

MOUNT CARMEL COLLEGE, BANGALORE

BIOGENEAIAC ASSOCIATION

# BIOGENESIS

**OCTOBER 2021 ISSUE**

FEATURE ARTICLE ON

# GENETICALLY MODIFIED FOODS

**THE MYTHS &  
THE TRUTHS**

## FEATURE ARTICLE

### ***THE TRUTH ABOUT "NATURAL" FOODS***

*"Genetic alteration due to breeding practices and genetic modification by adding transgenes all have similar end products."*

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# BIOGENESIS

THE OFFICIAL NEWSLETTER OF BIOGENEAIAC ASSOCIATION  
MOUNT CARMEL COLLEGE

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# Genetically modified food: the potential and hazards

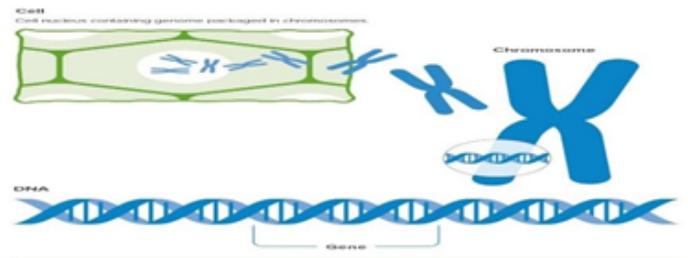
ADITI SINGH | BTCZ 2ND YEAR

What is genetically modified food?

Genetically modified foods (GM foods) are also known as genetically engineered foods (GE foods) or bioengineered foods produced from organisms that have had changes introduced into their DNA, using the methods of genetic engineering.

Some Advantages of GM foods:

- **Pest resistance:** Crop losses from insects and pests can be staggering, resulting in devastating financial loss for farmers and starvation particularly in developing countries. Consumers do not wish to eat food that has been treated with pesticides because of potential health hazards. Growing GM foods such as BT corn can help eliminate the application of chemical pesticides and could reduce the cost of bringing a crop to market.
- **Disease resistant:** There are many viruses, fungi and bacteria that can cause plant diseases. Plant biologists are working to create plants with genetically engineered resistance to these diseases.
- **Herbicide tolerance:** For some crops, it is not cost effective to remove weeds by physical means such as tiling, so farmers will often spray large quantities of different herbicides to destroy weeds which is a time consuming and expensive process that requires care, so that the herbicide\* doesn't harm the crop plant or the environment. Growing plants that are genetically engineered to be resistant to very powerful Herbicide's could help prevent environmental damage by reducing the amount of herbicide's needed. For example, Monsanto has created a strain of soybeans genetically modified to be unaffected by their



herbicide product roundup. A farmer grows these soybeans, which then only require one application of weed killer instead of multiple applications, reducing production costs and eliminating the dangers of agricultural waste run off.

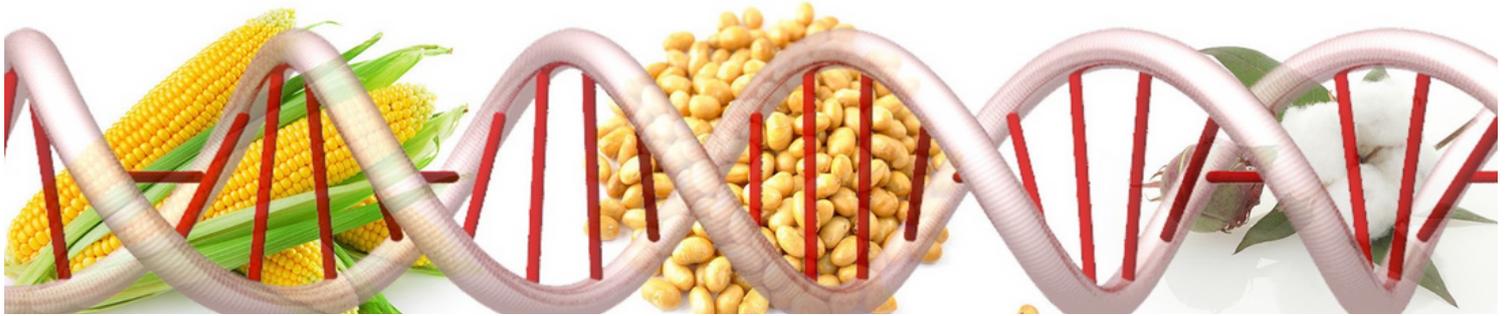
## CRITICISM AND HEALTH RISKS:

- **Reduced effectiveness of pesticides:** Just as some populations of mosquitoes developed resistance to the now banned pesticide DDT\*, many people are concerned that insects will become resistant to BT or other groups that have been genetically modified to produce their own pesticides.

Gene transferred to non target species: Another concern is that croplands engineered for herbicide tolerance and weeds will cross breed, resulting in the transfer of herbicide resistant genes from the crop into the waves. These super weeds would then be herbicide tolerant as well. Other introduced genes may crossover into non modified crops planted next to GM

crops. The possibility of interbreeding\* is shown by the defence of farmers against lawsuits filed by Monsanto.

- **Allergenicity:** There is a possibility that introducing a gene into a plant may create a new allergen or cause allergic reactions in susceptible individuals. Extensive testing of gene foods may be required to avoid the possibility of harm to consumers with food allergies.



Credits: <https://www.medium.com>

# THE TRUTH ABOUT NATURAL FOODS

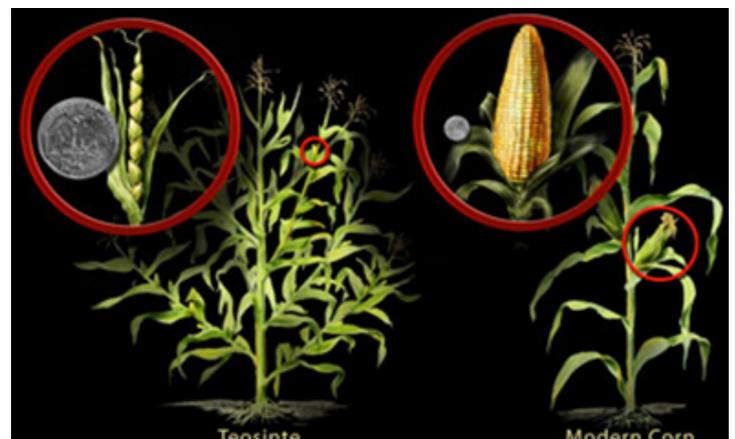
ANISHA JAI SINGH | BTCB 2ND YEAR

Perhaps the greatest reservation that the general population has about genetically modified food is that such food is “unnatural”. The very genetic composition of such a food has been tampered with, as opposed to “natural” foods that have been consumed by the human race for hundreds of years. These “natural” foods were cultivated by our ancestors and adding transgenes\* to such food would be like adding industrial waste to a natural lake. However, few people realize the extent to which today’s crops have been modified during the domestication process.

It was Charles Darwin who pointed out in his book - *The Origin of the Species*, that our domesticated crops have been so altered by breeding and selection, that at times it can be difficult to recognize their wild ancestors. Maize is an extreme example of Darwin’s observation, as cobs of teosinte bear little resemblance to those of modern maize. Thus, there is very little that is natural about our current crops. However, what makes Darwin’s observation so relevant to genetic engineering is that, except for a few cases that involve epigenetics\*, it is impossible to change the appearance of a plant without changing its DNA. Yet, the perception remains that breeding does not alter DNA.

Of course there are several differences between conventional breeding and genetic engineering but there are several similarities as well. We must keep in mind that natural evolution as a

response to environmental change, genetic alteration due to breeding practices and genetic modification by adding transgenes all have similar end products. The difference simply lies in the time period it takes to reach said end product.



Credits: National Science Foundation

*From ancient grass to modern corn*

# BETWEEN MYTH AND REALITY: GENETICALLY MODIFIED MAIZE

BULBUL SINGH | BTCZ 2ND YEAR

Due to public outcry, a preliminary toxicological study was conducted in the laboratory in order to evaluate the impact of Bt-maize on non-target insects. Monarch butterfly larvae, used as non-target insects, were fed milkweed plants dusted with Bt-pollen. The monarch butterfly, one of the most popular butterflies in the United States, leaves Mexico during spring to travel north where it lays its eggs. These hatch into caterpillars that eat exclusively milkweed, a plant commonly found in cornfields. In areas where maize is intensively cultivated, milkweed grows at a higher density than on non-agricultural land. As a result, it is realistic to propose that milkweed may become dusted with maize pollen and in the case of a Bt-cornfield, that monarch larvae could ingest Bt-pollen with milkweed leaves. Losey et al. found a 44% higher mortality in larvae fed with Bt-pollen compared to those fed with untransformed pollen, and a significant effect of maize pollen on monarch larvae feeding behaviour.

