

MOUNT CARMEL COLLEGE
BIOGENEAC ASSOCIATION

JANUARY 2022 ISSUE OF THE

biogenesis

THE WONDERS OF BIOTECHNOLOGY

PCR - BIOTECH'S
MASTERPIECE

PG 04

GENETICALLY
MODIFIED
MOSQUITOS

PG 06

THE QUEST FOR
HAPPINESS
Mind Numbing in
PTSD Patients

PG 10

HEALTH AND
HAPPINESS OF YOUR
CHILD LIES IN THE
OBTUSE STORY OF
INHERITANCE

PG 12

E.COLI - THE
BACTERIA OF
BIOTECHNOLOGY

PG 15

BIOGENESIS

THE OFFICIAL NEWSLETTER OF BIOGENEIAAC ASSOCIATION
MOUNT CARMEL COLLEGE

CONTENTS

1. FEATURE ARTICLES PG 04

| | |
|--|-------|
| <i>PCR - Biotech's Masterpiece</i> | pg 04 |
| <i>Rise of Genetically-Modified Mosquitos</i> | pg 06 |
| <i>New Tissue Clearing Methods Offer A Window Into The Brain.....</i> | pg 08 |
| <i>The Quest For Happiness: Biotechnology and Memory Numbing in PTSD Patients.....</i> | pg 10 |
| <i>Health And Happiness Of Your Child Lies In An Obtuse Story Of Inheritance</i> | pg 12 |
| <i>E.Coli - The Bacteria of Biotechnology</i> | pg 15 |
| <i>Development in Food Biotechnology</i> | pg 17 |

2. NEWS BRIEFING PG 19

Human and Medical Biotechnology -

| | |
|---|-------|
| <i>Friend Or Foe? The Anthrax Toxin and Its Ability to Alleviate Pain</i> | pg 20 |
| <i>mRNA Vaccine Technology has Assisted in the Repair of Broken Hearts in Mice.....</i> | pg 22 |

Animal Biotechnology -

| | |
|---|-------|
| <i>First Clinical-Grade Transplant of Gene-Edited Pig Kidney into Brain-Dead Humans.....</i> | pg 23 |
| <i>CIIE.CO in Partnership with GFI India Releases Study of Cultivated Meat Ecosystem.....</i> | pg 25 |

Plant and Agricultural Biotechnology -

Biochemical and structural characterization of quizalofop-resistant wheat acetyl-CoA carboxylase..... pg 27

Industrial and Environmental Biotechnology -

What if you got a chance to turn trash into treasure, sounds cliché right?..... pg 28

4. MISCELLANEOUS

PG 30

Gallery pg 30

Glossary pg 33

References pg 34

PCR - Biotech's Master Piece

JAYALAKSHMI MARNENI | 2ND YEAR MSC BIOTECHNOLOGY

INTRODUCTION

Polymerase Chain Reaction (PCR) is used to make millions of copies of a target piece of DNA. It is an indispensable tool in modern molecular biology and has transformed scientific research and diagnostic medicine.

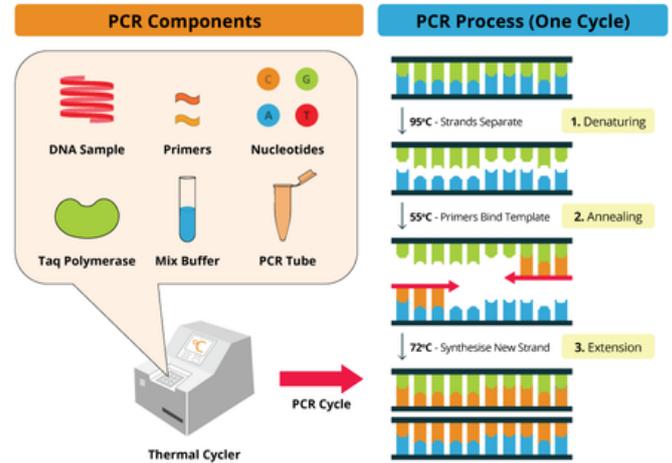
PCR has been around for a long time now: It was invented by Kary Mullis in 1985 while he was working as a chemist at the Cetus Corporation, a biotechnology firm in Emeryville, California. And today, a Google search for “polymerase chain reaction” throws up about 26,60,00,000 results, that’s how popular and vast it is.

DECODING THE PCR

What goes into PCR and how does it work?

The procedure of a basic PCR set up requires placing a small amount of the DNA containing the desired gene into a test tube. A large batch of loose nucleotides, which link into exact copies of the original gene, is also added to the tube. A pair of synthesized short DNA segments, that match segments on each side of the desired gene, is added. These "primers" find the right portion of the DNA and serve as starting points for DNA copying. When the enzyme *Thermus aquaticus* (Taq) is added, the loose nucleotides lock into a DNA sequence dictated by the sequence of that target gene located between the two primers.

The test tube is heated, and the DNA's double helix separates into two strands. The DNA sequence of each strand of the helix is thus exposed and as the temperature is lowered the



PCR Technique

Credits: www.bosterbio.com

primers automatically bind to their complementary portions of the DNA sample. At the same time, the enzyme links the loose nucleotides to the primer and to each of the separated DNA strands in the appropriate sequence. The complete reaction, which takes approximately five minutes, results in two double helices containing the desired portion of the original. The heating and cooling is repeated, doubling the number of DNA copies. After thirty to forty cycles are completed a single copy of a piece of DNA can be multiplied to hundreds of millions. All the steps in this entire procedure have different technical terms and require different temperatures in order to obtain desirable results.

ADVANCEMENTS IN PCR

In addition to simplifying molecular tasks typically carried out with the use of recombinant DNA technology, PCR has allowed a spectrum of advances ranging from the identification of

novel genes and pathogens to the quantitation of characterized nucleotide sequences. PCR can provide insights into the intricacies of single cells as well as the evolution of species.

Over the years, scientists have made many improvisations to the basic PCR set-up and this led to the introduction of various types of PCRs. They are:

Real-time PCR, Quantitative real time PCR (Q-RT PCR), Reverse Transcriptase PCR (RT-PCR), Multiplex PCR, Nested PCR, Long-range PCR, Single-cell PCR, Fast-cycling PCR, Methylation-specific PCR (MSP), Solid phase PCR, touch down PCR and many more, each of which is an advanced version of the basic PCR, serves different purpose and can be used by researchers depending on the type of their experiments and requirements.

APPLICATIONS

PCR has a wide range of applications and its usage is not restricted to just core biotechnology. It aids in the successful completion of many experiments and studies pertaining to various interdisciplinary sciences. Following are some of the examples:

Consumer genomics: PCR has enabled personalized genome testing. For example, nutrigenomics is a particular form of consumer

genomics that links genetic information to information about foods that might be better or worse for particular conditions, like inflammatory bowel disease.

Medicine: PCR is now used to diagnose and therefore aid in the treatment of many diseases, and it is widely used in research into the diagnosis, treatment and potential cure for a range of many others. One such example is the RT-PCR test for the diagnosis of COVID-19.

Environmental microbiology: PCR helps in the understanding of many environmental issues, particularly where the detection of microorganisms in the environment is required. PCR allows the identification and quantification of specific target species which are low in numbers. One common example is searching for pathogens or indicator species such as coliforms in water supplies.

Forensic science: PCR is a very important tool in the identification of criminals. DNA fingerprints (also called DNA profiles), identification of familial relationships, genomic DNA isolation and other molecular diagnostics and biochemical analyses can be undertaken forensically through the use of PCR. PCR allows DNA to be identified from tiny samples – a single molecule of DNA can be enough for PCR amplification.

Rise of Genetically-Modified Mosquitos

The Wolbachia Project and Oxitec's Friendly Mosquito

DEEPTHI JOJI | BTZ 1ST YEAR

INTRODUCTION

Mosquitoes-the most deadliest animal. According to the World Health Organization about 725,000 people are killed every year by mosquito borne diseases. Malaria alone affects over 200 million people out of which 600,000 people die. Malaria is just one of the many diseases that mosquitoes help to spread, there are many other diseases like dengue, yellow fever and encephalitis to name a few. Mosquitoes are one of the few animals that you can find anywhere in the world and at various times of the year during their peak breeding season they outnumber and help spread diseases.

Diseases spread by these tiny creatures infect a large number of people annually and cause deaths of many. But what can be the cure? Definitely medicines to treat these diseases do work but when we look at the grassroot level the primary reason for the high degree of spread of these diseases it always points out to the main vector of these diseases-the mosquito making it the most dangerous animal, not in itself but because of the pathogens it carries.

THE WOLBACHIA PROJECT-SINGAPORE

Singapore is home to 5.5 million people and in 2020 they had 26,000 dengue cases registered breaking its previous record number of 22,000 cases in 2013.

In order to solve this problem, Singapore's

government laboratories have bred bacteria (*Wolbachia*) carrying mosquitoes in rows of pallets where they've separated male pupae for release in the worst hit dengue areas.

Dengue is spread by the female *Aedes aegypti* mosquitoes. The Wolbachia project uses genetically modified male mosquitoes which when it mates with a female mosquito (which are not genetically modified) do not fertilize the eggs thus preventing the eggs from hatching. Since the lifespan of the female mosquito is just upto 7 days they die, new eggs are not hatched so the spread of the disease is reduced.

The core areas of the study sites within one year of release of these mosquitoes saw upto 88% fewer dengue cases compared to areas where these mosquitoes weren't released.

