MOUNT CARMEL COLLEGE, BANGALORE

BIOGENEIAC ASSOCIATION

BIOGENESIS

SEPTEMBER 2021 ISSUE

FEATURE ARTICLE ON

Marine Biotechnology

BIOGENESIS

THE OFFICIAL NEWSLETTER OF BIOGENEIAC ASSOCIATION
MOUNT CARMEL COLLEGE

CONTENTS

Marine Biotechnology

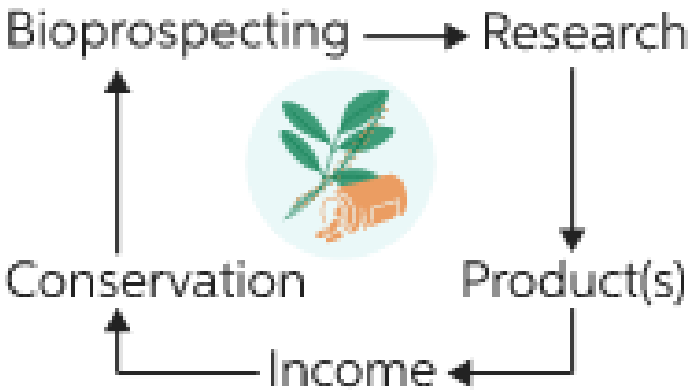
71% of the earth's surface is covered with oceans. The marine environment is a treasure casket of biological and chemical activity of a wide variety of marine organisms from prokaryotes to eukaryotes, which are of great importance to medicine, nutrition, cosmetics, agriculture and other industries. Marine biotechnology is the creation of products and processes from marine organisms through the application of biotechnology, molecular and cell biology, and bioinformatics. It is the field of science that deals with ocean exploration for development of new pharmaceutical drugs, chemical products, enzymes, and other products and processes. It also deals with the advancement of aquaculture and seafood safety, bioremediation, biofuels, among others.

What is Marine Bioprospecting?

ADITI SINGH | BTCZ 2ND YEAR

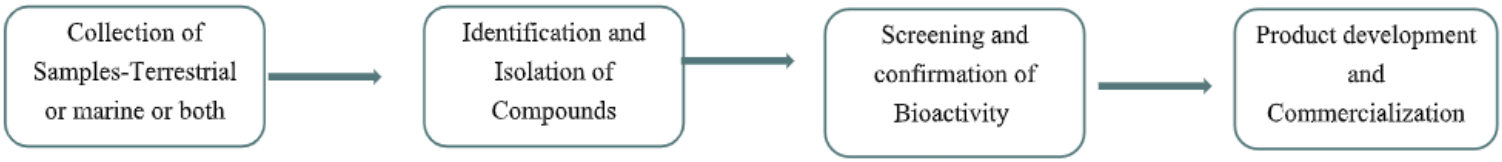
The ocean, which is called the "mother of origin of life", is also the source of structurally unique natural products that are mainly accumulated in living organisms. Marine bioprospecting is the process of identifying unique characteristics of marine organisms for the purpose of developing them into commercially valuable products. Marine bioprospecting, also known as marine natural products research, is concerned with the exploration and exploitation of the rich biological and chemical diversity found in marine organisms which inhabit the oceans. With the help of different molecular and biotechnological techniques, humans have been able to elucidate many biological methods applicable to both aquatic and terrestrial organisms. The role of marine bio prospecting is such a development can, help to explore and use knowledge about enzymes and microorganisms for the industrial utilisation of biomass. It will be possible to create high value bulk products and fine chemicals from renewable sources using processes that require less energy and create less pollution of these rounding environment. Investment in marine bio prospecting is an important part of the government's plans for building knowledge and development of industry and commerce, particularly in the high North.

The marine bioprospecting contracts can be a significant tool for the development of a successful access and benefit sharing mechanism that will safeguard the interests of the indigenous communities as well as monitor the use of marine bioresources in an environment friendly and sustainable manner.