These authors concluded that their results had “potentially profound implications for the conservation of monarch butterflies” and that it was imperative to “gather the data necessary to evaluate the risk associated with new agrotechnology and to compare these risks with those posed by pesticides and other pest-control tactics”.

Despite the fact that these results have received considerable criticism from the scientific community, they were extensively used by the media who have grossly exaggerated the threat posed to the monarch butterfly by transgenic maize. To accurately gauge the impact of Bt-pollen an evaluation of the risk encountered when using new pest management systems, such as GM plants must be considered by comparison with the current practices. European maize borers are commonly controlled by spraying *B. thuringiensis* preparations used as a biopesticide, regardless of their deleterious effect on non-target organisms. The insecticide, k-cyhalothrin, has a dramatic effect on monarch larvae which died within hours and due to insecticide drift, the survival of larvae outside the cornfield was also reduced.



Credits: [www.truththeory.com](http://www.truththeory.com)

Therefore, compared to the currently used methods for pest management, Bt-maize represents an improvement for non-target organism survival. This paper was followed by extensive media coverage which further misinterpreted the laboratory results, leading non-scientists to a massive opposition to Bt-maize and biotechnologies.

For 6000 years of traditional breeding, landraces have constantly changed due to human intervention and diversity has been promoted for the development of additional new varieties. To protect this diversity, the Mexican Government declared a moratorium in 1998 on planting transgenic maize anywhere in the nation.

However, there is no scientific evidence that out-crossing from engineered crops could endanger maize biodiversity. The second worry is the possibility of introgression leading to an increase in the fitness of wild relatives. If transgenes confer an evolutionary advantage to the species, then their prevalence in wild population would be expected to increase progressively. With GM crops, the most likely traits to confer such advantages would be herbicide tolerance and insect resistance. Introgression of a herbicide resistance gene could lead to a potential weed problem and to a decrease of the herbicide efficiency, but this has meaning only in an agricultural setting, and in the absence of the herbicide pressure, the selective advantage would disappear rapidly.

The effects of insect resistances, such as those conferred by Bt genes, are central to the debate as changes in these resistances, caused by plant–insect co-evolution, are difficult to predict. Gene flow is constant and because maize varieties cross readily, almost everyone agrees that GM maize may be growing in Mexico. What science must now resolve is whether or not the flow of transgenes into maize landraces will have significant negative impacts on either maize genetic diversity or on the broader environment.

# GENETICALLY MODIFIED FOODS: THE MYTHS AND THE TRUTHS

VINAYA KRISHNAN | BTCB 2ND YEAR

## **GABA and the gene-edited tomato**

Gamma aminobutyric acid (GABA) is a compound which is produced naturally by our brain and is linked to reduced feelings of anxiety and low blood pressure. This neurotransmitter\* essentially blocks the impulses between nerve cells in the brain, by inhibiting the transmission of action potentials.

Since dietary therapy is preferential over medication as an initial treatment for patients with mild high blood pressure, intake of GABA daily through diet aids in reducing the symptoms of the condition.

Researchers found that during the tomato fruit development, three GAD genes (SIGAD1-3), three GABA-T gene (SIGABA-T1-3), and one SSADH gene (SISSADH) are expressed, of which SIGAD 2 and/or SIGAD 3 and SIGABA-T1 are important for GABA biosynthesis and catabolism respectively, but there is a loss of function as the plant matures. Thus, the GABA levels in tomatoes are increased by genetically manipulating SIGAD 2, SIGAD 3 or SIGABA-T1. This was done using CRISPR/Cas 92\* technology where the C terminal of SIGAD 2 and SIGAD 3 were targeted, where 30 and 48 amino acids at the C terminal of SIGAD 2 was used as the target site. Introduction of stop codon\* at the 30 and 48 amino acids for SIGAD 2 and 37 amino acid for SIGAD 3 via CRISPR/Cas 9 lead to increased accumulation of GABA in the tomato fruit.



Credits: [www.sanatech-seed.com](http://www.sanatech-seed.com)

# FUTURE OF GENETICALLY MODIFIED FOODS

The current and future applications of GMO's in agriculture and food crops

VISMITHA.S & SHARON VERONICA | BTCZ 3RD YEAR

Despite the technical difficulty, substantial progress is now being made with genetically modifying food crops. For example, oilseed rape can now be modified to produce oils with wide ranging characteristics through selective modification of the length and degree of saturation of the fatty acids produced—fatty acids such as laurate, typical of tropical vegetable oils, can now be produced in temperate oilseed crops. Similarly, the balance of sugar and starch in potatoes, which affects the processing quality of potatoes for snack food production (too much sugar produces a dark, poor tasting product), can also now be modified on an experimental scale.

Modern genetic techniques are being used to identify and manipulate the genes for biologically active components of food crops, such as natural toxicants (for example, potato glycoalkaloids and kidney bean lectin), anti-nutrients (for example, trypsin inhibitors), and allergens (for example, certain nut proteins). Such developments are at early stages but in the longer term are almost certain to lead to the development of foods that lack these undesirable components.

On an industrial scale, deterioration of fruits and vegetables is a huge problem: for example, the tendency of plant tissue to turn brown at a cut or peeled surface often has to be controlled through the use of preservatives such as sulphite. Damaged cells release the enzyme polyphenol



Credits: [www.isaaa.org](http://www.isaaa.org)

*Genetically modified oil-seed crops*

oxidase, which catalyzes the conversion of monophenols (released from separate subcellular compartments), to Quinone's, which oxidizes to form brown polyphenolic pigments. Genetic modification and other molecular and biochemical techniques are being used to completely unravel the biochemistry of fruit and vegetable ripening and deterioration, and many new methods of preserving these foods, without the use of chemical preservatives, are likely to be developed.

Another possibility generating much interest is the use of crops to provide renewable sources of valuable materials such as vaccines, drugs, bioplastics, and other industrial materials. In parallel, cattle and sheep are being genetically modified to produce pharmaceutical chemicals in their milk, so that drugs can be produced much more efficiently and cost effectively. Although f

ull discussion of this is beyond the scope of this article, there is hope that food crops such as banana could be used to produce and deliver vaccines in tropical regions.

The USDA estimates that of the 430 million acres of cultivated crop land in the US, approximately 40% (170 million acres) is currently used to produce GMO crops. The current lines of GMO crops used in The US have been primarily developed to aid farmers. These GMO crops either have lower production costs or can be expected to have higher yields under various stresses such as predation by specific insects. The targets of this technology have also primarily been major (large acreage) crops such as maize (corn), soybeans, cotton, and canola; however as of 2015, 14 GMO crops were in commercial production. The biotechnology companies that have developed these GMO products are able to reap financial benefits from their investments in this technology by selling seed to farmers. Enhancing the ability of people in underdeveloped countries to have increased vitamin A precursor in their diet though the development of GMO crops has been demonstrated. In this case, 'Golden Rice' engineered to produce this nutrient could reduce the impact of this vitamin deficiency on human health; reducing blindness and death in (some estimates suggest one million per year of) people suffering from vitamin A deficiency. These innovative applications of plant GMO use certainly could be an area of future development. The USDA recently approved several important commercial varieties of potato that carry a gene

from a wild species related to cultivated potato that has increased resistance to the fungal disease late blight- well known since the European potato famine of the late 19th century. It can be expected that both the range of crop plant species engineered for disease resistance, as well as the acreage dedicated to production of these crops will increase in the future

An alfalfa variety has been developed with this technology that has reduced lignin and thus improved digestibility for animals.

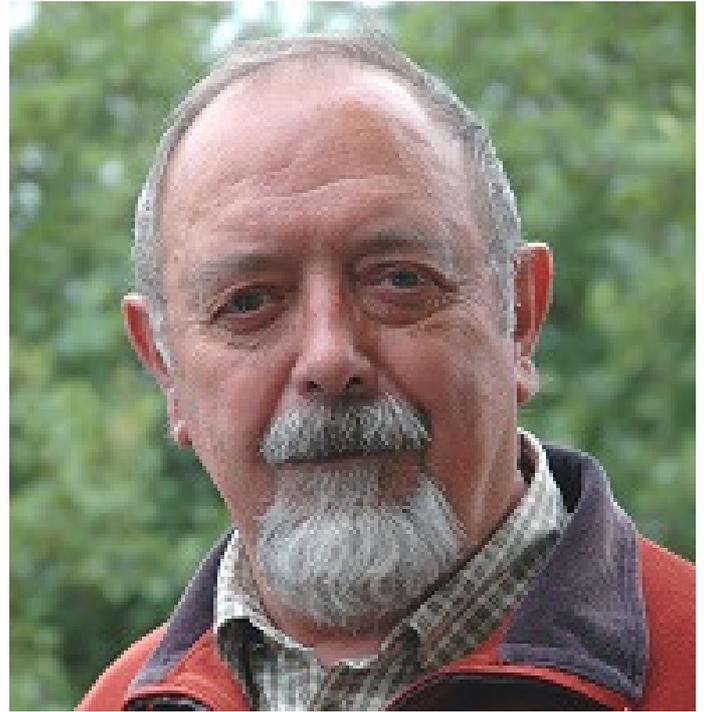
Disease resistance of papaya was one of the first applications of GMO technology several decades ago. These innovative applications of plant GMO use certainly could be an area of future development.

