug delivery, material sciences etc.

14. Stem cells for infectious diseases

The multipotent mesenchymal stem cells currently focused by innovators for its therapeutic impact due to the immune-modulatory effects, through a variety of bioactive factors, which actively contribute to mitigate with tissue damage, inflammation, and infection associated with bone, cartilage, lungs, pancreas, the central nervous system, the gastrointestinal track, and the circulatory system. The MSCs enhance the remodelling of diseased body parts, regulate the immune system, enhance treatment by inducing angiogenesis or blood vessel development, be chemotactic, and induce cellular recruitment. Novel therapy needs to develop utilizing the potential of MSCs differentiation process depends on the environment and using the active communication between the newly administered cells host tissue.

15. Biofuels

Biofuels offer an excellent alternative for fossil fuels and currently contributing in a small amount to the growing global demand, and biological alternative sources of renewable energy exploration are the need of this hour. Biochemical and Bioinformatics understanding and analysis of energy-generating pathways across the three-domain of life with the support of current scientific knowledge may lead to unlocking the mysteries of alternate fuels. Develop sustainable alternative fuels which can be generated from biomass and emerging fuels that could reduce the load on the non-renewable fuels and decrease the level of pollution.

16. **Biodefense development of a multi-dimensional antidote platform**

Nextgen biodefense is a need of time. It includes measures to restore biosecurity against pathogenic organisms, bacteria, viruses, fungi, and biological toxins potential warfare to exploit and eliminate biological threats in the context of bio-war or bioterrorism. Rapid detection of biological threats or infectious diseases by forensic and intelligence operations need of more algorithms in bioinformatics for biodefense databases and also a need of potential antidote database. Innovative computational applications are required in order to explore next-generation genome sequence, marker database, antibiotic resistance database with mitigation and medical intelligence for the forensic operation to handle bio-threats.

17. Precision Medicine

According to Food and Drug Administration (FDA), Precision medicine, sometimes known as 'personalized medicine' is an innovative approach to tailoring disease prevention and treatment that considers differences in people's genes, environments, and lifestyles. The sector includes generating genetic profile data as well as clinical data which are analysed to design the personalised patient health care. The challenges of generating, managing, and processing the data as well as accurately designing the treatment would warrant many innovative methods.

18. **Antibody Engineering- Building better antibodies**

Antibodies have been used in various therapies. The Recent technological innovations provide insights on various markers, receptors, ligands, and other biomolecules, which are part of cell signalling that trigger immune reactions. The structural modification of antibodies based on the target can influences/ trigger an action on a particular target to create an immune response to get rid of the targeted cell or foreign materials. Amid the continuing pandemic and resistance to current antibiotics, innovations in antibody engineering may solve to develop better & novel therapeutics harnessing the immune system to fight disease.

19. Biosensors – development of electrochemical detection system for Wearable Devices & paper microfluidics detection kits

Biological receptors are integrated into a biosensor to selectively capture a target of interest detection capabilities with the gold standard method. Antibody-based medical diagnostic biosensors, biomarkers based on body fluids such as tears, blood, urine, and breast milk, biosensors that mimic olfaction for recognizing odors combined with microelectronics and 3D-printing are emerging in this sector. These biosensor can be used in medical devices including diagnostics, for better sensing capacity.

20. **Development and Application of organoids through 3D bioprinting**

3D bioprinting innovation lead towards fabricating complex biological constructs layer-by-layer assembly of biomaterials with applications of therapy, drug screening, disease modelling, to address the unmet needs in the development of precision medicine and personalized treatments. The current challenges of developing organoids are reprogrammed cell proliferation, development of required shapes by internal vascularization, biomimicry for supporting biological and nonbiological material attachment and maintaining the activity of cells, promoting cellular proliferation and differentiation, guiding tissue regeneration and promoting functional maturity. Innovation in this emerging domain of 3D bioprinting demanding more innovative solutions and have huge market potential with numerous applications.