Credits: www.chegg.com

FOUR PHASES OF BIOPROSPECTING ACTIVITY ARE AS FOLLOWS



Credits: www.environment.gov.za

The Marine Ecosystem As A Source Of Cosmetics

ANISHA JAI SINGH | BTCB 2ND YEAR

Cosmetics have been a part of our daily lives and are developed by active ingredients with the aim to attain a specific look and to protect skin's health. With more research, marine ingredients, especially the ones extracted from microalgae[1] and microorganisms (bacteria and fungi),became increasingly popular among industrial groups working on cosmetic and skin products as they offer several benefits. They are more sophisticated and can be eco-friendly. Some of the cosmetic ingredients derived from the marine ecosystem are:

1.Marine algae

Extracts of the marine algae Laminaria help protect against excessive water loss and thus help in the moisturisation of the skin. Undaria pinnatifida is another marine algae that is rich in polyunsaturated fatty acids[2] and amino acids like serine which are some of the key elements in skin moisturisation. Moreover, DNA extracts from marine algae such as Undaria pinnatifida, Durvillaea antarctica and Ascophyllum nodosum are also well-known for their skin moisturisation properties. Marine algae like Algaria esculenta also help to slow down the transfer of melanin to melanosomes[3] and thus is marketed as an anti-dark spot serum . Yet another marine algae Dunaliella salina produces β-carotene in large amounts. This carotenoid[4] helps restrict the formation of reactive oxygen species[5] and thus has anti-ageing properties. Marine algae and seaweed also help in protecting the skin from UV rays and also have skin whitening properties.They can also be used to make fragrance.

2. Marine fish derived substances

Marine fish-derived collagen is widely used in cosmetic formulations due to its excellent skin repair and regeneration properties.Despite its origin, the marine fish-derived collagen has low odor and improved product mechanical strength. It also possesses a better absorbing capacity than collagen obtained from other animal sources. Fish-derived proteins and peptides have also been investigated for their capacity to provide a protection to the skin from UV radiation. Fish skin and jellyfish (Rhopilema esculentum) collagen and collagen hydrolysate also provide efficient protection against the harmful effects of UV radiation. They not only provide protection against the degradation of skin lipids but also stimulate collagen synthesis, preventing photo-aging[6].

3. Sea water and sea mud

Sea water minerals also have beneficial properties. Sea water contains minerals (sodium, potassium, magnesium, calcium, sulfates, and chlorides) which are beneficial for the skin. Moreover, sea salts can be used in cosmetics for skin care. Deep-sea water has beneficial properties on general health and especially on skin health and can help with conditions like atopic dermatitis. The health benefits are related to the minerals contained in the sea water and to the quality of the deep-sea water sources. Sea mud contains various nutrients and minerals, and has been used in skin care and cosmetic product formulations for their beneficial effects and therapeutic properties on psoriasis and other skin-related disorders. Sea mud helps to retain water, balances skin pH, promotes acne repair and prevention, and exhibits anti-aging properties. However, sea water and sea mud can contain toxic elements that occur naturally or due to pollution and must therefore be subject to strict control The potential applications of natural molecules derived from the marine world promise a bright future for the cosmetic industry that is constantly looking for innovation. Therefore, a wide variety of marine natural products have received increased attention. However, their potential has not been utilised completely especially for deep sea-inhabiting marine organisms that have yet to be described.

Estée Lauder put Resilience on the market in the early 2000. The product contains pseudopterosin, an extracellular extract taken from the Caribbean Sea whip (a soft coral).