## Ingo Potrykus

JANHAVI A | MS203016 | BTCB 2ND YEAR

Prof. Potrykus was born on December 5, 1933 in Hirschberg/Schlesien, Germany. He studied biology at the University of Cologne and earned his doctorate with a thesis at the Max-Planck-Institute for Plant Breeding Research. After several years at the Institute of Plant Physiology, University of Hohenheim, he became research group leader at the Max-Planck-Institute for Plant Genetics. In 1976, he transferred to Basel to establish the area of plant genetic engineering at the Friedrich Miescher-Institute.

Motivated by the upcoming food crisis problem of malnutrition in developing countries and the potential of gene technology to contribute to food security, the research group is dedicated to genetic engineering projects aimed at improving the yield stability and food quality of rice, wheat, millets and manioc crops. Research focuses on problems which cannot be solved by traditional methods. Results and technology are transferred to developing countries via international research centres, free of costs and restrictions on property rights. The best known result is -Golden Rice-, a new rice variety providing provitamin A, which is widely seen as the model example how to sustainably reduce malnutrition in developing countries. Since his retirement, Ingo Potrykus - as president of the international Humanitarian Golden Rice Board - is devoting his energy to guiding Golden Rice towards sustainable farmers across the many hurdles of a GMO-crop. To this



Source: [biobasedpress.eu](http://biobasedpress.eu)

*Ingo Potrykus - retired since April 1999 - was full Professor of Plant Sciences, specifically of Biotechnology of Plants, at the Institute of Plant Sciences of the ETH Zurich since June 1, 1987.*

end, collaboration has been established with 14 rice institutions in India, China, Vietnam, Bangladesh, Indonesia, and the Philippines.

He has been awarded with ISPMB International Award in Plant Molecular Biology and Biotechnology 2000, American Society of Plant Biologists (ASPB) Leadership in Science Public Service Award 2001, Crop Science of America (CSSA) 2001, CSSA President's Award 2002, European Culture Award in Science 2002, to name a few.

## Henry M. “Hank” Beachell

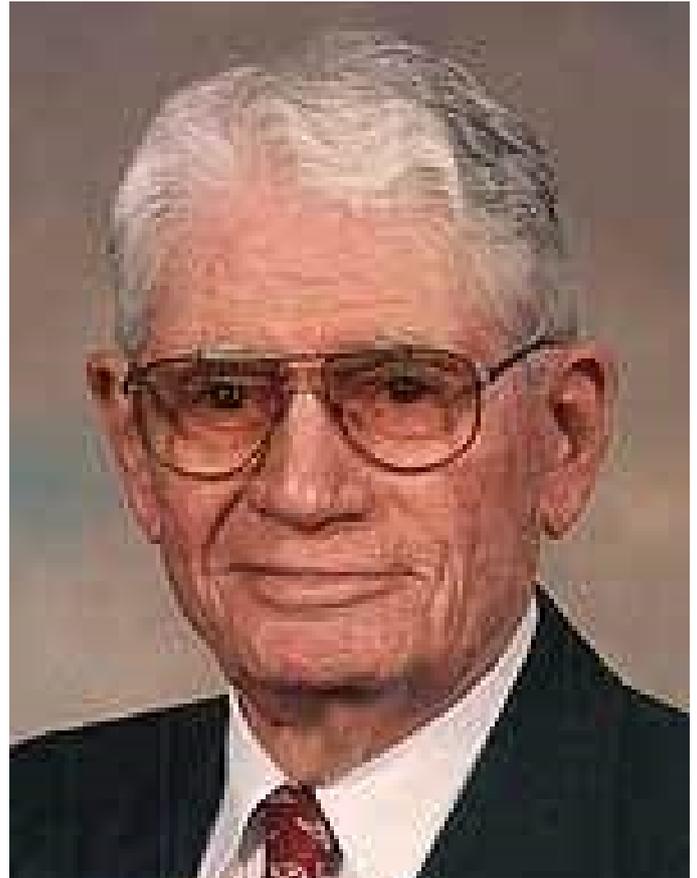
DIA SAJI | BTCZ 1ST YEAR

*Beachell has been called the most important person in rice improvement in the world.*

Henry Monroe "Hank" Beachell born on 21st September, 1906, was an American plant breeder. His research led to the development of hybrid rice cultivars that saved millions of people around the world from starvation.

Born in Waverly, Nebraska, Beachell and his family moved to a corn and wheat farm in western Nebraska. In 1930, he earned a bachelor's degree in agronomy from the University of Nebraska–Lincoln, where he was a member of the Farmhouse fraternity. After obtaining a Master's degree at Kansas State University, Beachell worked for the U.S. Department of Agriculture in Texas. There, he created nine rice varieties, which eventually accounted for more than 90 percent of the U.S. long-grain rice production. He went to International Rice Research Institute (IRRI) in 1963 after his retirement from the DOA. He created a high-yielding rice variety IR8 in 1964, based on the previous work by Peter Jennings. IR8 was officially released by IRRI in 1966. It dramatically increased the yields of Asian rice from 1 or 2 tons per hectare to 4 or 5 tons per hectare. It played a significant part in the Green Revolution.

As farmers planted higher-yielding rice, nutrition improved in many Asian countries, and farmers



Source: geni.com

increased their incomes. Beachell was awarded an honorary doctorate from the University of Nebraska in 1972. Beachell has received many international awards, including the 1987 Japan Prize and 1996 World Food Prize. As a centenarian, Beachell consulted with RiceTec, the only commercial hybrid rice-breeding program in the U.S., up until his death.

In addition to his remarkable rice breeding achievements, Beachell has been a dedicated and enthusiastic mentor to dozens of young research scientists who have become leaders of rice breeding programs worldwide, significantly increasing the quantity and quality of this vital food crop. He died on 13th December, 2006, at the age of 100.

# The Woman Who Created GMOs: The Queen of Agrobacterium

ANANYA KALLIANPUR | BTCZ 3RD YEAR

Mary-Dell Chilton, born February 2nd 1939 in Indianapolis, Indiana, is one of the founders of modern plant biotechnology. She earned a B.S and Ph.D. in chemistry from the University of Illinois. She later completed Postdoctoral work at the University of Washington. She pioneered the field of genetic engineering in agriculture and in her decades long career at Syngenta she founded the research on genetically modified seeds. She is majorly responsible for many of the pest resistant GMO foods we use today. She has published over 100 scientific publications, which is a feat for any man or woman scientist today.

In 1977, as a research faculty member at the University of Washington in Seattle, she led an interdepartmental team that was focused on the microbe that causes crown gall disease in plants. They proved that the microbe causing crown gall disease develops a way to transfer a part of its own genetic material to the gall cell, which causes them to grow. Several years after this she worked with Professor Andrew Binns, Ph.D., at the University of Pennsylvania, where they created the very first transgenic or genetically modified plant. This work led the way for agricultural biotechnology and drastically changed the way in which plant genetic research is conducted.



Source: [americanhistory.si.edu](http://americanhistory.si.edu)

**A leader in the industry:** Since her career began, Chilton has broken the glass ceiling for women in science. She has broken not only gender barriers but she has broken innumerable scientific barriers as well. In a time when few women could educate themselves, she earned a doctorate in Chemistry. As a woman student, Mary-Dell Chilton had a hard time being taken seriously. At the University of Illinois, she tried to enrol in an astronomy course but was told to wait. "The hell with that," she said, and switched to chemistry. Self-confident, she ignored gender challenges and focused on her love of scientific mysteries. At the time many debates sparked from the mystery behind microbial plant diseases.