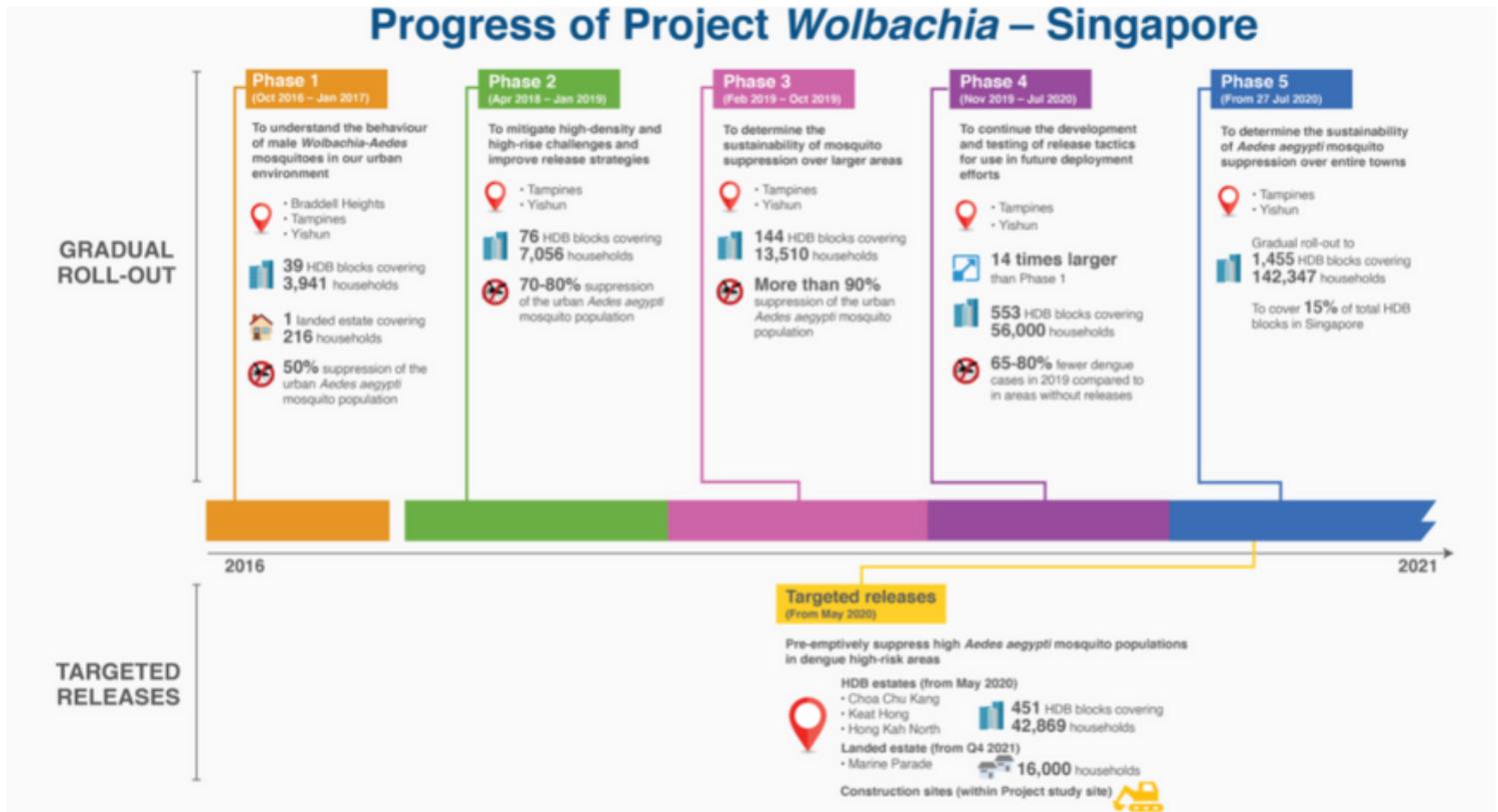
OXITEC'S FRIENDLY MOSQUITO

Oxitec, a UK based biotech company developed



Genetically modifying *Aedes aegypti*

Credits: www.medicaldaily.com



NEA's Phased Approach to Implement Wolbachia-Aedes Suppression

Credits: www.nea.gov.sg/

a bioengineered male *Aedes aegypti* mosquito to mate with the normal female mosquitoes responsible for transmitting diseases. The males carry a gene that passes to their offspring and kills the female progeny in early larval stages. The male offspring won't die but will act as carriers of this gene and pass it into future generations. So, as more of the females die the population of the *Aedes aegypti* mosquitoes should dwindle.

Oxitec has previously field tested these in Brazil, Panama, Cayman Islands and Malaysia and recently they got the permission to release these mosquitoes after much push-back from residents and regulatory complications for almost over a decade in Florida Keys.

OTHER ADVANTAGES OF GENETICALLY-MODIFIED MOSQUITOES

The major advantage as pointed above is definitely the fact that when the population of mosquitoes decreases the degree of spread of diseases also decreases. But other than that, using genetically modified mosquitoes can decrease our dependence on insecticides. The wide use of insecticides have made insects resistant to them. As insect resistance to insecticides is going to be a problem, the control of destructive insects like mosquitoes without the use of insecticides by genetically modifying them is a very bright solution.

New Tissue Clearing Methods Offer A Window Into The Brain

SREEPRIYA P | BTCZ 3RD YEAR

The mammalian brain is made up of billions of neurons connected in distinct circuits, each performing a different physiological function. Researchers are rebuilding precise three-dimensional maps of brain networks to better understand how these diverse neurons and circuits are linked to mental activity and disorders.

The mammalian brain is difficult to image in three dimensions. As light passes through tissue layers, it is scattered by a number of substances including water, lipids, and proteins. The image resolution is reduced as a result of this. Due to advancements in microscopy equipment and numerous labelling approaches, tissue optical clearing technology* has advanced quickly over the last decade. The observation of the entire mouse body at single-cell resolution or thick tissue slices at the nanoscale level has been made possible by consistent modification of primary methods for optical tissue transparency, with the goal of making intact primate and human brains or thick human brain tissues optically transparent. Optical clearance paired with flexible large-volume tissue labelling technology can retain anatomical integrity while also allowing numerous molecular information to be seen in situ from intact samples. It also introduces a novel method for researching complex tissues, which is critical for understanding the functional structure of healthy brains as well as the mechanisms behind neurological diseases.



Optical clearing tech to image thick brain tissue

Credits: www.cdn.the-scientist.com

Reduced scattering is one approach to increase resolution. This is accomplished by first eliminating water and lipids from the tissue. Then compounds with a refractive index in the range of proteins are added. Refractive index is a measurement of how much light bends as it travels through molecules. Light beams can converge to increase imaging resolution by establishing near-homogenous refractive indices in the molecules that fill the tissue environment. Most tissue cleaning procedures, which have been used effectively on hard tissues like bone for decades, function on this concept.

Researchers have devised chemical mixes that better retain tissue architecture and protein structures, and tissue clearing technologies have continued to improve. Fluorescent labels can be used using the most up-to-date approaches. Researchers can identify neurons and even intracellular components with ever-increasing precision when they are combined with modern tissue processing technologies like as automated cell counting.

Clearing treatments now available are not designed to clear both soft tissues like the brain and spinal cord as well as calcified hard tissues like bone at the same time. Because peripheral nerves in the spinal cord are attached to the vertebrae, which are too opaque for imaging, it's difficult to see complete connections between the central and peripheral nervous systems.

The process is similar to other clearing protocols except it uses polyethylene glycol (PEG)* for enhanced fluorescence preservation and contains two additional steps: decalcification of hard tissues and decolorization of colored tissues such as liver, which looks red because it contains high levels of iron. For those working with small body parts, the tissues can be passively immersed in chemical reagents. Alternatively, clearing solutions can be circulated throughout the body

using a perfusion pump for whole body clearing.

The physical structure and functional network of the brain is the neural circuit, which is made up of neurons connected by synapse. They reflect the pattern of neuron connection and activity transfer between neurons. The ability to examine the neural circuits of full intact tissues provides an anatomical foundation for signal coding and routing study, and tissue optical clearing with submicron resolution* appears to be the best way. Due to the inconsistency of tissue transparency, fluorescence retention, and tissue morphological invariance, the neural circuits are viewed using the optical clearing approach, which lights up certain routes for various activities.

The Quest For Happiness: Biotechnology and Memory Numbing in PTSD Patients

ANISHA JAI SINGH | BTCB 2ND YEAR

“Canst thou not minister to a mind diseased, pluck from the memory a rooted sorrow, raze out the written troubles of the brain, and with some sweet oblivious antidote cleanse the stuffed bosom of that perilous stuff which weighs upon her heart?”
- Macbeth (Act 5, Scene 3)

What causes PTSD?

PTSD (post-traumatic stress disorder) is a mental disorder that develops in individuals who either experience or witness a horrifying event. This disorder is characterized by symptoms such as severe anxiety, nightmares, flashbacks and intrusive thoughts about the trigger incident (*Torres*). When an individual witnesses a particularly horrifying event, there may be such an intense release of stress hormones that the particular memory is consolidated more strongly in our minds than a normal one. This also results in the individual frequently recalling the intense emotions they associated with that incident (*Kass 222-223*).

What are beta blockers?

Beta blockers (beta adrenergic receptors antagonists) are drugs that are usually used to treat cardiovascular diseases (*Jan and Farzam*). They bind to beta receptors that are mainly responsible for signalling in the sympathetic nervous system (*Alhayek and Preuss, 2021*) which is the part of the nervous system that controls the “fight or flight response” (*Alshak and Das, 2021*).

The role of beta-blockers:

In 2002, Roger K. Pitman and his colleagues published a study in which they administered propranolol (a beta blocker) to emergency room

patients within six hours after a traumatic experience (mostly car accidents) and for ten more days after the incident. One month later, it was shown that the group who received propranolol had lower cases of PTSD symptoms. After three months, when the PTSD symptoms of the two groups were comparable, the group that had received propranolol showed lower psychophysiological response to triggers, such as images of the incident (*Kass 224*).

Ethical dilemma:

Although the possibility of helping PTSD with memory numbing seems appealing, it poses several ethical problems. Firstly, according to psychologists, blunting a victim’s memory is a short term solution and to properly treat any mental disorder, intrusive thoughts must be acknowledged, confronted and worked through. Secondly, altering emotionally significant memories may create a false perception of the world. For example, a witness of murder who’s memory is numbed, may associate the incident as something that wasn’t very terrible. This opens up the possibility that we as humans, become creatures that are unmoved by wrongdoings and cruelty – we begin to accept the intolerable as tolerable (*Kass 225-231*).