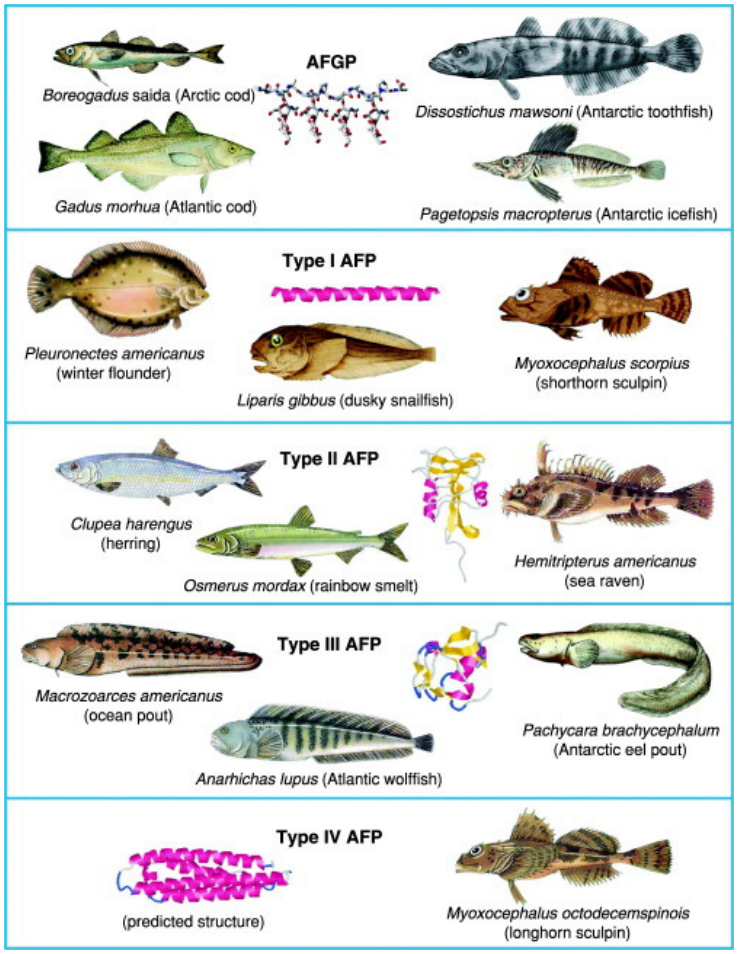
Antifreeze Proteins & It's Significance

TANISHA GAYON | BTCZ 2ND YEAR

One of the most successful examples of identifying novel genes with promising applications involves genes for antifreeze proteins (AFPs). A/F Protein, Inc., of Massachusetts, is a leader in the production of antifreeze proteins. Many of the first AFPs were isolated from the bottom-dwelling fish species such as northern cod, which live off the coast of northern Canada, and Antarctic fish teleosts, which live in extremely cold ice-laden waters; some of the most severe environments on earth. Subsequently, AFPs have been isolated from a number of other cold-water species, including winter flounder (Pleuronectes americanus), sculpin (Myoxocephalus scorpius), ocean pout (Marcrozoarces americanus), smelt (Osmerus mordax), and herring (Clupea harengus).

Structurally, most AFPs have extensive alpha helices* and are held together by large numbers of disulfide bridges. AFPs function to lower the freezing temperature of fish blood and extracellular fluids, thus protecting fish from freezing in rigid marine waters. Seawater freezes at approximately -1.8°C. AFPs typically lower the freezing point* of fish body fluids by approximately 2°C to 3°C. Currently, the majority of AFPs are isolated from fish blood.

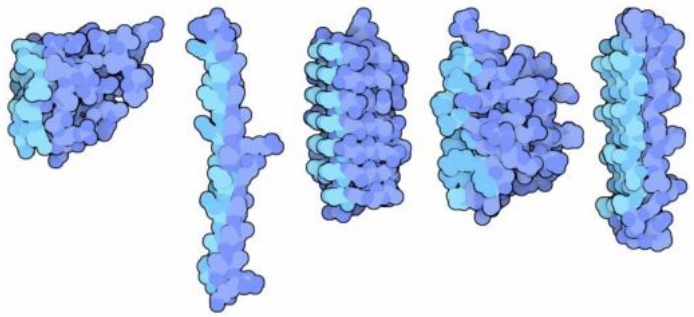
AFPs protect living organisms from freezing in a variety of ways. They can bind to the surfaces of ice crystals to modify or block ice crystal formation, lower the freezing temperature of biological fluids, and protect cell membranes from cold damage. Because of these unique abilities, a number of innovative applications for these cryoprotective* proteins are being developed.



Antifreeze protein structures shown along with the corresponding fish species. The structure of the gadid and notothenioid antifreeze glycoproteins (AFGPs), as well as the longhorn sculpin antifreeze peptide (AFP) are from structural modeling. The structures of type I, II, and III AFPs are experimentally solved by X-ray crystallography and/or nuclear magnetic resonance spectroscopy.

Antifreeze protein structures shown along with the corresponding fish species. The structure of the gadid and notothenioid antifreeze glycoproteins (AFGPs) and the longhorn sculpin antifreeze peptide (AFP) are from structural modeling. The structures of type I, II, and III AFPs are experimentally solved by X-ray crystallography and/or nuclear magnetic resonance spectroscopy.