In Chilton's word, "It was a hot issue then, whether genes could get transferred to a higher plant. There had been claims it was possible, so I spent the first part of my career debunking them. Only later did we find a way that really worked.". Chilton as she remembers the moment that it was proven that bacterial genes had been transferred into plant gall cells, "I had a tape with the radioactivity measurements from our experiment and was doing the calculations at my kitchen table after the kids had gone to bed. I said, 'My God, the DNA is there!' Before that experiment, I was sure that you could not get bacterial genes to recombine with plant genes- there is no homology between the two. I just absolutely did not believe it. It went against everything I had ever learned in school, so I set out to prove this crazy idea was wrong. And it turned out, in the process of trying to prove the idea wrong, I proved it was indeed right.". Her work with the bacteria *Agrobacterium tumefaciens*, was only the beginning in the long list of her contributions to the betterment of agriculture.

Chilton began working at the legacy companies of Syngenta in 1983. Her research resulted in improving the ability of plants to resist insects and disease and tolerate extreme environmental conditions. She has spent a majority of her life dedicated to her love of science and nature and retired at the ripe old age of 79. Her life's work in genetically modified plants has changed the landscape of agriculture today and the food we eat globally. Chilton to this day continues to inspire and touch individual lives within the science community and is a legendary mentor to young laboratory scientists.



Source: [americanhistory.si.edu](http://americanhistory.si.edu)

"I give young people today the same advice I've given throughout my career," she says. "Pursue what you love and what fascinates you and the rest will follow." By pursuing what you love, you can aspire to be the next Mary-Dell Chilton of India.

**Awards and Recognition:** Her work at Syngenta eventually resulted in improving ability of plants to resist insects and disease and even tolerate harsh weather conditions. To honour her many achievements at Syngenta, the company dedicated the Mary-Dell Chilton Centre in 2002.

Over the past few years, she has received various prestigious awards for her ground breaking research that produced the first transgenic plant. The US department of Agriculture (USDA) recently inducted Chilton into its Hall of heroes. A plaque at the entry hall of the USDA serves as a permanent tribute to her. She was also inaugurated into the 2015 National Inventors Hall of fame (NIHF).

Additionally, she is a 2013 World Food Laureate, which is the foremost international award which seeks to recognise the achievements of individuals who have advanced human development by improving the quality, quantity and availability.

UP NEXT



# NEWS BRIEFING



The most exciting developments of the field in the month of October

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# Mademoiselle, which flavoured vaccine would you prefer?

## EDIBLE VACCINES- THE NEW FUTURE

Has eating vaccines ever been a myth?! If so, myths turned real! Get your vaccine at your next food court!

SHIFA AND A. SOPHIA EVANGELINE | BTCZ 3RD YEAR

17 SEPT 2021

*University of California-Riverside (UCR) in collaboration with scientists from UC San Diego and Carnegie Mellon University.*

Since a person's birth, throughout their life, people constantly keep getting vaccinated for various illnesses. If by any chance a few people were living under a rock for the past decade, thanks to the 2020 debacle, everyone, now, has been familiarised with what exactly vaccines are and how they work.

Vaccines are recognized worldwide as one of the most important tools for combating infectious diseases. They are given in the form of injections (shots), liquids, pills, or nasal sprays which help teach one's body's immune system to recognize and defend against harmful microbes. Vaccines contain weakened or inactive parts of a particular organism (antigen) that triggers an immune response within the body.

### **Vaccine, a knight in shining armour for your health**

Vaccines play a crucial role protecting us from various diseases which could be very serious and detrimental to our health. So getting immunity from a vaccine is safer than getting immunity by falling sick with the disease as the severity of symptoms is vastly reduced and not as deadly. There also are a couple of diseases whose vaccines are actually proven to bring about a better immune response than actually falling sick due to the disease.

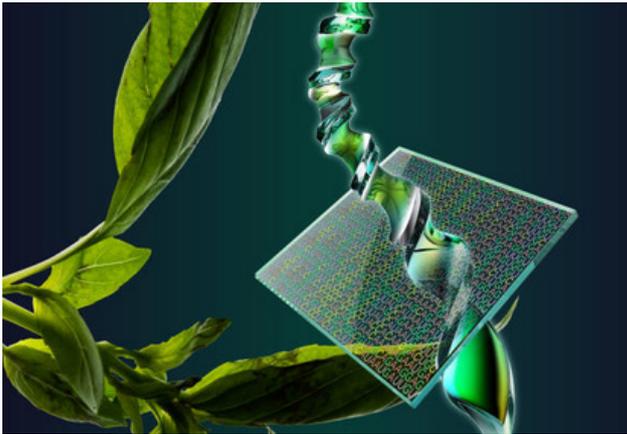
### **Needle free vaccines bringing stability**

Currently there are various delivery systems which include injection via needle and syringe into either subcutaneous fat or into viable skin (epidermis and dermis), vaccine antigens and adjuvants given orally in infants, novel polymeric microneedle systems for delivery of DNA vaccines and nasal and oral delivery systems.

Despite vaccines being highly viable, the currently available vaccines possess shortcomings, such as inefficient triggering of a cell-mediated immune response and the lack of protective mucosal immunity and due to this, recent work has been focused on vaccine delivery systems as an alternative to injectable vaccines, to increase antigen stability and improve overall immunogenicity.

These novel vaccination delivery systems offer several advantages over the injectable preparations including self-administration, reduced cost, stability, and elimination of a cold chain. There has been recent interesting developing edible vaccines with the help of molecular farming, having plants synthesise medications and vaccines. Using mRNA technology developed from genetic engineering and synthetic biology, scientists

can introduce brand new biochemical pathways into plant cells—or even wholeplants—essentially turning them into single-use bioreactors. This technique of employing plant-based mRNA vaccines is already being used to treat Gaucher disease and shows promising results.



Credits: Yuujji

### **Synthetic mRNA, a friend in need-**

mRNA vaccines are synthetic, information-carrying molecules made in laboratories by scientists. They trick the body into producing a part of the micro-organism's proteins itself. This mRNA after entering the host, serves as a manual for the host's cells, who read it as instructions to build the viral protein and therefore create some of the microbe's molecules themselves. These proteins are solitary and do not assemble to form a virus. The immune system then detects these viral proteins and starts to produce a defensive response to them.

Here, the mRNA vaccines can be successfully delivered into the part of plant cells where it will replicate, demonstrating that plants can produce enough mRNA to rival a traditional shot.

### **Tailor made fruit vaccines for you-**

The initial idea of molecular farming was

conceived in 1986. Molecular farming is the genetic modification of plants to synthesize proteins and other biomaterials for commercial use. A vision of molecular farming is to produce edible therapeutic vaccines and medications that can be consumed as fruits or vegetables. Using genetic engineering, synthetic biology, and nanotechnology, scientists can introduce biochemical pathways in plants and turn them into single-use bioreactors that can synthesize the desired proteins.

Currently, microorganisms and animal cells are genetically modified and cultured to produce commercially useful therapeutics. A major downside of this biomanufacturing\* process is contamination. An alternative approach - plants, which can be genetically engineered to replace microorganisms and mammalian cells. A vector\* carrying the foreign DNA for the desired protein is introduced into the plant cells. The foreign DNA is integrated into the plant genome and the plant's protein machinery is hijacked into producing the desired proteins. The resulting therapeutic proteins are stored in seeds and other plant cell compartments that are easily extracted.

Researchers at the University of California-Riverside are working on turning edible plants like spinach and lettuce into mRNA vaccine factories. The key to making this work is chloroplasts. Chloroplasts are the site of photosynthesis. They also exhibit untapped

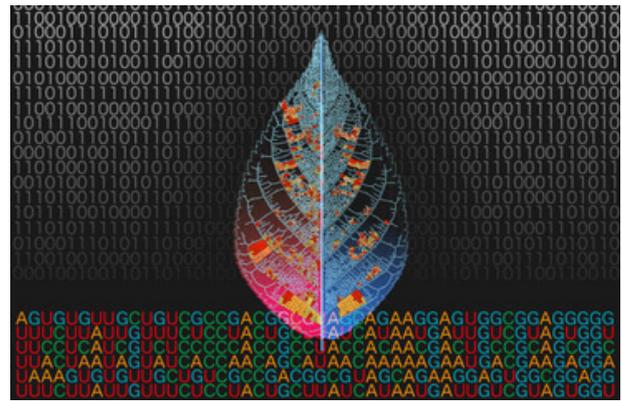
potential for producing desired proteins, since chloroplasts can express genes that are not naturally part of the plant genome.

The major advantage of such plants is that they are easy and cheap to grow. It is easier to avoid contamination and the process is environmentally sustainable. An additional advantage is our vast knowledge of agriculture, which makes it easier to cultivate such plants. Plant-produced vaccines are far more potent. Most traditional vaccines require the use of adjuvants\* to enhance an immune response. In plants, the resulting vaccine is a soup of plant biomolecules. These molecules act as an adjuvant and stimulate an immune response. This lowers the production cost.