Safety and efficacy of CVD medications in PTSD

| Medication class | Safety | Efficacy |
|--------------------------|---|--|
| ACEIs/ARBs | Hyperkalemia, renal impairment, hypotension | ACEIs and ARBs may decrease hyperarousal symptoms |
| Beta-blockers | Sleep disturbances, bradycardia, hypotension | Propranolol may decrease signs and symptoms of PTSD, both acutely and chronically |
| Calcium-channel blockers | Constipation, hypotension | Verapamil may improve serum cholesterol in patients with PTSD |
| Alpha-1 antagonists | Dizziness, headache, orthostatic hypotension | Prazosin is well studied and shown to reduce frequency of PTSD nightmares. Doxazosin and terazosin may be considered second-line |
| Alpha-2 agonists | Dizziness, headache, orthostatic hypotension | Clonidine may reduce agitation. Guanfacine may reduce frequency of PTSD nightmares in children but not adults |
| Antihistamines | Drowsiness, confusion, increased appetite | Cyproheptadine and hydroxyzine may reduce the frequency of PTSD nightmares and improve sleep quality |
| Serotonin antagonists | Drowsiness, orthostatic hypotension. Priapism relatively rare | Trazodone and nefazodone may reduce the frequency of PTSD nightmares and improve sleep quality |
| TCA's | Conduction abnormalities. Not safe for use in patients with CVD | TCA's may be as effective as SSRIs in treating anxiety and depression associated with PTSD |

ACEI: Angiotensin-converting enzyme inhibitor; ARB: angiotensin receptor blocker; CVD: cardiovascular disease; PTSD: posttraumatic stress disorder; TCA: tricyclic antidepressant

Beta blockers as compared to other drugs used to treat PTSD

Credits: www.cdn.mdedge.com

Conclusion: Although beta blockers may seem like a miracle drug for anyone suffering from PTSD, the ethical dilemma associated with them forces one to think about the posthuman society that critics of biotechnology often preach about. Moreover, the short term relief that beta blockers offer make them seem like a quest for pseudo-happiness rather than true recovery.

Health And Happiness Of Your Child Lies In An Obtuse Story Of Inheritance

SHIFA | BTCZ 3RD YEAR

INTRODUCTION

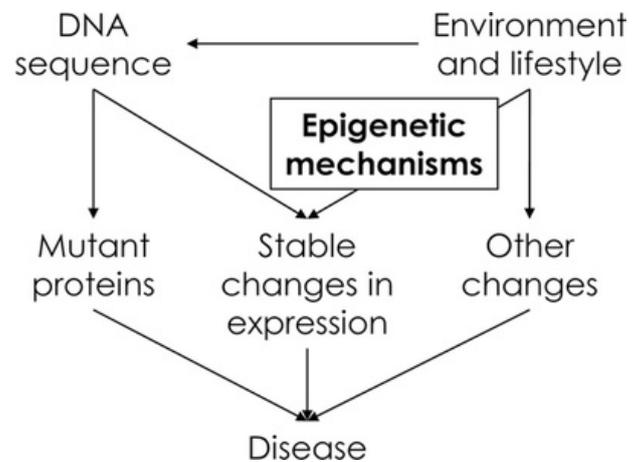
DNA- the basic plan of a life form, is inherited from parents to offspring by the miracle of meiosis at the time of Prophase I. This is what is widely known and accepted as the main reason for the genetic makeup of an offspring resembling both its parents. But recently, researchers at the University of British Columbia have discovered that DNA is not the only player in town! Epigenetic heredity, rediscovered some 30 years ago, is being considered as the other factor of inheritance. Due to it being relatively latent, the extent to which it happens in mammals remains largely unknown.

A recent study done on mice has brought to light how epigenetic inheritance could “pass on a turbo-boosted immune system to their kids and grandkids—all without changing any DNA sequences”.

Genes Locked? If Genes Could Speak You Would Fly!

Transmission of epigenetic markers from one generation to the next, which affects the traits of the offspring without altering the primary structure of DNA, in other words, epigenetically, is called transgenerational epigenetic inheritance.

Recent studies suggest that there might be more than just DNA helping in transfer of characters, and variations. These studies say that epigenetics is at the root, above DNA, regulating how genes are expressed.



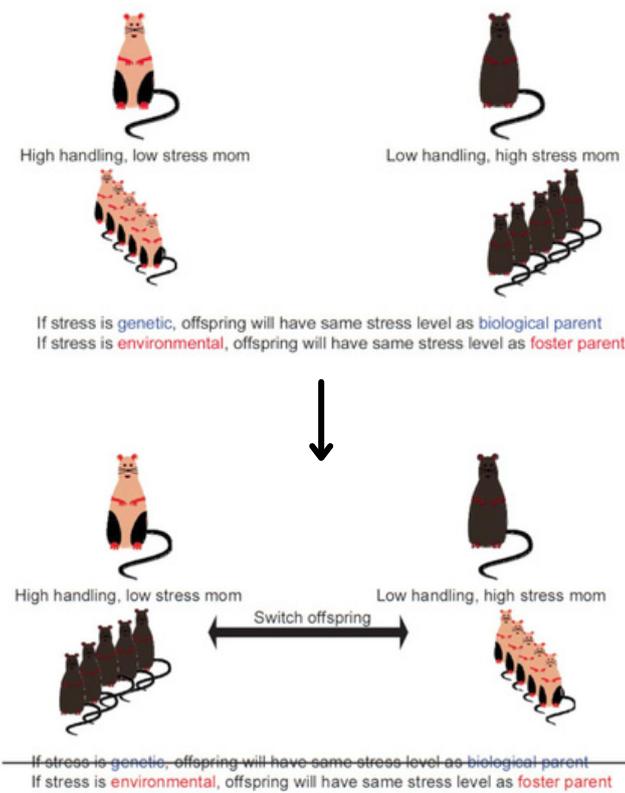
Epigenetic Mechanisms and Hypertension

Credits: www.ahajournals.org

It is common knowledge that DNA is the coding base for proteins, which in turn make enzymes and hormones in various designated parts of the body. Not every cell in our body has the same function despite having the same DNA. This is because of the ability of cells to silence certain parts of the DNA so as to achieve the necessary requirements for that particular area. For instance, cells of different organs perform different functions. The eye helps one to see, while the stomach helps in digestion. This level of control is dubbed epigenetics, or “above genetics.”

One of the most common ways to silence DNA is by addition of chemical mutagens to genes so as to disrupt their normal usual functions of production of proteins. This in turn silences the genetic code without damaging the gene itself. These chemical tags are thought to be completely removed at the embryonic stage, resulting in a blank slate for the next generation to start anew.

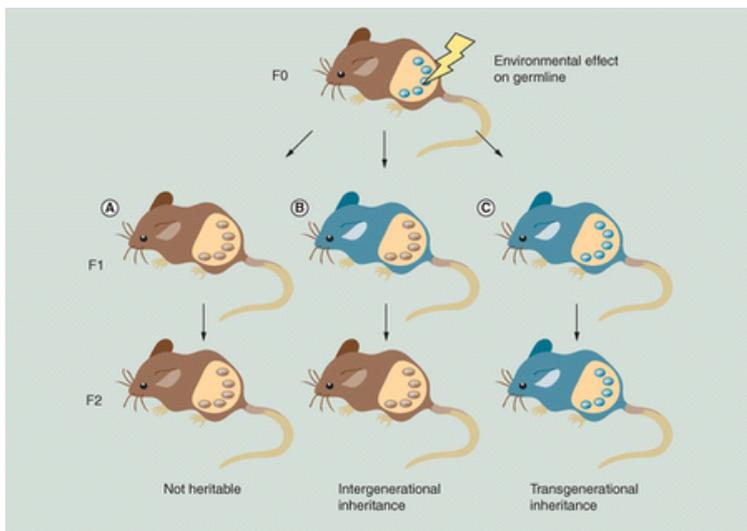
“A now famous study showed that a famine during the winters of 1944 and 1945 altered the



Epigenetics: How the environment influences our genes

Credits: www.encyclopedie-environnement.org

metabolism of kids who, at the time, were growing fetuses.” This led to those kids being more susceptible to obesity and diabetes, even though their genes did not change. “Similar studies in mice showed that fear and trauma in parents can be passed onto pups—and grandkids—making them more susceptible, whereas some types of drug abuse increased the pups’ resilience against addiction.”



Transgenerational Epigenetic Inheritance

Credits: www.semanticsholar.org

Trained Immunity, Your Sickness- Savior of Your Future Generations

The new study, surrounding “trained immunity”, suggests that an individual's experiences in life can change the epigenetic makeup of their offspring similar to how the immune system can learn and “remember previous infections to better fight off the next round.” Mice born to parents or grandparents previously infected, had a more open epigenetic landscape. That is, they were able to rapidly turn on and access certain genes helping the immune cells at the time of need.

Here, the team exposed adult mice to infectious elements like fungi or yeast particles to simulate an infection. Once recovered, the mice were mated with healthy mice, resulting in normal-looking baby pups. These offspring, when came in contact with potential pathogens like *E. Coli* had a much stronger immune reaction compared to mice with non-infected parents.

What was even more impressive was that this super-immunity continued to the next generation. The grandkids of mice originally infected also showed lower bacteria levels in their system after rummaging around a bacteria-rich environment. However, the protection tapered in the third generation, the great-grandkids, suggesting that whatever was passed on could go on only for so long.

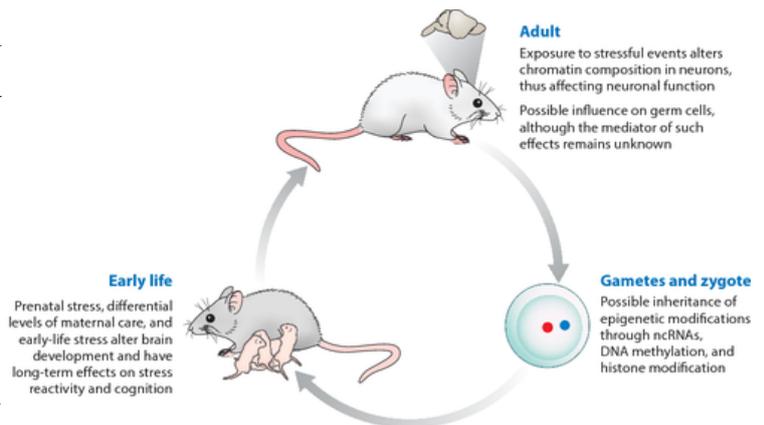
Giraffe’s Necks an Odyssey of Evolution and Inheritance

The first perplexing discovery was on the surface of their immune cells. The white blood

cells and other “attackers” present didn’t seem any different between disease-resistant mice and other normal ones. But upon further inquiry, they found that the epigenetic landscape of these immune cells in the site of origin ie; the bone marrow, told a completely different story.

Mice having the ability to turn certain immune cells on in time of need carried one type of immune soldier which was especially primed for action, with a boosted metabolism and responsiveness to threats. The question that boggled the minds of these researchers was how could these changes be passed on to the next generation when the parents themselves hadn’t ever directly experienced an infection before?

One such answer seems to be altering the male gamete- sperm. Results from studying the epigenetic landscape of the bone marrow cells concluded with finding a “fingerprint” that better primed white blood cells to protect the pups from any bacteria. Fortified sperm wasn’t the only solution they discovered though, as mice born from previously infected mothers also showed significant turbo-boosted immunity, though its inheritance pattern remains a mystery. “How changes in immune cell epigenetics are telegraphed to reproductive cells is also anyone’s guess”, but it has been speculated that the messenger RNA may be responsible for it.