AFPs are used to create transgenic* fish and plants with enhanced resistance to cold temperatures and freezing. For instance, salmon cannot produce antifreeze molecules; thus, they die when exposed to near-freezing water. Waters off the coast of eastern Canada, too cold for wild species of salmon, are being considered as potential aquaculture habitat for freeze-resistant species of transgenic salmon containing AFP genes. AFP gene promoter sequences* from ocean pout are also being used in recombinant DNA experiments to stimulate growth hormone (GH) in salmon. Transcription* from the AFP promoter is stimulated by cold temperatures; therefore, transgenic fish containing this construct synthesize large amounts of growth hormone when they are raised in cold water.



Several different antifreeze proteins (left to right: the ocean pout, the winter flounder, and three very active proteins from insects, the yellow mealworm beetle, the spruce budworm moth, and the snow flea, with the ice-binding portions in lighter blue).
Graphic: David S. Goodsell and the RCSB PDB | CC-BY-4.0

Cryoprotection of human cells, tissues, and organs is a promising medical application of AFPs. Cold storage of oocytes* used for in vitro fertilization is one potential application. Bovine oocytes were incubated for 24 hours at 4°C in the absence (control) or presence of different types of AFPs or antifreeze glycoprotein (AFGPs), a carbohydrate-rich type of AFP, and then fertilized with bovine sperm. AFP- and AFGP- treated oocytes showed fertilization rates similar to those of fresh oocytes, thus indicating that AFPs can provide cold protection of oocytes that will maintain their ability to be fertilized.

AFPs may prove helpful in the storage of a number of human tissues, including blood, and for the development of new protocols for the cryogenic stage of human organs such as the heart and liver prior to their use in transplantation surgery. Finally, AFPs may be used to improve shelf-life* and the quality of frozen foods by altering their ice crystallization properties. Scientists have even proposed AFPs to control ice formation on aircraft and roadways.

Genomic Characterisation Of The Barnacle *Balanus improvus* Reveals Extreme Nucleotide Diversity In Coding Regions

SREEPRIYA PRADEEP | BTCZ 3RD YEAR

Barnacles are sessile marine crustaceans encompassing around 1200 species that are usually gregarious and can be found at high densities in shallow and tidal waters around the globe.

Barnacles were in many respects the first model organism in evolutionary biology as reflected in Darwin's work, with their specialized morphologies and reproductive systems making them ideal for testing theories on biological evolution. However, barnacles are also of importance for diverse aspects of marine biotechnology. They are one of the main biofouling organisms on man-made underwater constructions, such as the piping of cooling units and ship hulls, causing considerable ecological and economic impact.

Despite causing considerable ecological and economic impacts, there is a surprising void of basic genomic knowledge, and a barnacle reference genome is lacking. They play key roles in the marine ecosystem of intertidal rocky shores. However, they can also establish populations in the deep-sea down to 2000 m. Many barnacle species are epibionts* on various marine animals including turtles and whales, where they are filter feeders and have a commensal relationship with their host. Barnacles produce one of the strongest underwater adhesives and are therefore of great interest in many applications.

Gene expression is dependent on life-stage, environmental conditions, and the tissue investigated. In addition, gene expression studies using transcriptome sequencing* with short sequencing-reads on organisms that lack a reference genome are also unsatisfying in that it requires the generation of a de novo assembly*. Genome characteristics of *B. improvisus* in an attempt to establish a future high-quality reference genome, besides setting the scene for future genome projects on B. improvisus, also reports important insights into the extreme nucleotide diversity in the coding regions of this species, which will have consequences for applications in both marine biofouling* and marine biotechnology.

Credits: https://www.chesapeakebay.net/

The genome of the bay barnacle *Balanus improvisus* is based on short-read whole-genome sequencing and experimental genome size estimation. It has been shown both experimentally by DNA staining and flow cytometry and computationally by k-mer analysis that B. improvisus contains a haploid genome size of ~ 740 Mbp. A pilot genome assembly rendered a total assembly size of ~ 600 Mbp and was highly fragmented with an N50 of only 2.2 kbp. Further assembly-based and assembly-free analyses revealed that the very limited assembly contiguity is due to the *B. improvisus* genome having an extremely high nucleotide diversity in coding regions and an overall high repeat content of at least 40%. We also report on high variation in the α-octopamine receptor OctA, which might increase the risk that barnacle is resistance toward antifouling agents*.

The genomic features described here can help in planning for a future high-quality reference genome, which is urgently needed to properly explore and understand proteins of interest in barnacle biology and marine biotechnology and for developing better antifouling strategies.

This picture has been taken by Andrew Butko.