The U.S. Food and Drug Administration approved the first and only human use of plant-derived therapeutic protein for treating Gaucher disease\*. Canada-based Medicango and England's GlaxoSmithKline developed a promising COVID-19 vaccine candidate grown in the Australian weed, *Nicotiana benthamiana*. The vaccine mimics the surface layer of the SARS-CoV-2 to induce an immune response. The plant-derived vaccine is currently in late-stage clinical trials.

Despite the promising results, researchers have stated that the number of individuals immunized with plant-based vaccines elicited an immune response that is lower than individuals immunized with traditional vaccines.

Nevertheless, the rise of CRISPR and other gene-editing tools make it a possibility to generate a good immune response from plant-produced vaccines. As of now, plant-based therapeutics are in the preclinical development phase. Even if technologically possible, it will be set back due to the public's animosity towards GMOs.



credits: Yuuji

# A new insight into cellular recycling

Discovery of functioning of protein responsible for recycling cellular material

**NIKHILA MOHAN & SHRUSHTI SHENOY | BTCZ 2ND YEAR**

04 OCT 2021

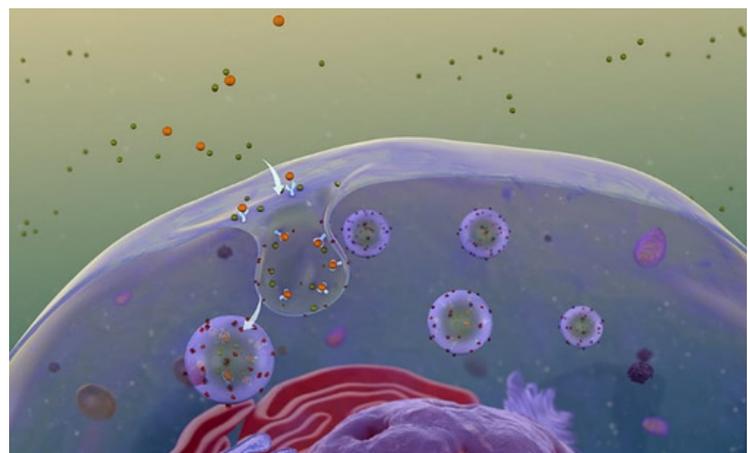
*Indian Institute of Science (IIT), Gandhinagar and the Indian Institute of Science, Bengaluru*

In a new study, researchers from the Indian Institute of technology (IIT) Gandhinagar and the Indian Institute of Science Bengaluru, have demonstrated the functioning of a motor protein responsible for recycling material inside a cell. These findings are crucial since faulty recycling in cells is responsible for many disorders including Alzheimer's disease, Huntington's disease, and Cancer.

Animal cells take in extracellular materials, a few proteins and lipids by a process called Endocytosis. Some of the endocytosed components are recycled back to the plasma membrane by a process known as recycling endocytosis. The material taken in is sorted within sorting endosomes; whatever is meant for recycling to the plasma membrane is then sent into a tubular membranous network called the Tubular Recycling Endosomes (TRE).

Motor proteins play a key role in recycling endocytosis as they generate forces to lift the cargo and carry them to the cell periphery along pre-designated lanes of microtubules. The current study shows the mechanism of functioning of one such motor protein— KIF13A, belonging to the kinesin-3 family. The study performed by Subba Rao Gangi Setty and team illustrates how a family of enzymes called guanosine tri phosphatases (GTPases) regulate the activity of KIF13A, which in turn control what happens to the TREs.

KIF13A, acts in pairs to ferry TREs along microtubules. Wild type (WT) KIF13A (or when not bound to cargo) exists as a single, inactivate molecule. The researchers, led by Virupakshi Soppina of IIT Gandhinagar, reveal that a protein called Rab22A, a GTPase, binds to the neck region of inactive KIF13A monomers to activate them – “like a zipper”. The researchers performed cloning and transfection experiments on cultured cells, followed by live cell imaging direct fluorescence spectroscopy and in vitro single molecule reconstitution assays to study the interaction between KIF13A and Rab22A. they found out that binding of Rab22A Relieves a kink in the structure induced by proline, and this opens up the KIF13A structure to pair up. If two



*Credits: indiabioscience.org*

inactivate KIF13A monomers are akin to either side of a zipper when it is open, the Rab22A can be compared to the slider that joins both sides and help them pair up. Rab22A is the molecular switch that controls the two states of KIF13A- active and inactive. This study is the first of its kind to report a Rab protein regulating activity of a motor protein to facilitate intracellular transport. This information is vital to further understand disease arising from faulty Rab-motor protein interaction. Also, KIF13A has been known to play a role in trafficking of viral particles- understanding its regulation can be a step forward in prevention or treatment of viral diseases.



# 'Junk DNA' defines differences between humans and chimps

What makes us human? The answer may be found in overlooked DNA

RAKSHITHA B R | BTCZ 2ND YEAR

08 OCT 2021

Lund University, Sweden

The chimpanzee is our closest living relative in evolutionary terms and research suggests our kinship derives from a common ancestor. About five to six million years ago, our evolutionary paths separated, leading to the chimpanzee of today, and Homo Sapiens, humankind in the 21st century.

In a new study, stem cell researchers at Lund examined what it is in our DNA that makes human and chimpanzee brains different -- and they have found answers.

"Instead of studying living humans and chimpanzees, we used stem cells grown in a lab. The stem cells were reprogrammed from skin cells by our partners in Germany, the USA and Japan. Then we examined the stem cells that we had developed into brain cells," explains Johan Jakobsson, professor of neuroscience at Lund University, who led the study.

Using the stem cells, the researchers specifically grew brain cells from humans and chimpanzees and compared the two cell types. The researchers then found that humans and chimpanzees use a part of their DNA in different ways, which appears to play a considerable role in the development of our brains.

"The part of our DNA identified as different was unexpected. It was a so-called structural variant of DNA that were previously called "junk DNA," a long repetitive DNA string which has long



Credits: [www.sciencedaily.com](http://www.sciencedaily.com)

been deemed to have no function. Previously, researchers have looked for answers in the part of the DNA where the protein-producing genes are -- which only makes up about two per cent of our entire DNA -- and examined the proteins themselves to find examples of differences."

The new findings thus indicate that the differences appear to lie outside the protein-coding genes in what has been labelled as "junk DNA," which was thought to have no function and which constitutes the majority of our DNA. "This suggests that the basis for the human brain's evolution are genetic mechanisms that are probably a lot more complex than previously thought, as it was supposed that the answer was in those two per cent of the genetic DNA. Our results indicate that what has been significant for the brain's development is instead perhaps hidden in the overlooked 98 per cent, which appears to be important. This is a surprising finding."

# Lizard Regenerates Perfect Tail Using Stem Cells!

Introducing dorsoventral patterning in adult regenerating lizard tails with gene-edited embryonic neural stem cells.

**SRIJITA DAS | BTCZ 1ST YEAR**

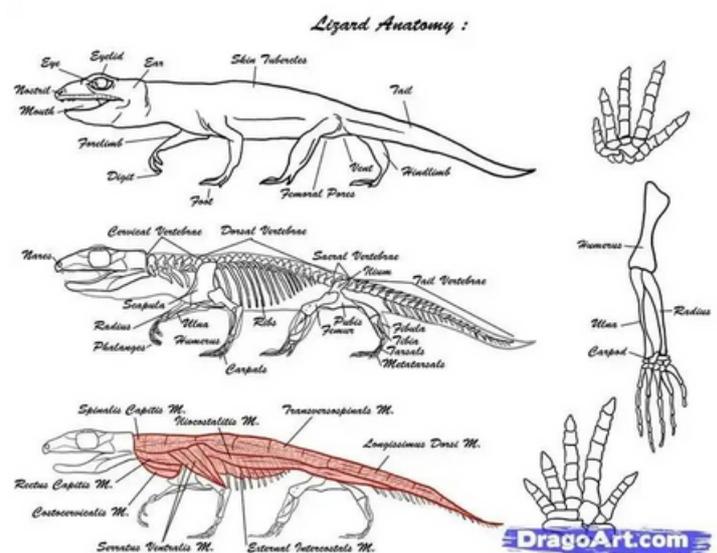
14 OCT 2021

*University of Southern California*

Lizards can regrow severed tails, making them the closest relative to humans that can regenerate a lost appendage. But in lieu of the original tail that includes a spinal column and nerves, the replacement structure is an imperfect cartilage tube. "This is one of the only cases where the regeneration of an appendage has been significantly improved through stem cell-based therapy in any reptile, bird or mammal, and it informs efforts to improve wound healing in humans," said the study's corresponding author Thomas Lozito. These new and improved lizard tails exhibit what is known as "dorsoventral patterning" -- meaning they have skeletal and nerve tissue on the upper or dorsal side, and cartilage tissue on the lower or ventral side. "Lizards have been around for more than 250 million years, and in all that time no lizard has ever regrown a tail with dorsoventral patterning, until now," said Lozito. "My lab has created the first regenerated lizard tails with patterned skeletons. "To achieve this, the team of scientists analyzed how lizard tails form during adult regeneration, compared to embryonic development. In both cases, neural stem cells (NSCs) -- the stem cells that build the nervous system -- play a central role. Adult NSCs produce a molecular signal that blocks skeletal and nerve formation and encourages cartilage growth, effectively "ventralizing" both sides of the tail. This results in the cartilage tube typical of regenerated tails. Even in the absence of this