Epigenetic Mechanisms of Depression

Credits: www.semanticscholar.org

As much as this research seems exciting in terms of expanding our horizon in variations and specific important mutations, such changes aren’t always good as they can be detrimental to health, despite being efficient at fighting off bacterial invaders, such as causing strong inflammatory responses, or can also trigger atherosclerosis, heart and blood vessel diseases, and even accelerated aging.

What we learn in the science community from this study is that DNA isn’t the only route of inheritance. Other factors also play roles in it. Hence, a lot of studies should be carried out to better understand if the Laws of inheritance still stand against our current knowledge, and if Darwin’s original theory of evolution was correct.

E. coli: The bacteria of biotechnology

VINAYA KRISHNAN | BTCB 2ND YEAR

INTRODUCTION

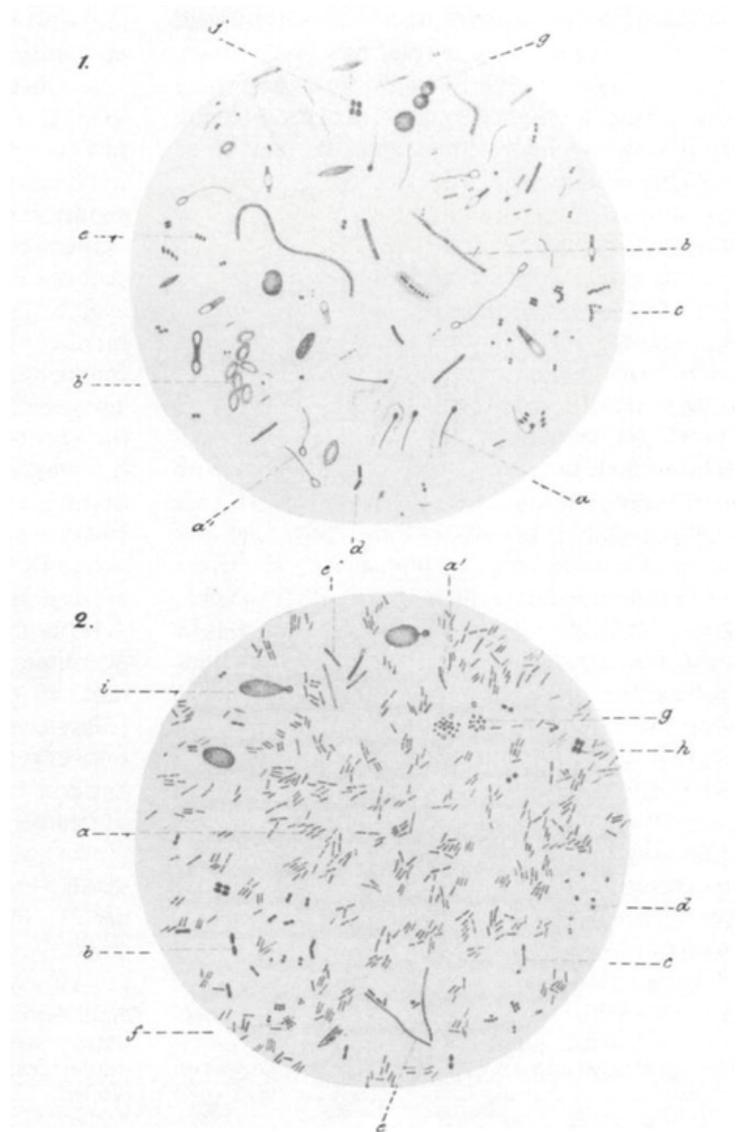
Escherichia coli is a gram-negative, rod-shaped bacterium that inherently lives in the gut of warm-blooded animals and is named after its discoverer, Dr. Theodore Escherich. There are many *E. coli* strains or subtypes present, most being harmless to humans except for a few. Since the birth of molecular cloning, first introduced in the late 1960s, *E. coli* has been used to introduce DNA sequence into the host genome or for research on the foremost topic of biomedical and biological sciences.

1.The Discovery:

This model organism was first discovered in the year 1884, by the German microbiologist and pediatrician, Theodore Escherich who began a study of the infant gut microbe or “flora” and their roles in diseases and digestion. During this study he found a fast-growing bacterium that he called *Bacteria coli commune*, which is now known to us as *Escherichia coli* which was renamed by Castellani and Chalmers in the year 1919.

2.The *E. coli* genome and Plasmid:

The complete genome sequencing of *E. coli* was done on K-12 MG655 strain and was published in 1997. The most famous plasmid of *E. coli* is the F plasmid which played a crucial role in the process of bacterial conjugation. This plasmid is also used in many genetic techniques commonly used to dissect prokaryotic systems and has been central in elucidating the basic mechanism of plasmid replication and transmission process.



Escherich's drawing of the bacteria seen under a light microscope.

Credits: www.intechopen.com

3.The phylogenetic groups of *E. coli*:

a. The commensal *E. coli*- These are one among the first gut-colonizers and help establish an anaerobic environment of the gut which enables further colonization of anaerobic bacteria. The *E. coli* is provided with “food and shelter” from its host and the host is supplied with vitamin K and colonization resistance.

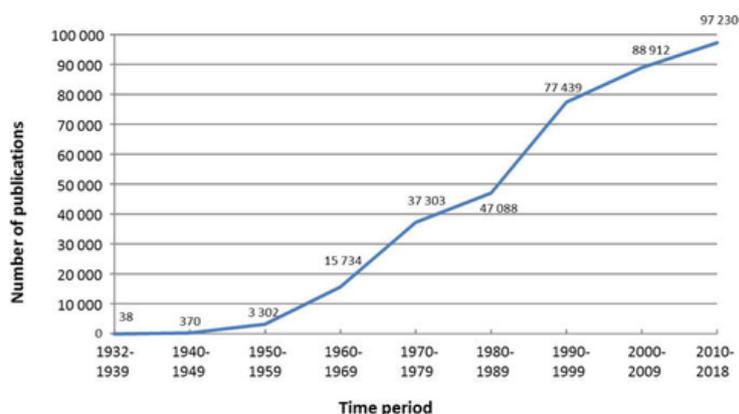
b. The pathogenic *E. coli*- Major groups are the intestinal pathogenic *E. coli* (IPEC) and extraintestinal pathogenic *E. coli* (ExPEC).

4.The “workhorse” *E. coli*:

E. coli is known for its fast-growing rate in chemically defined media and its application as an extensive molecular tool. Due to these purposes, they are an important model organism, and is often called the “workhorse” of molecular biology.

Latest discoveries and use of *E. coli* in research:

- Engineered *E. coli* produced pyocyanin at same levels of *Pseudomonas aeruginosa*. Pyocyanin produced by *E. coli* cells can be used for electro-fermentation systems. These pyocyanin also have antifungal and antimicrobial properties.



The number of publications in PubMed for the search term “*Escherichia coli*” in the time frame from January 01, 1932 to December 31, 2018

Credits: www.intechopen.com

- Development of an O-polysaccharide based recombinant glycoconjugate vaccine in engineered *E. coli* against ExPEC O1.

| Contribution | Authors | Year |
|--|--|------|
| Molecular biology, physiology, and genetics | | |
| Elucidation of the genetic code | Crick FH, Barnett L, Brenner S, and Watts-Tobin RJ | 1961 |
| DNA replication | Lehman IR, Bessman MJ, Simms ES, and Kornberg A | 1958 |
| Transcription | Stevens A | 1960 |
| Life cycle of lytic bacteriophages | Ellis EL and Delbrück M | 1939 |
| Gene regulation of the <i>lac</i> operon | Jacob F and Monod J | 1961 |
| Gene regulation of the <i>ara</i> operon | Englesberg E, Irr J, Power J, and Lee N | 1965 |
| Discovery of restriction enzymes | Linn S and Arber W | 1968 |
| Identification of genes controlling antimicrobial drug tolerance in stationary phase | Hu Y and Coates AR | 2005 |
| Role of global regulators and nucleotide metabolism in antibiotic tolerance | Hansen S, Lewis K, and Vulić M | 2008 |
| Metabolic control of persister formation | Amato SM, Orman MA, and Brynildsen MP | 2013 |
| Swarming motility behavior | Harshey RM and Matsuyama T. | 1994 |
| Elucidation of the structure and function of ATP synthase | Capaldi RA, Schulenberg B, Murray J, and Aggeler R | 2000 |
| Conjugal DNA transfer | Tatum EL and Lederberg J | 1947 |

| Evolution | | |
|---|---|------|
| Random nature of mutation | Luria SE and Delbrück M | 1943 |
| Relationship between genomic evolution and adaptation | Barrick JE, Yu DS, Yoon SH, Oh TK, Schneider D, Lenski RE, and Kim JF | 2009 |
| Role of adaption, chance, and history in evolution | Travisano M, Mongold JA, Bennet AF, and Lenski RE | 1995 |
| Adaptive mutation | Cairns J, Overbaugh J, and Miller S | 1988 |
| Role of historical contingency in evolution | Blount ZD, Borland CZ, and Lenski RE | 2008 |
| Origin of novel traits | Blount ZD, Barrick JE, Davidson CJ, and Lenski RE | 2012 |
| Long-term fitness trajectories | Wiser MJ, Ribeck N, and Lenski RE | 2013 |
| Effect of sexual recombination on adaptation | Cooper TF | 2007 |
| Predator-prey interactions (bacteriophage) | Chao L and Levin BR | 1977 |
| Genetic engineering and biotechnology | | |
| Molecular cloning and recombinant DNA | Cohen S, Chang A, Boyer H, and Helling R | 1973 |
| Generating precise deletions and insertions | Link AJ, Phillips D, and Church GM | 1997 |
| Gene replacement | Herring CD, Glasner JD, and Blattner FR | 2003 |

Discoveries in research involving *E. coli* bacteria model

Credits: www.intechopen.com

Developments in Food Biotechnology

JUHI SINGH | BTCZ 3RD YEAR

INTRODUCTION

Food biotechnology is the application of modern biotechnological techniques to process, manufacture and preserve food more efficiently. Genetically modifying foods to improve their nutritional quality, taste and agricultural needs has been a major improvement in the past few decades. But apart from GM Foods, there have also been several technological advancements in the food industry with the use of biotechnology.