21. **Biotech Nanobots - Hybrids Nanorobots**

Innovative designing of nano-sized robots that are enough to enter the bloodstream and perform certain precise tasks such as targeting and killing cancer cells, delivering drugs to infectious sites. Nanorobot designs may include biomolecules/DNA-based structures containing cancer-fighting drugs that bind only with a specific biomarker found on cancer tumours/ target cells. Once it attaches, the robot releases its drug into the tumour/ target cells. Such precision delivery

of the drug exactly to target, avoid overloaded toxicity in patients, and reduce the side effects and improving the patient experience.

22. Artificial Intelligence-Solve drug design, discovery, vaccine innovation and Precision medicine

AI enables innovators to automate a wide range of processes, helping them scale up their operations. For instance, Innovators can leverage AI to speed up the screening of drug discovery process, screening of billion molecules that don't exist in nature, biomarkers screening to discover novel, innovative products. Currently, Big data is complex, so noisy & sparse and heterogeneous available in biological and clinical data streams. Unique AI algorithms allow to solve these problems by exploring the raw data from medical scans, drug database, and crop disease patterns/symptoms, biomolecules, microbiomes, screen phenotypes, and develop rapid solutions.

23. Revolutionizing the Biotech Industry through Big Data

The unprecedented amount of data available in virtual libraries with Millions of compounds, Biomolecules, Bio-markers, genetic, ethnic, medical, microbial, bioinformatics and other biological data capable of integrating and transform into innovative solutions. These unexplored Big data & analytics solutions allow BioTech innovator to tap into this wealth of data to drive innovation for a wide array of problems through real investigation of this massive data. Innovations based on artificial Intelligence, augmented machine learning and deep learning for Predictive Analytics, Prescriptive Analytics and other technologies that assist in resolving the challenges surrounding big data.

24. Biochemical smell Sensors. Rapid detection

Development of Olfactory biological sensor System/ technologies based on the biological nose as a model that mimics human/Animal olfaction that capable of detecting different types of odour components highly accurate high sensitivity with support of AI technologies to detect health, diseases, mixtures of gases, environmental risks, including COVID-19, etc. with a wide range of other possible applications in medicine, lifestyle, fragrance research, biosafety, industry, environment, agriculture, food industries etc,.

25. Drug Delivery Systems

Develop formulations or devices that enable the delivery of the therapeutic substance to selectively reach the site of action without causing issues in the non-targeted sites

26. Drugs and biomaterials from Oceans

To explore the biodiversity of seas and oceans and to explore potential molecules which can be further developed as potential drugs as well as useful biomaterials for many applications. Novel applications for characterized biomaterials also would increase the usability of the molecules from oceans.

27. Optical sensors

It converts light into an electrical signal. It is a small device integrated to several instruments. It has the potential to apply in various field of biomedical/biotechnology/agriculture.

28. Handheld device

An innovative portable device that can be carried and held in one's palm as a replacement for heavy instruments, especially those needed in field studies, rather than taking samples to labs. There are several such devices, including smartphone-based devices, targeting various applications.

29. Smart agriculture

It integrates the information and communication technologies along with the machine/devices. It includes sensors, software, data science, robotics, connectivity. Innovative with Sophistication of agriculture would be an asset that ensures a high yield with less human labour.

30. Hyperspectral imaging

It collects and processes a wide range of electromagnetic spectrum in the form of an image. It is extensively used in agriculture for the detection and identification of crops.

31. Laser ablation

It is a technique where the surface materials of solid are removed by irradiating laser. Both CW and pulsed lasers are used in this case and choose according to the applications. Laser ablation-based surgery is getting popular.

32. Green synthesis

It is an emerging field in bionanotechnology, which is an alternative to physical and chemical methods. With the help of eco-friendly and safe reagents, various nanoparticles are synthesized and are used in the detection/identification of pathogens.

33. Biomanufacturing

Biomanufacturing is using biological systems to manufacture special molecules of interest which may include drugs, biomaterials, food, beverage as well as speciality chemicals. Biomanufacturing may include cell culture methods, fermentation, and recombinant technology. Optimizing the manufacturing conditions, automation and scalability are current challenges in the sector. Innovation and discovery of new molecule of interest may be valuable for the ever-changing demand for drugs and biomaterials.