ventralizing signal, adult NSCs are incapable of generating new nerve tissue for the dorsal side of the tail. In contrast, embryonic NSCs produce this "ventralizing" signal only in the cartilage region that becomes the lower or ventral side of the tail. Meanwhile, in the absence of this signal, the upper or dorsal side develops skeletal and nerve tissue. Thus, the tail acquires the intricate dorsoventral patterning characteristic of original embryonic appendages. However, if embryonic NSCs are implanted into adult tail stumps, they respond to the ventralizing signal, and fail to develop into dorsal structures.

To overcome these obstacles, Lozito's team used gene-editing tools to make embryonic NSCs unresponsive to the ventralizing signal, and surgically implanted these cells into adult tail stumps -- leading to the regeneration of perfect tails.



Credits: www.dragoart.com

# Biotechnological development of plants for space agriculture

Plant Biotechnology to improve nutritional quality of space crops

**B.KAVYA | BTCB 2ND YEAR**

14 OCT 2021

*Laboratory of Space Biology, Institute of Urban Agriculture,  
Chinese Academy of Agricultural Sciences*

The ideal plant for cultivation in space would provide as many nutrients from as few inputs as possible. Biotechnology could be used to produce a potato cultivar suitable for humans in space.

We propose a Whole-Body Edible and Elite Plant (WBEEP) strategy for space crop improvement. Relying on plant biotechnology, the WBEEP strategy aims to develop crops with more edible parts, richer nutrient content, higher yields, and higher mineral nutrient use efficiencies for space farms.

Why do we select potato for space agriculture?

Potato (*Solanum tuberosum* L.) is believed to be one of the top contenders for space agriculture due to the following advantages:

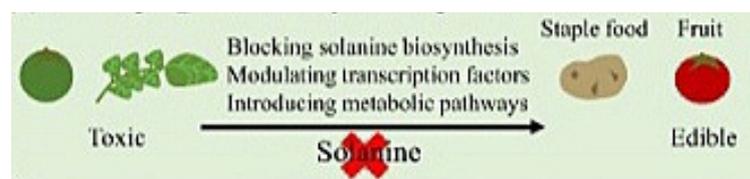
- (1) high harvest index and tuber yield and carbohydrate-rich tubers that can provide a large amount of energy for humans.
  - (2) simple horticultural and food processing requirements.
  - (3) high tolerance against stresses with the ability to develop normally during spaceflight.
- Importantly, potatoes can be asexually propagated through tubers and sexually propagated through seeds. Asexual reproduction can ensure the regeneration of food resources and stable nutritional value, while sexual reproduction can guarantee a higher propagation

coefficient and lower storage and transportation costs.

However, potatoes cannot be efficiently cultivated in space until inherent defects related to their high solanine content, low yield and nutrient accumulation, and low fertilizer use efficiency are overcome. Below, we describe a WBEEP strategy for potato improvement that might create a WBEEP-potato for space farming.

Developing whole-body edible plant for WBEEP-potato.

Plants whose whole bodies are edible would be desirable for space farms because they can bring humans more food and reduce waste. However, potato stems, leaves, and berries are inedible. The aerial parts of potato plants contain accumulated solanine (primarily  $\alpha$ -solanine and  $\alpha$ -chaconine), which defends against pests and pathogens but is toxic to humans. In space farming systems, with highly controlled environments, solanine-mediated plant resistance would be unnecessary.



Credits: [www.naturecommunications.com](http://www.naturecommunications.com)

If solanine were removed, the whole potato plant could potentially become edible. To block the accumulation of solanine in potato plants, biosynthesis can be targeted. For example, silencing or mutating genes encoding the cytochrome P450 enzyme GAME4, the dioxygenase DPS or the AP2/ERF transcription factor GAME9 greatly reduced solanine content. Tomatoes can also produce toxic solanine (primarily  $\alpha$ -tomatine) but can convert solanine into the non-bitter and non-toxic glycoside esculeoside A in fruits. Since solanine metabolism involves several enzymatic reactions in common between potatoes and tomatoes, it might be possible to introduce solanine metabolism genes from tomatoes into potatoes to reduce solanine accumulation.

# Biological activity of chitosan inducing resistance efficiency of rice after treatment with fungal based chitosan

Effectiveness of FC treatments for use in agriculture as a potential biostimulant.

S.KHIRAN | BTCB 2ND YEAR

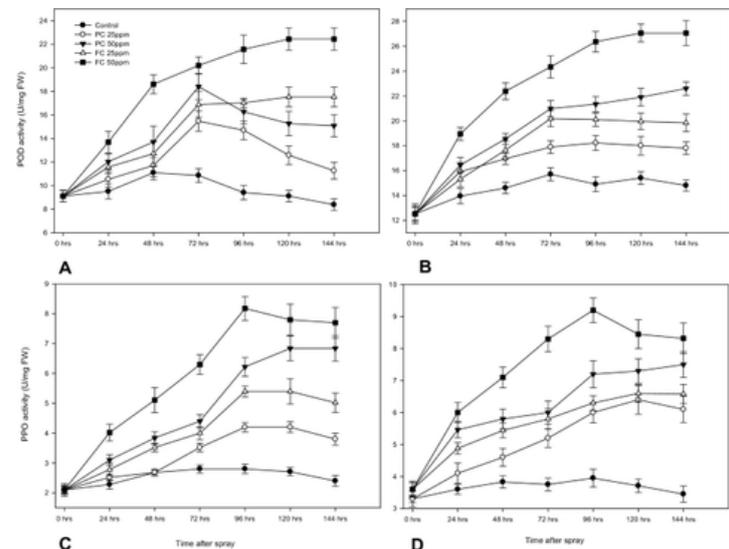
14 OCT 2021

Rice (*Oryza sativa* L., Poaceae) is a vital cereal grown in a wide array of ecosystems, as one of the top sustaining foods for the global population. The primary stress comes from trying to protect the crop from pathogen-caused diseases and insect pests. However, some of these chemical treatments have posed negative effects on the micro and macro environmental fauna, increasing the impacts from bacterial leaf blight (BLB), one of the most devastating rice pathogens, *Xanthomonas oryzae* pv. *oryzae* (Xoo) that causes severe yield loss.

Reduced pathogen resistance and management of the left-over rice stubble are among the most critical challenges faced in rice cultivation. A novel and eco- friendly strategy to synthesize 'Fungal Chitosan' (FC) from *Aspergillus niger* using rice straw could serve as a sustainable treatment approach to improve disease resistance and yields while effectively managing the rice stubble waste.

The FC treatment promoted germination as well as growth parameters in rice varieties, TN1 (high yielding-susceptible) and PTB33 (low yielding-resistant) better than commercial chitosan (PC). Treatments of exogenously applied FC to plants produced direct toxicity to Xoo and reduced the BLB disease index by 39.9% in TN1. The capability of FC to trigger a cascade of defense

pathways was evident from the measurable changes in the kinetics of defense enzymes, peroxidase (POD), and polyphenol oxidase (PPO). FC treatment increased POD levels in TN1 by 59.4%, which was 35.3% greater than that of untreated PTB33. Therefore, the study also demonstrated the protective agent against BLB of rice (*Oryza sativa*) that could be produced from stubble waste and improve rice stubble management strategies.



CREDITS: www.nature.com

The graph shows effects of fungal chitosan (FC) and product chitosan (PC) treatments on POD activity in rice plants (A—TN1, B—PTB33) and on PPO activity in rice plants (C—TN1, D—PTB33).

# Helping coral reefs survive under climate change

Biologist calls for extending the natural adaptive capacity of corals through nature-based approaches.