a. Enzyme Food Processing: Enzymes that can catalyze highly specific reactions that preserve and enhance flavor and texture are used. Microorganisms like bacteria and fungi are used to obtain these enzymes. For instance, papain, a proteinase enzyme present in papaya fruits is being extracted and used as a meat tenderizer. Many microbial enzymes like Amylase, Protease, Lipase, etc. are produced in bulk amounts by fermentation technology and used in various industries due to their advantages like constant production and cost effectiveness. The enzyme food processing falls under “clean label” and “all natural” categories as they do not use harsh chemicals and thermal treatments.

b. Aseptic packaging and sterilization technologies: Many other developments like aseptic packaging which is the process of filling sterilized commercial products into sterile containers and food irradiation which exposes food with radiation that destroys organisms which cause spoilage and illness. It has also



Aseptic sterilizing units in manufacture of pharmaceuticals
Credits: www.axys-network.com

completely replaced in-container sterilization of liquid foods. Aseptic condition involves three steps i.e. thermal sterilization, sterilization of packaging material and conservation of sterility.

c. Manufacturing of instant consumption food products: Food products like instant milk powders and decaffeinated coffees that are used on a daily basis by millions are also products of food biotechnology. Industrial evaporators are used to remove one-third of the water content of milk, and then it is processed into a powder.

d. Improving Health and Nutrition: There are many health benefits that food biotechnology offers, by manipulating the genes of organisms, we are able to get more nutritious products than before which is improving overall human health. For instance,



Golden Rice when comparing its colour to white rice

Credits: www.synbiowatch.org

golden rice is a genetically modified variety of rice that has precursor of Vitamin A, and thus when consumed, can help overcome vitamin A deficiency.

e. Wine making- Genetic engineering of industrial yeast is done in wine making. The malolactic gene of *Lactobacillus delbrueckii* was introduced into a yeast strain which was then used in fermentation of wine, to give increased malate conversion to lactate, which improves tastes and quality of red and white wines.

f. Removing allergens in food: Biotechnology industries are also trying to remove allergens from food. Various techniques in biotechnology are applied to remove proteins that bring out the allergies. A famous example is the new soybean line produced by artificial hybridization with reduced allergic sensitivity.



Malolactic fermentation of wine improved

Credits: www.matthewclark.co.uk



Bt cotton with improved insect resistance

Credits: www.indoasiancommodities.com

g. Sustainable farming practices: Agricultural biotechnology is also helping farmers to grow more food on less land and reducing the dependence on pesticides. For instance, the genetically modified Bt cotton has genes from a bacterial species, allowing it to naturally express pest resistance. Such techniques and several others have the potential of advanced crop production, enhancement and improvement of food security at global level.

UP NEXT



NEWS BRIEFING



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

READ ON TO FIND OUT THE LATEST IN

| HUMAN & MEDICAL BIOTECHNOLOGY |

| ANIMAL BIOTECHNOLOGY |

| PLANT & AGRICULTURAL BIOTECHNOLOGY |

| INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY |

Friend Or Foe? The Anthrax Toxin and Its Ability to Alleviate Pain

SOPHIA EVANGELINE ALDRIN | BTCZ 3RD YEAR

20 December 2021

Harvard Medical school

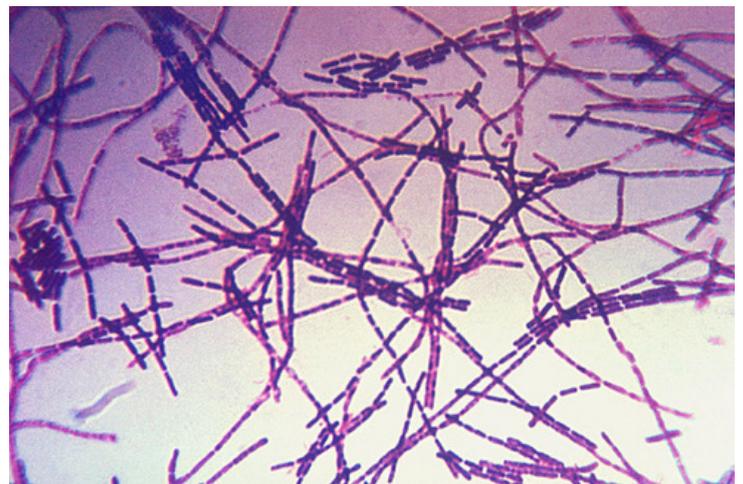
Anthrax is a term often associated with fatal illness and bioterrorism. This rare but serious infection is caused by *Bacillus anthracis*, a gram-positive bacterium naturally found in soil. It can transmit to humans through the skin, by inhalation, by injection, and by ingestion of the anthrax spores. Once the spores gain entry into the host, *Bacillus anthracis* produces toxins that cause the fatal anthrax infection in humans and animals.

Results of a recent study headed by scientists at Harvard Medical School have found that the terror-inducing bacterium has an untapped potential in anesthesiology. A component of the anthrax toxin can effectively silence pain in animals by altering the signaling in dorsal root ganglion (DRG) sensory neurons, or the nerves that relay pain signals to the spinal cord.

The team started by studying the gene-expression data of pain-sensing neurons and determined that these neurons had receptors for anthrax toxins, whereas other neurons lacked such receptors. Anthrax toxin is composed of three proteinaceous subunits: PA (protective antigen), LF (lethal factor), and EF (edema factor). The subunits combine to produce two different toxins, lethal toxin (PA+LF) and edema toxin (PA+EF). PA binds to the ANTXR2 nerve cell receptors and forms pores that serve as an entry point for EF and LF to enter the neuron.

The edema toxin (PA+LF) alters signaling within the nerve cells and effectively silences the pain.

The researchers also confirmed that the anthrax toxin which altered signaling in cultured human nerve cells produced similar analgesic effects in live mice. Anthrax toxin was injected into the lower spines of mice and this prevented it from sensing high-temperature, mechanical stimulation, pain caused by inflammation, and pain caused by nerve cell damage. Another important observation was made- the animals' vital stats such as heart rate, motor coordination, and body temperature were not affected. The toxin had the capability to precisely target pain fibers and block the pain without widespread side effects.



A photomicrograph of Bacillus anthracis bacteria using Gram's stain technique.

Credits: www.cdc.gov

As the analgesic effect diminished, the treated nerve cells remained physiologically intact, thus indicating that the pain-relieving effects were due to altered signaling within the treated nerve cells.

Furthermore, the research group combined components of the botulinum toxin with anthrax toxin to create an engineered molecular cargo to test the selective targeting property of the toxin. The researchers observed that the combination produced a similar analgesic effect in both DRG cultures and mice. This result demonstrates that the sensory function of pain-sensing nerve cells can be selectively targeted by anthrax toxin.

Currently, opioids are the most effective analgesics, but they have severe side effects such as addiction, tolerance, and breathing difficulties. These new findings point to novel avenues for the development of potent and precision-targeted analgesics with minimal to non-existent side effects. However, the researchers caution that as the work progresses, the safety of the toxin must be monitored because the anthrax protein can disrupt the integrity of the blood-brain barrier.

mRNA Vaccine Technology has Assisted in the Repair of Broken Hearts in Mice

Thanks to the technology used in mRNA coronavirus vaccines, immune cells in the bodies of mice have been temporarily reprogrammed to repair damaged hearts by removing scar tissue.

S. KHIRAN | BTCB 2ND YEAR

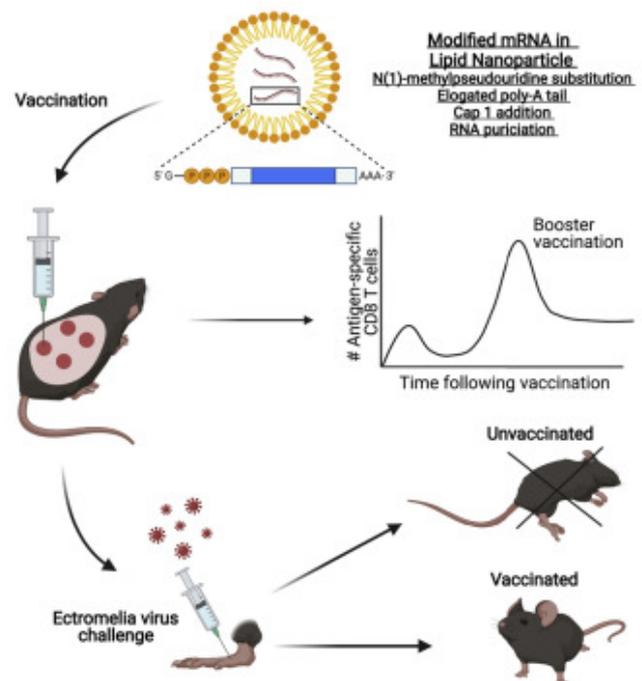
6 January 2022

University of Pennsylvania.

CAR T-cells, genetically engineered immune cells, are already being used to treat cancer, but they are exceedingly expensive. The mRNA technique, which temporarily modifies these cells, could drastically reduce expenditures. “CAR-T therapy has been a breakthrough, but it costs a lot,” says Aghajanian at the University of Pennsylvania. “We’re hoping this is the next step in CAR-T-type technology that will allow more access. This type of thing you can get to developing countries, to remote areas.” Conventional CAR T-cells are made by taking T-cells from a person’s body, genetically engineering them to add a gene for a “chimeric antigen receptor” and then returning them to that individual’s body.

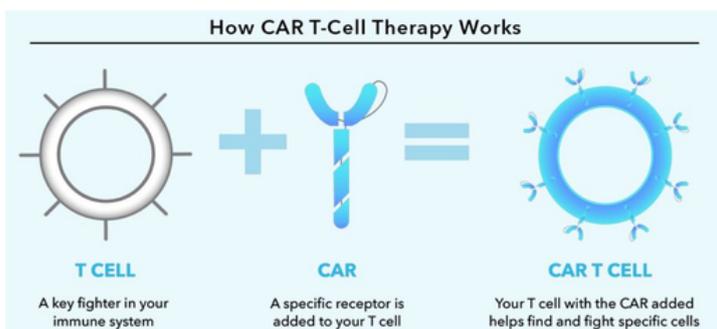
These therapies can be quite successful against blood malignancies like leukemia, but generating the cells in a lab is expensive. By delivering genes in the form of mRNAs, Aghajanian's team is able to convert T-cells into CAR T-cells without removing them from the body.

The mRNAs are wrapped in the same fatty balls, known as lipid nanoparticles, as the coronavirus vaccines from Pfizer/BioNTech and Moderna. However, in this case, the lipid nanoparticles are coated with antibodies that bind to T-cells. Although the team had been working on their study before the vaccines, Aghajanian believes that the widespread usage of vaccines will make it easier for regulators to approve alternative uses of lipid nanoparticles.