**RUVIZA MUSKAN | BTCZ 2ND YEAR**

12 OCT 2021

*University of Konstanz*

Coral reefs\* are the rainforests of the seas, and 30 percent of all marine biodiversity depends on them. In economic terms, they support the livelihoods of around a billion people around the globe. At the same time, coral reef ecosystems are severely threatened by climate change. In an article published in the current issue of the online journal *Nature Reviews Earth & Environment*, Professor Christian Voolstra from the University of Konstanz, along with an international group of experts, describes how to extend and harvest natural adaptive processes to increase the resilience of corals in order to increase the resilience of the reef ecosystems they build. The researchers call for implementing nature-based approaches and developing associated methods to extend the natural heat resilience of corals. The objective in a way is to provide an arsenal of methods that can help corals help themselves.

The 1.5-degree climate warming target is not enough- The historically close adaptation of corals to their surrounding climate is their Achilles heel under climate change. Even the goal of limiting global temperature rise to 1.5 degrees is not enough to save coral reefs.

Restoring coral reefs by means of fragmenting corals to grow new colonies has not proven very successful, because the same corals are used that bleached before. Therefore, the researchers are concentrating on methods that can improve the survival of restored coral.



CREDITS: <https://www.nature.com/>

Resistant and less resistant colonies- One option is to select better source material. Not all corals demonstrate the same level of sensitivity. For example, there are reefs with extremely resistant corals that retain their properties when used as material for restoring colonies. To identify such coral species, Voolstra's research group developed the rapid test CBASS (Coral Bleaching Automated Stress System) to determine the heat resistance of corals. Voolstra recently applied this test during field work in the Red Sea. "We observed a large natural variation of very resistant and very susceptible colonies even within the same reef," says Voolstra.

Getting coral offspring used to harsher environmental conditions- Another approach to optimize restoration is making the corals more resistant through conditioning. The method of "environmental hardening" introduces very young corals, or coral larvae, to harsher environmental conditions



CREDITS: <https://www.enn.com>

by gradually applying a low level of stress. Furthermore, as corals live in symbiosis with their associated algae as so-called holobiont\*, this symbiosis\* can be used to increase the stress tolerance of the corals.

# BIOMASS INTO BIOFUELS!

Advances in the bio and chemo catalytic of biomass components into biofuels and value added chemicals

**JENOLEENA G | BTCZ 3RD YEAR**

18 OCT 2021

Biomass has been identified as a renewable alternative to fossil resources in producing promising transportation biofuels as well as highly valuable products. The complex composition of naïve biomass makes it difficult to be utilized. Pre-treatment is crucial for the further utilization. Saddler and coworkers reported the improved activity from the use of enzymes in tuning the hydrolysis of cellulose through introducing acid functions into the structure of lignin for the pre-treatment. They found that the use of 16% Na<sub>2</sub>SO<sub>3</sub> or 32% C<sub>2</sub>H<sub>6</sub>Na<sub>4</sub>O<sub>12</sub> into the pulp would not induce clear delignification exhibiting the similar behavior to the proper dosage of HSO<sub>3</sub><sup>-</sup> and HCO<sub>3</sub><sup>-</sup> into the structure of lignin. It provides a new way to utilize enzymes for biomass pre-treatment.

Pyrolysis is one of crucial tools to upgrade biomass into value-added products. Bi and coworker studied the co-operation effects of catalyst component on the pyrolysis process, compared with the unitary candidate in the microwave reactor. They investigated the deoxygenation behavior and reaction kinetics including pyrolysis kinetics and pathway of biomass-derived monomers (i.e., cellulose, hemicellulose, and lignin). They found the activation energy of 10KP/10Bento and 10KP/10Clino (the mixture of 10% K<sub>3</sub>PO<sub>4</sub> plus 10% clinoptilolite) was a little lower or close to those of other candidates at 30 wt.%. They got the conclusion that catalyst mixtures could

enhance the catalytic activity clearly, which is attractive to lower the synthesis cost of bio-oils and biochar.

Biomass-derived bisphenol A (BPA) is a widely utilized fine chemical in various areas (e.g., medicine and organic synthesis), while the residual BPA is difficult to be degraded by nature. Yan and coworkers reported a photocatalytic route to degrade BPA using a porous ZnO photocatalyst. The effects of various parameters were investigated and porous ZnO photocatalyst can remove 99% BPA in 1 h. The results of EPR analysis confirmed that H<sup>+</sup>, ·O<sup>-2</sup>, and e<sup>-</sup> played an important role in the removal efficiency. This study offers a photocatalytic route to deal with biomass-derived chemicals.

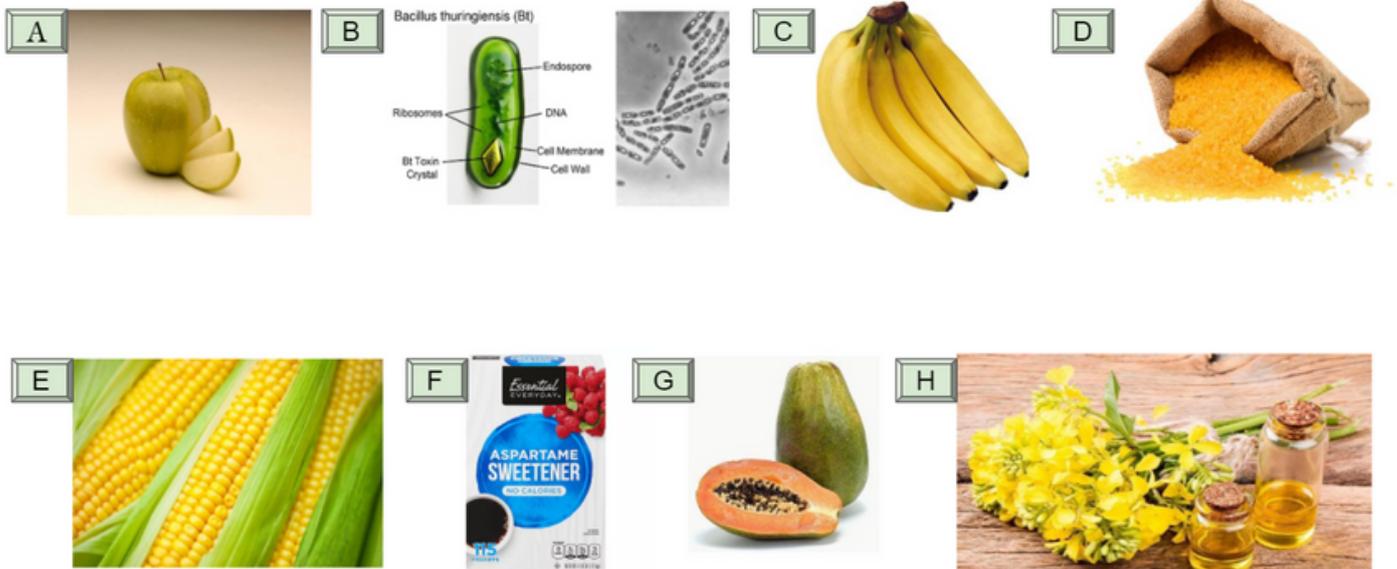
A variety of biomass-derived chemicals can be selectively produced from biomass, among which cyclopentanol can be used as a versatile eco-friendly solvent in various applications. Zhang and coworkers fabricated a bimetallic Ru-Mo catalyst for hydrogenation-rearrangement reactions of furfurals, achieving 89.1% cyclopentanol yield using 1%Ru-2.5%Mo/CNT pre-reduced at 600°C. The weak acidity and strong hydrogenation activity of the bimetallic Ru-Mo catalyst were found to be important for the synthesis of cyclopentanol from furfural-like compounds

# PIC YOUR QUIZ

MEENA CHANDAR | BTCB 3RD YEAR  
 RIA GURUNG | BTCB 1ST YEAR

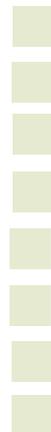
## INSTRUCTIONS:

1. Here we have a grouped of labeled pictures.
2. Below it is a set of questions.
3. The task is to match the answer with the respective question with the help of given pictures.
4. Be sure to pick your answer well.



{GM- Genetic Modification }

1. Genetic modification will save this from extinction due to Panama disease-
2. Genetic modification enriched this with vitamin A-
3. This is produced from GM E. coli-
4. GM altered the fatty acid composition-
5. Organism used in GM corn and cotton-
6. Most widely grown crop in USA and GM for insect resistance-
7. GM saved this from the ringspot disease in Hawaii-
8. GM to prevent browning and prevent food waste-



# GLOSSARY

*Genetically modified food: the potential and hazards, PG 01-02*

- 1 Herbicide:** Substances used to control unwanted plants.
- 2 DDT:** Dichlorodiphenyltrichloroethane is an insecticide used in agriculture.
- 3 Interbreeding:** The act of Mixing different species or varieties of animals or plants to Produce hybrids.