Molecular Therapy: Lipid-nanoparticle-encapsulated mRNA vaccines induce protective memory CD8 T cells against a lethal viral infection

Credits: www.cell.com



Car-T cell therapy

Credits: www.lyfboat.com

First Clinical-Grade Transplant of Gene-Edited Pig Kidneys into Brain-Dead Human

UAB researchers tested for the first time the human preclinical model for transplanting genetically modified pig kidneys into humans.

RUVIZA MUSKAN | BTCZ 2ND YEAR

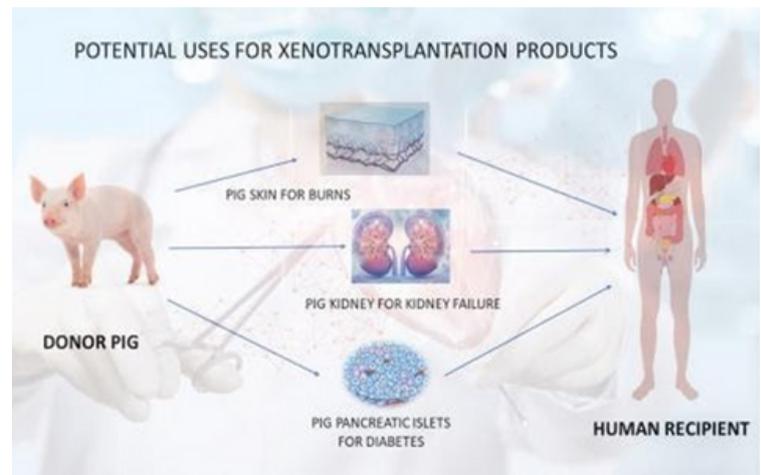
20 January 2022

University of Alabama, Birmingham

Researchers announce the first peer-reviewed research outlining the successful transplant of genetically modified, clinical-grade pig kidneys into a brain-dead human individual, replacing the recipient's native kidneys. These positive results demonstrate how xenotransplantation* could address the worldwide organ shortage crisis. The study recipient had two genetically modified pig kidneys transplanted in his abdomen after his native kidneys were removed. The organs were procured from a genetically modified pig* at a pathogen-free facility.

For the first time, the pig kidneys transplanted were taken from pigs that had been genetically modified with 10 key gene edits that may make the kidneys suitable for transplant into humans. This process demonstrates the long-term viability of the procedure and how such a transplant might work in the real world. The transplanted kidneys filtered blood, produced urine and, importantly, were not immediately rejected. The kidneys remained viable until the study was ended, 77 hours after transplant.

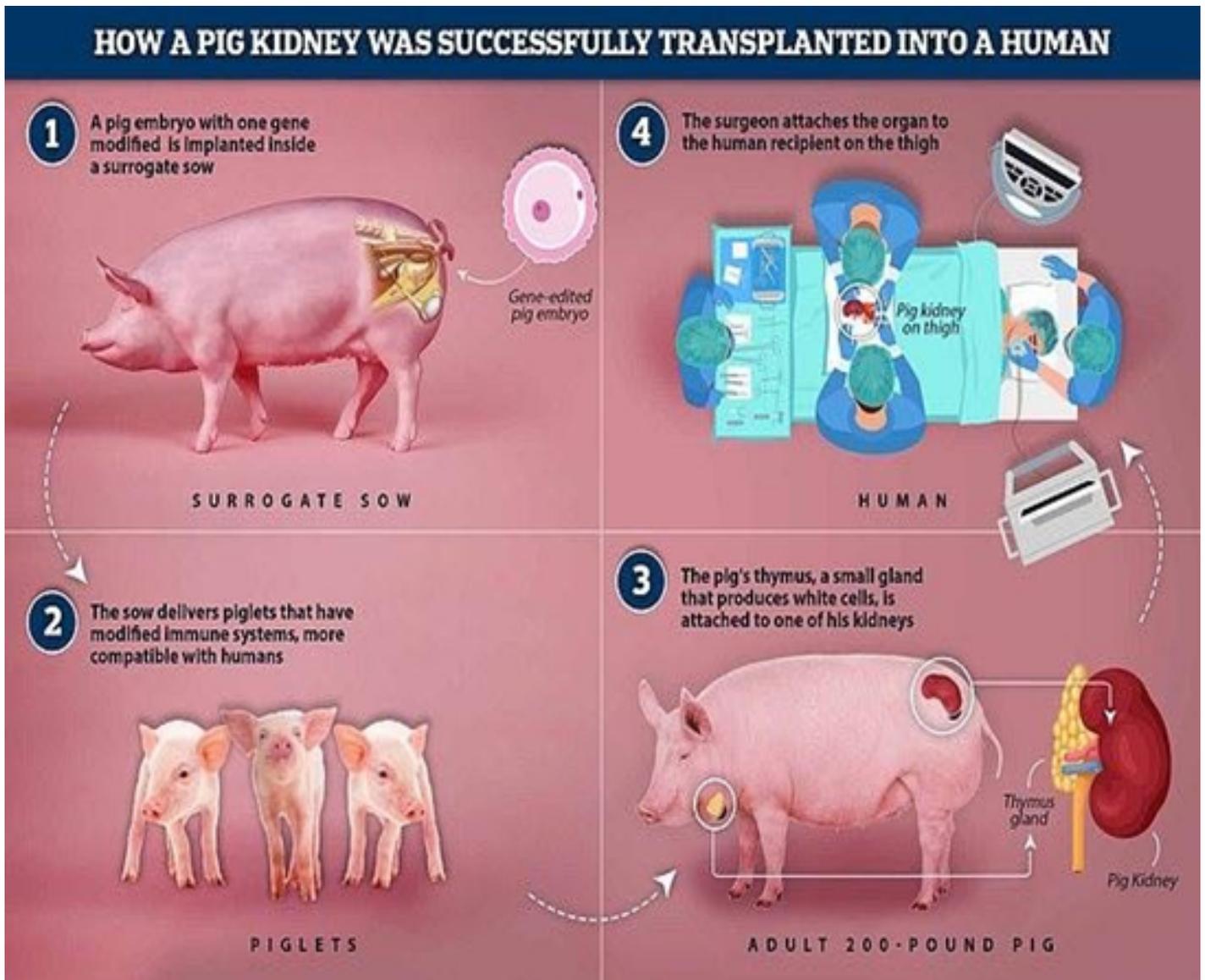
This game-changing moment in the history of medicine represents a paradigm shift and a major milestone in the field of xenotransplantation, which is arguably the best solution to the organ shortage crisis said Jayme Locke.



Credits: /www.fda.gov

The natural lifespan of a pig is 30 years, they are easily bred and can have organs of similar size to humans. Gene editing* in pigs to reduce immune rejection has made organ transplants from pigs to humans possible, which could offer help to thousands of people who face organ failure, disease or injury. Genetically modified pig kidneys have been extensively tested in non-human primates. In addition to this evaluating genetically modified pig kidneys in a human preclinical model research may provide important information about the potential safety and efficacy of kidneys in human transplant recipients, including in clinical trials.

This effort is supported by biotechnology pioneer United Therapeutics Corporation, which awarded a grant to UAB to launch the innovative xenotransplantation program. Revivicor, Inc., a subsidiary of United Therapeutics, provided the genetically modified pig that was the source of the investigational xenotransplant kidneys.



Credits: <https://twitter.com//events/>

CIIE.CO in Partnership With GFI India Releases Study of Cultivated Meat Ecosystem

VAISHNAVI SAXENA | BTC 1ST YEAR

25 January 2022

CIIE.CO (Capital, Incubation, Insights, Everything) X GFI (Good Food Institute)

CIIE.CO in partnership with GFI India, has just released a landscape study of the cultivated meat ecosystem in India. Cultivated meat, which is synthesized by 'farming animal cells' rather than the very inefficient process of raising and slaughtering animals. This study would definitely improve human and planetary health.

In the last few years, the industry has developed excitement and thrill around the world alongside other 'smart protein' categories such as plant-based meats, with investment in cultivated meat startups surpassing \$1 billion in 2021.

The new study by CIIE.CO(IIM Ahmedabad) and GFI India is drawing up a roadmap for the advancement of bio-manufacturing and the cultivated meat industry - a critical step towards a sustainable, secure, and just food system.

With problems like malnutrition, pandemics, natural calamities, etc., the world needs investment and advancement in the industries of the future and 'SMART PROTEIN' is one of them.



India being one of the self-sufficient and global competitor will help establish a global market for natural food supply and also create a lot of job opportunities. With growing awareness and customer preferences, entrepreneurs and innovators have realized the need for infusing technology to create products for the future. And this can prove to be a perfect time to accelerate the momentum around cultivated meat and smart protein.

The area of 'smart protein' will be an opportunity to create an exponential impact through next-generation solutions for contributing to food security, clean environment, conserving natural resources and more.

This report has paved the way for the global state of the alternative protein industry, the economic, sustainability, and public health benefits of the sector and the value Indian science, business, and investment can make India as a strong bio-manufacturing hub for innovative, affordable and accessible products for domestic and global markets.



This will definitely give a boost to the Indian economy and market.

The success of the industry will rely heavily on scientific advancements and academia alike. And India, with its vigorous, strong and healthy biopharmaceutical industry, agricultural biodiversity, and world-class talent pool, offers immense value to the international smart protein sector in this regard.

Biochemical and structural characterization of quizalofop-resistant wheat acetyl-CoA carboxylase

MALEEHA AFAQ | BTCZ 2ND YEAR

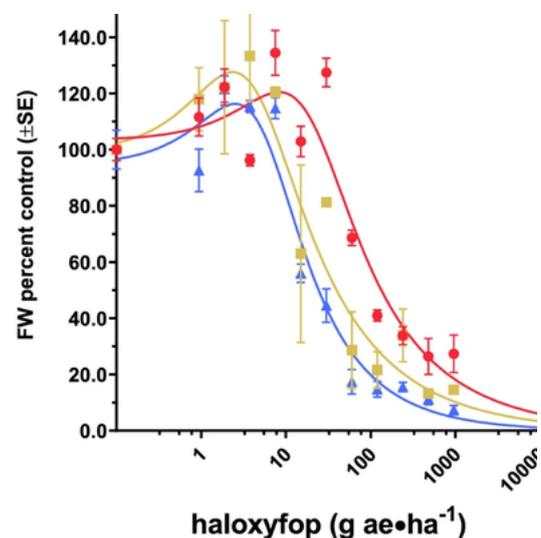
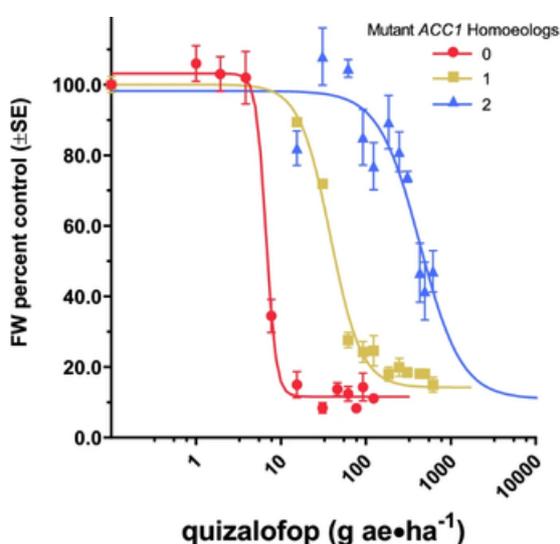
13 January, 2022

Raven Bough & Franck E. Dayan

A nucleotide mutation seen in wheat resulted in an alanine to valine amino acid substitution in acetyl coenzyme A carboxylase. Mutation in acetyl-CoA (ACCase) in ACC1 resulting in an alanine to valine amino acid substitution at position 2004 of the *Alopecurus myosuroides* results in **quizalofop** resistance in wheat, quizalofop is a post-emergence herbicide that effectively controls grass weeds and is often detected in the environment. Genotypes which showed homozygous mutation in one or two ACC1 homoeologs were seven- and 68-fold more resistant to quizalofop than a wildtype winter wheat in greenhouse experiments, respectively. In *in vitro* conditions, ACCase activities in protein extracts which are soluble from these varieties are 3.8- and 39.4-fold more resistant to quizalofop, with the homozygous mutation in either one or two genomes, relative to the wildtype.

The mutation does not affect or alter the specific activity of wheat ACCase, which means that this resistance trait does not affect the catalytic functions of ACCase.

Modeling of wildtype and quizalofop-resistant wheat ACCase demonstrates that the A2004V amino acid substitution causes a reduction in the volume of the binding pocket that hinders quizalofop's interaction with ACCase. The binding affinity of quizalofop is also reduced because of these mutations. However, the A2004V mutation does not affect **haloxyfop** binding. Haloxyfop functions as a proherbicide, an acetyl-CoA carboxylase inhibitor and an agrochemical. Continued *in vivo* and *in vitro* experiments reveal that the mutation, in fact, adds negative cross-resistance to haloxyfop, with quizalofop-resistant varieties exhibiting higher sensitivity to haloxyfop than the wildtype winter wheat line.



Models of quizalofop (A) and haloxyfop (B) herbicide dose effects on whole-plant growth by genotype

Credits: nature.com

What if you got a chance to turn trash into treasure, sounds cliché right?

Biomining to turn waste into gold using microbes

SRIJITA DAS | BTC 1ST YEAR

18 January 2022

BRAIN (Biotechnology Research and Information Network), Germany

High-value metals make the modern world go round, but the way we extract and dispose of them is far from sustainable. Biomining could be an elegant and lucrative alternative.

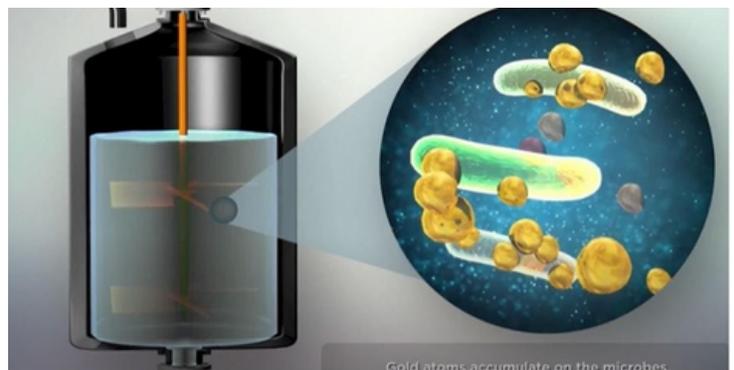
From the gold and silver in consumer electronics to the rare earth elements needed to power renewable energy technologies, metals underpin the transition to a high-tech, low-carbon economy.

It's estimated that precious metals worth billions are lost every year from electronic waste alone, the vast majority of which goes unrecycled. There are growing concerns around the environmental and humanitarian effects of conventional mining practices. And yes there is an alternative to this.

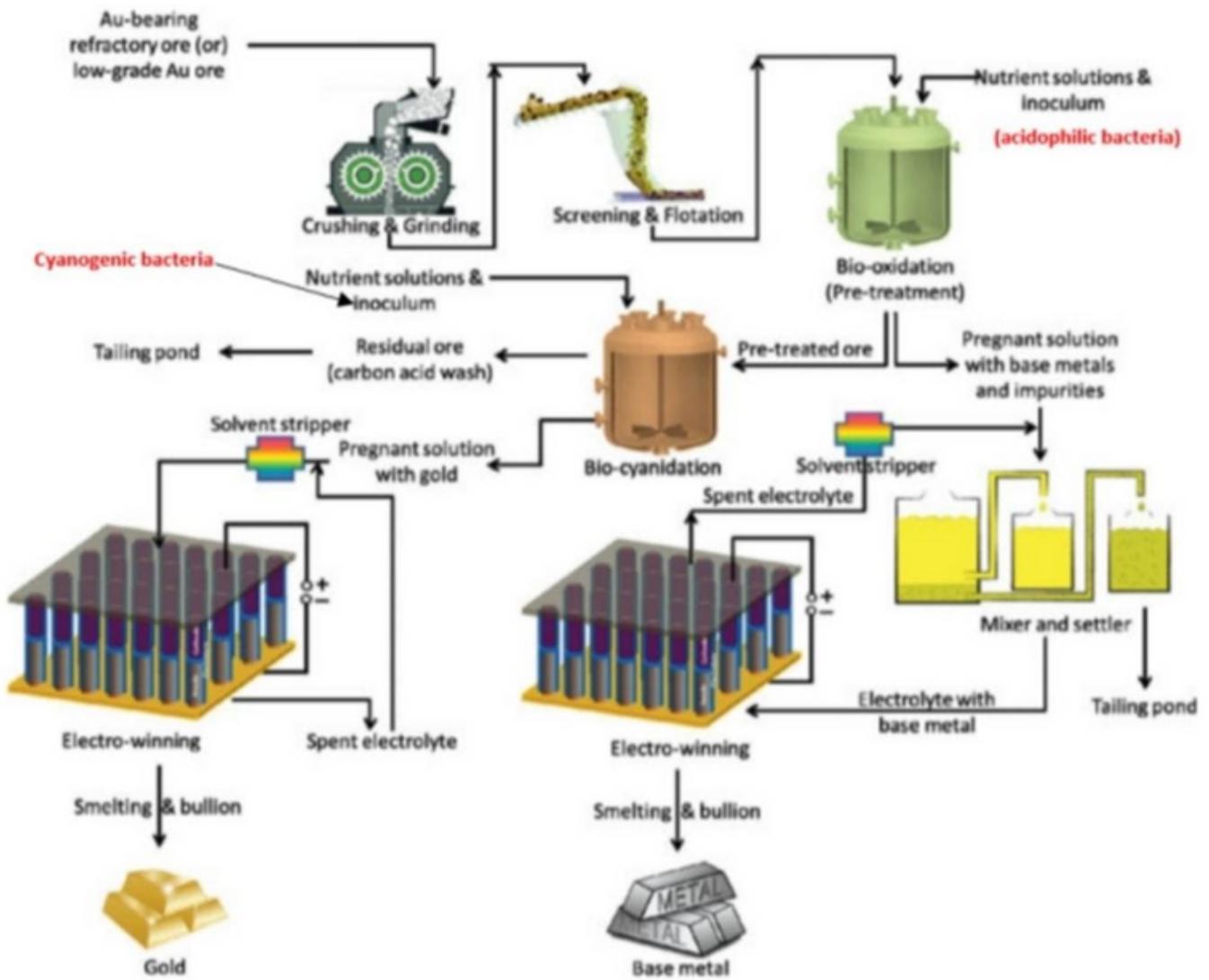
A wealth of microbial species, often from extreme environments, have evolved the ability to extract metals from their surroundings. Some produce acids and metal-scavenging proteins to dissolve metals from solid rocks, in a process called **bioleaching**. Others employ their own cell walls to extract and accumulate metal ions from liquids. By harnessing these miniature miners, the emerging field of biometallurgy could tackle many of the issues associated with conventional metal supply chains.

"The major advantage is the sustainability of the processes," said Gabor, BRAIN's Manager Technical Business Development. "It replaces aggressive or toxic chemicals by microbial biomass and significantly reduces the energy demand and consequently the CO₂ footprint of metal recovery processes by a factor of three compared to the virgin mining and chemical recycling of gold. Compared to pyrometallurgical recycling (smelting), the CO₂ footprint is still reduced by a factor of two."

The company (BRAIN) grounds e-waste into a powder, adding acids and oxidants to dissolve the metals into a liquid solution, where the microbes are able to find gold and accumulate it on their surface. The gold-coated microbes can then be filtered out and refined to liberate the precious metal.



Mint's microbes accumulate dissolved gold on their outer surface.
Credits: www.labiotech.eu



The overall process flow chart of bioprocessing (biooxidation and biocyanidation) of gold-bearing refractory ore

Credits: etn-sultan.eu

GALLERY

»»» VISMITHA S | BTCZ 3RD YEAR

DESIGNER BABIES TO SUPER HUMANS



Credit: Shutterstock

In just a few years, geneticists are going to discuss the enhancement options with pregnant women about their unborn child. With CRISPR gene editing, scientists are making tremendous strides toward being able to edit an embryo to remove problematic genes, thereby reducing the likelihood of certain diseases and physical anomalies. 'Designer babies' have become a feasible reality, as there have been, although controversial, successful instances where there was a creation of a designer baby.

MARINE SOURCE FOR ANTI-CANCER DRUG

CYTARABINE: The nucleosides spongothymidine and spongouridine isolated from *Tectitethya crypta*, a marine demosponge species in Phylum Porifera, led to the development of cytarabine. It is used to treat acute leukemia, acute lymphocytic leukemia and non-hodgkin's lymphoma. Cytarabine was approved for human use in 1969. It is given by injection into a vein, under the skin, or into the cerebrospinal fluid. It is also known as cytosine arabinoside.