*The Truth about natural foods, PG 03*

- 1 Transgenes -** A transgene is a gene that has been transferred naturally, or by any of a number of genetic engineering techniques from one organism to another.
- 2 Epigenetics -** Epigenetics is the study of how cells control gene activity without changing the DNA sequence.

*Genetically Modified Foods: The Myths and the Truths, PG 06*

- 1 Neurotransmitter:** Often referred to as body's chemical messenger, these are molecules used by the nervous system to transmit messages between neurons or from neurons to muscle.
- 2 CRISPR/Cas 9:** It is a technology used to edit genes, adapted from a naturally occurring genome editing system seen in archaea and bacteria.
- 3 Stop Codon:** It is a trinucleotide sequence within a messenger RNA (mRNA) molecule that signals a halt in protein synthesis. The three stop codons are; amber (UAG), opal or umber (UGA) and ochre (UAA).

*Mademoiselle, which flavoured vaccine would you prefer? PG 15*

- 1 Biomanufacturing:** A type of manufacturing in the biotechnology industry, which utilizes biological systems to produce commercially useful biomaterials.
- 2 Vector:** A DNA molecule used as a vehicle to carry a desired DNA sequence into another cell.
- 3 Adjuvants:** Molecules administered in conjunction with an antigen to generate a stronger immune response.
- 4 Gaucher disease:** An inherited lysosomal storage disorder, which results in buildup of fat-laden Gaucher cells in bone marrow, liver, and spleen.

*Helping coral reefs survive under climate change, PG 26*

- 1 Coral reef –** a coral reef is an underwater ecosystem characterized by reef building corals.
- 2 Holobiont –** is an assemblage of a host and the many other species living in or around it.
- 3 Symbiosis –** interaction between two different organisms living in close physical association, typically to the advantage of both.

## REFERENCES

*Genetically modified food: the potential and hazards, pg 01-02*

1. Weasel, Lisa H. 2009. *Food Fray*. Amacom Publishing.

*The Truth about natural foods, pg 03*

1. Parrott, Wayne. "Genetically modified myths and realities." *New Biotechnology* 27.5 (2010): 545-551.
2. <https://en.wikipedia.org/wiki/Transgene>
3. <https://medlineplus.gov/genetics/understanding/howgeneswork/epigenome/>

*Between myth and reality: genetically modified maize, pg 04-05*

1. <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1082.2983&rep=rep1&type=pdf>

*Genetically Modified Foods: The Myths and the Truths, pg 06*

1. <https://www.freethink.com/science/gene-edited-tomato>
2. <https://www.ncbi.nlm.nih.gov/books/NBK513311/>
3. <https://www.nature.com/articles/s41598-017-06400-y>

*Future of Genetically Modified Foods, pg 07*

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1115027/>
2. <https://gmo.uconn.edu/topics/the-future-of-gmo-crops/>

*Ingo Potrykus, pg 09*

1. <https://ethz.ch/en/the-eth-zurich/organisation/who-is-who/retired-professors/details.Nzc4MjA=.TGlzdC80MDEsMTk1NzY4MzcwOQ==.html>
2. <http://www.academyofsciences.va/content/accademia/en/academicians/ordinary/potrykus.html>
3. Picture 1- <https://www.biobasedpress.eu/2018/12/can-we-engineer-life-4-6-golden-rice/ingo-potrykus/>

*Henry M. "Hank" Beachell, pg 10*

1. [https://en.wikipedia.org/wiki/Henry\\_Beachell](https://en.wikipedia.org/wiki/Henry_Beachell)
2. <https://agrifetoday.tamu.edu/1996/10/18/beachell-wins-world-food-prize/>
3. [https://beaumont.tamu.edu/eLibrary/Newsletter/2006\\_Sept\\_Newsletter.pdf](https://beaumont.tamu.edu/eLibrary/Newsletter/2006_Sept_Newsletter.pdf)
4. <https://www.geni.com/people/Henry-M-Beachell/6000000032624018996>

*Mary-Dell Chilton, pg 11*

1. [https://en.wikipedia.org/wiki/Mary-Dell\\_Chilton#Career\\_and\\_research](https://en.wikipedia.org/wiki/Mary-Dell_Chilton#Career_and_research)
2. <https://www.tspr.org/post/woman-who-created-gmos>
3. <https://www.syngenta.com/fr/node/1301>
4. Images : <https://americanhistory.si.edu/american-enterprise/new-perspectives/only-one-room/mary-dell-chilton>

*Mademoiselle, which flavoured vaccine would you prefer? pg 15*

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5287301/><https://singularityhub.com/2021/08/17/the-next-vaccine-could-be-edible-and-grown-in-a-plant/>
2. <https://www.genengnews.com/news/plants-as-mrna-factories-for-edible-vaccines/>

*A new insight into cellular recycling, pg 18*

1. <https://indiabioscience.org/news/2021/a-new-insight-into-cellular-recycling>

*Future of Genetic Testing for Preventive & Diagnostic Health, pg 20*

1. <https://www.financialexpress.com/>

'Junk DNA' defines differences between humans and chimps, pg 21

1. <https://www.sciencedaily.com/releases/2021/10/211008105736.htm>

Lizard Regenerates Perfect Tail Using Stem Cells! pg 22

1. <https://www.sciencedaily.com/releases/2021/10/211014141958.htm>

Biotechnological development of plants for space agriculture, pg 23

1. Wheeler, R. M. *Potato and human exploration of space: some observations from NASA-sponsored controlled environment studies.*

2. Zhang, C. et al. *Genome design of hybrid potato.*

Biological activity of chitosan inducing resistance efficiency of rice after treatment with fungal based chitosan, pg 25

1. Kalaivani, K., Maruthi-Kalaiselvi, M. & Senthil-Nathan, S. *Seed treatment and foliar application of methyl salicylate (MeSA) as a defense mechanism in rice plants against the pathogenic bacterium, Xanthomonas oryzae pv. oryzae. Pest Biochem. Physiol. Nature.com*

Helping coral reefs survive under climate change, pg 26

1. <https://www.sciencedaily.com/releases/2021/10/211012130712.htm>

BIOMASS INTO BIOFUELS! pg 28

1. <https://www.frontiersin.org/articles/10.3389/fbioe.2021.769995/full>

PIC YOUR QUIZ (credits for images), pg 29

1. Arctic apple- <https://www.okspecialtyfruits.com/arctic-apples-help-show-fruits-true-quality/>

2. Bacillus thuringiensis- <https://www.indiamart.com/proddetail/bacillus-thuringiensis-8656353591.html>

3. <https://u.osu.edu/cmifsud7588/2019/05/18/bacillus-thuringiensis/>

4. Cavendish Banana- <https://www.e-fresco.io/cavendish-banana-teul.html>

5. Corn- <https://www.mdanderson.org/publications/focused-on-health/gmos-cancer.h15-1589046.html>

6. Aspartame-

[https://www.davessuperduper.com/shop/pantry/cooking\\_and\\_baking\\_needs/sugars\\_and\\_sweeteners/essential\\_ever\\_yday\\_sweetener\\_aspartam](https://www.davessuperduper.com/shop/pantry/cooking_and_baking_needs/sugars_and_sweeteners/essential_ever_yday_sweetener_aspartam)

7. [e\\_packets/p/5778871](https://www.davessuperduper.com/shop/pantry/cooking_and_baking_needs/sugars_and_sweeteners/essential_ever_yday_sweetener_aspartam)

8. Canola Oil- <https://www.ariyancorp.com/canola-oil-2/>

9. Rainbow Papaya- <https://www.okspecialtyfruits.com/the-fascinating-story-of-rainbow-papayas/>

10. Golden rice- <https://source.wustl.edu/2020/02/no-clear-path-for-golden-rice-to-reach-consumers/>

***PIC YOUR QUIZ ANSWERS:*****1-C-** Cavendish Banana**2-D-** Golden rice**3-F-** Aspartame**4-H-** Canola Oil**5-B-** *Bacillus thuringiensis***6-E-** Corn**7-G-** Rainbow papaya**8-A-** Arctic Apple

# BIOGENESIS

OCTOBER 2021 ISSUE

## GENETICALLY MODIFIED FOODS

### THE MYTHS & THE TRUTHS

Thankyou for reading! Stay tuned for more.

#### THE BIOGENEAC ASSOCIATION

TEACHER CO-ORDINATOR : Ms. Nivedita Patil

SECRETARIES: Shruthi Rajaram | Rupashri Balaraman  
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