Credit: Pixabay

GALLERY

»»» RIA GURUNG | BTC 1ST YEAR

3D PRINTING HUMAN ORGAN TRANSPLANTS



Credit: newsweek.com

Artificial limbs have been around for a quite a while and is not an uncommon feat, and through the years there has been a steady improvement in the mobility and versatility of bionic limbs. 3D printing has now taken bionic technology even further by artificially constructing internal organs like heart, kidney and transplant them successfully. A group of scientists at Wake Forest University have grown artificial urinary bladder sacs and transplanted them into people successfully.



Credit: Daily Express

Artificial corneas are created in the lab using synthetic plastic polymethyl methacrylate as a material. This is an excellent transparent plastic with very good tissue tolerance and optical properties. This procedure of transplanting artificial corneas is called as keratoprosthesis, and restores vision in patients with corneal blindness.



Credit: BBC News

A face transplant is a process in which skin grafts are used to replace all or a part of the patient's face with a donor's face. Recently, due to the advancement in 3D technology, a transplant patient, whose face was severely damaged in an accident, received a new nose, lips, teeth, and cheekbones during the 24-hour long surgery. This highly complex and time-sensitive surgical procedure was facilitated by 3D printing and virtual 3D design.

GALLERY

»»» RIA GURUNG | BTC 1ST YEAR



Credit: Business Insider.

HEALTHY CHOCOLATE

Scientists claim that in another five years, they could unlock the secret of how to make chocolate healthy by changing the genetic code of the cocoa bean. There are certain chemicals called flavonols present in the cocoa beans which lower blood pressure and can help keep the heart healthy. Therefore, the scientists believe that they can change the DNA of the cocoa tree so it produces beans with far higher levels of flavonols. And they also hope to produce beans that can help fight off diabetes, as well as making the fat in cocoa much healthier.

SYNTHETIC FOODS: LAB GROWN MEAT

Synthetic biology, or simply “synbio,” involves the creation of entirely new organisms with DNA sequences created from whole scratch on a computer. These organisms, typically bacteria or algae, are used to produce valuable commodities such as flavorings and oils in industries currently, but it is unnoticed and unannounced owing to public stances. Scientists have recently developed a process to grow synthetic meat products by taking stem cells from animals; feeding those cells required nutrients, and speeding up their growth in a bioreactor.



Credit: proteinreport.org

GLOSSARY

New Tissue Clearing Methods Offer A Window Into The Brain, pg 08

1 Tissue optical clearing technology: Tissue clearing technique aims to make tissue transparent by minimizing light scattering and light absorption, thus allowing deep imaging of large volume samples.

2 PEG (Polyethylene Glycol): is a polyether compound derived from petroleum, and can be modified and crosslinked into a hydrogel to be used to mimic the extracellular matrix (ECM) environment for cell encapsulation and tissue studies

3 Submicron resolution: viewing details and components that are less than a micron in diameter or less than a micron in a (specified) measurement.

First clinical-grade transplant of gene-edited pig kidneys into brain-dead human, pg 23

1 Xenotransplantation: The process of grafting or transplanting organs or tissues between members of different species.

2 Genetically modified organism: Any organism whose genetic material has been altered using genetic engineering techniques.

3 Gene editing: A type of genetic engineering in which DNA is inserted, deleted modified or replaced in the genome of a living organism.

REFERENCES

PCR - Biotech's Masterpiece, pg 04

1. https://www.sciencelearn.org.nz/image_maps/35-what-is-pcr-used-for
2. http://siarchives.si.edu/research/videohistory_catalog9577.html
3. https://www.bosterbio.com/media/images/MB_PCR_components.png

Rise of Genetically Modified Mosquitos, pg 06

1. <https://www.indiatimes.com/technology/science-and-future/singapore-dengue-genetically-modified-mosquitoes-521477.html>
2. <https://www.nea.gov.sg/corporate-functions/resources/research/wolbachia-aedes-mosquito-suppression-strategy>
3. <https://www.worldmosquitoprogram.org/en/work/wolbachia-method/how-it-works>
4. <https://www.nature.com/articles/d41586-021-01186-6>
5. <https://www.bbc.com/news/world-36320744>
6. <https://www.oxitec.com/en/news/oxitecs-friendly-mosquito-technology-receives-us-epa-approval-for-pilot-projects-in-us>

New Tissue Clearing Methods Offer A Window Into The Brain, pg 08

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7571329/>
2. [https://www.cell.com/iscience/pdf/S2589-0042\(20\)31085-3.pdf](https://www.cell.com/iscience/pdf/S2589-0042(20)31085-3.pdf)
3. https://cdn.the-scientist.com/assets/articleNo/66465/iImg/33675/uploads/ueda_scale-bar.png

The Quest For Happiness: Biotechnology and Memory Numbing in PTSD Patients, pg 10

Works Cited

1. Alhayek, Soubhi, and Charles V. Preuss. "Beta 1 Receptors." *PubMed*, 11 August 2021, <https://pubmed.ncbi.nlm.nih.gov/30422499/>.
2. Alshak, Mark N., and Joe M. Das. "Neuroanatomy, Sympathetic Nervous System - StatPearls." *NCBI*, 26 July 2021, <https://www.ncbi.nlm.nih.gov/books/NBK542195/#article-29800.s1>.
3. Jan, Arif, and Khashayar Farzam. "Beta Blockers - StatPearls." *NCBI*, 13 December 2021, <https://www.ncbi.nlm.nih.gov/books/NBK532906/>.
4. Torres, Felix. "What Is PTSD?" *American Psychiatric Association*. <https://www.psychiatry.org/patients-families/ptsd/what-is-ptsd>
5. Kass, Leon. *Beyond Therapy: Biotechnology and the Pursuit of Happiness*. Executive Office of the President (United States of America), 2003.
6. Image credit: https://cdn.mdedge.com/files/s3fs-public/Image/July-2017/CP01608038_t2.PNG

Health And Happiness Of Your Child Lies In An Obtuse Story Of Inheritance? pg 12

1. <https://singularityhub.com/2021/11/02/how-mice-transmitted-turbocharged-immune-systems-to-their-offspring-through-sperm/>
2. <https://www.sciencedirect.com/science/article/pii/B9780128053881000158>
3. [Lumey LH et al. \(2007\) Cohort profile: The dutch Hunger Winter Families Study. Int J Epidemiol. 36: 1196-1204](#)
4. [Figure 6 in the article Epigenetic mechanisms of depression and antidepressant action.](#)
5. [Figure 1 in the article Epigenetic Mechanisms and Hypertension](#)
6. [Figure 6 in the article Transgenerational epigenetic inheritance: adaptation through the germline epigenome?](#)

E.Coli - The Bacteria of Biotechnology, pg 15

Works Cited

1. Idalia V-MN, Bernardo F. 2017 Jul 12. *Escherichia coli as a Model Organism and Its Application in Biotechnology. Escherichia coli - Recent Advances on Physiology, Pathogenesis and Biotechnological Applications.* doi:10.5772/67306. [accessed 2022 Jan 15]. <https://www.intechopen.com/chapters/53916>.
2. View. 2019 Apr 5. *Bacteria that changed the world: Escherichia coli. More Than A Dodo.* [accessed 2022 Jan 15]. <https://morethanadodo.com/2019/04/05/bacteria-that-changed-the-world-escherichia-coli/>.
3. Blount ZD. 2015. *The unexhausted potential of E. coli.* eLife. 4. doi:10.7554/elife.05826. [accessed 2022 Jan 15]. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4373459/>.
4. Rosano GL, Ceccarelli EA. 2014. *Recombinant protein expression in Escherichia coli: advances and challenges.* *Frontiers in Microbiology.* 5. doi:10.3389/fmicb.2014.00172. [accessed 2022 Jan 15]. <https://www.frontiersin.org/articles/10.3389/fmicb.2014.00172/full>.
5. Images credit: <https://www.intechopen.com/chapters/68841>

Development in Food Biotechnology, pg 17

1. <https://foodtechconnect.com/2010/12/21/the-future-of-biotechnology>
2. <https://passel2.unl.edu/view/lesson/d23fda63fd18/11>
3. <https://www.ncbi.nlm.nih.gov/books/NBK235032/>
4. <https://amrita.edu/news/enzymes-food-industry/#:~:text=Some%20of%20the%20enzymes%20generally%20employed%20in%20food,of%20glucans%20in%20malt%20and%20and%20other%20materials>
5. <https://www.technologynetworks.com/immunology/news/removing-food-allergens-at-the-source-343001>
6. https://studiousguy.com/biotechnology-examples/#Golden_Rice

Friend or foe? The anthrax toxin and its ability to alleviate pain, pg 20

1. <https://scitechdaily.com/can-a-dangerous-toxin-from-anthrax-microbes-quench-pain/>
2. <https://www.nature.com/articles/s41593-021-00973-8>
3. <https://www.cdc.gov/anthrax/basics/index.html>

mRNA vaccine technology has assisted in the repair of broken hearts in mice, pg 22

1. https://www.newscientist.com/article/2303617-mrna-vaccine-technology-has-helped-repair-broken-hearts-in-mice/?utm_campaign=later-linkinbio-newscientist&utm_content=later-23621025&utm_medium=social&utm_source=linkin.bio

First clinical-grade transplant of gene-edited pig kidneys into brain-dead human, pg 23

1. <https://www.sciencedaily.com/releases/2022/01/220120091128.htm>

CIIE.CO in partnership with GFI India releases study of cultivated meat ecosystem., pg 25

1. <http://www.fnbnews.com/Top-News/ciieco-in-partnership-with-gfi-india-releases-study-of-cultivated-meat-ecosystem-66198>

Biochemical and structural characterization of quizalofop-resistant wheat acetyl-CoA carboxylase, pg 27

1. <https://www.nature.com/articles/s41598-021-04280-x>

What if you got a chance to turn trash into treasure, sounds cliché right?, pg 28

1. <https://www.labiotech.eu/in-depth/biomining-sustainable-microbes/>
2. <https://etn-sultan.eu/2021/02/01/biomining-of-gold/>

JANUARY 2022 ISSUE OF THE

biogenesis

THE WONDERS OF
BIOTECHNOLOGY

THANKYOU FOR READING!

STAY TUNED FOR MORE.

THE BIOGENEAC ASSOCIATION

TEACHER CO-ORDINATOR : Mrs. Sandhya K S

SECRETARIES: Shruthi Rajaram | Rupashri Balaraman
Akanksha C A | Sharen Shilpa



To know more about us and keep up with our updates, follow our Instagram handle @biogeneiacmcc