Biotechnological Solutions To Assess, Monitor & Remediate Metal Pollution In The Marine Environment

PEMA LHAMU | BTCB 2ND YEAR

The colossal rise in human population, industrialization, and increased human activities along coastal regions have cumulatively caused an escalation in the abundance of metals in marine environments. Although naturally released in the oceans through weathering and leaching processes, metal discharge has drastically increased due to anthropogenic activities* such as industrial discharge, wastewaters, agricultural effluents, fossil fuel combustion.

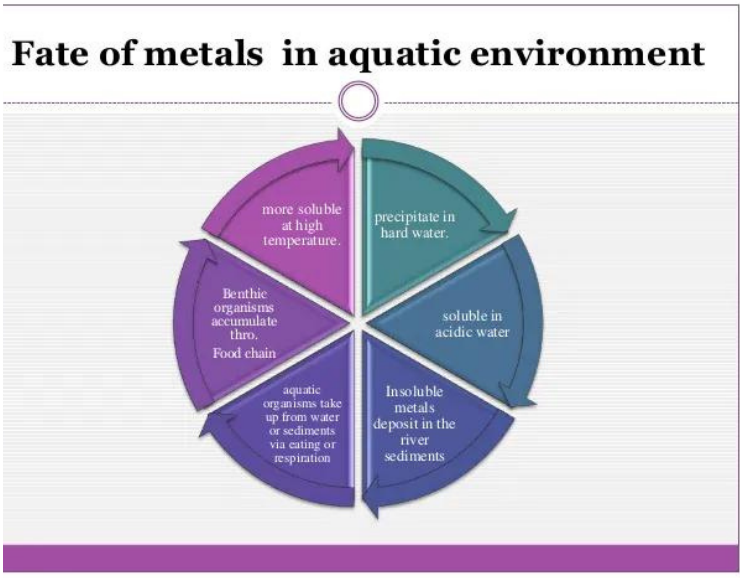
Metal-toxicity* is becoming an issue of increasing environmental concern since they are persistent (even at low concentrations), have an accumulative behaviour (namely in sediments), and are capable of long-range transport via suspended particles. Also, they can either remain dissolved or suspended in the water column and become bio-available to be incorporated by organisms, entering food chains. Despite several attempts to circumscribe and contain metal contamination, the enormity of this issue seems to outrun the remedial measures. There is an imperative need to restore the ecological balance of these ecosystems by providing effective counter measures in the marine environment.

Environmental biotechnology provides pivotal tools for assessing, monitoring, remediating and mitigating the adverse effects of metal pollution in the marine domain. Several marine organisms, ranging from algae to plants and from invertebrates to vertebrates, have metal sorption or metal accumulation abilities. They provide valuable information on the temporal and spatial variations of bioavailable metals within the marine environment. Marine bacteria and fungi are considered suitable biosensors for metal toxicity measurements, for monitoring metal bioremediation processes, and can act as metal detoxification* agents. Bioremediation* processes involving marine bacteria, fungi, algae and plants are efficient, eco-friendly and less expensive options of containing metal pollution compared to conventional (chemical and physical) methods.

Marine biotechnological techniques addressing metal pollution have been steadily developing; researchers have created several environmental applications-oriented processes that help combat metal pollution in the marine environment. However, there are restrictions to the applicability of certain processes and others are not widely popularized.

Thus, a re-awakening and a compilation on the topic of metal pollution in the marine environment is necessary. This topic aims to bring together the most recent advances and biotechnological approaches, tools, and solutions that may assist in the assessment, monitoring, detoxification, and remediation of metals in marine environments.

Therefore, novel microorganisms should be bio prospected and screened for bioremediation without causing adverse effects.



Credits: Slideshare.net/heavy-metal contamination

The possibilities of production of biosurfactants* from microorganisms grown on petroleum hydrocarbons will effectively improve the bioremediation potentials on oil pollutants, particularly oil polluted marine environment and exemplify the eco-sustainable bioremediation that can be achieved in sensitive marine and fragile environments.

Dr. Claud Ephraim ZoBell

JUHI SINGH| BTCZ 3RD YEAR

Dr. ZoBell was born in Provo, Utah, but his family moved to Rigby, Idaho, when he was young. He pursued studies in biology and bacteriology at the University of California at Berkeley. BY the time he was awarded his Ph.D. in 1931, he had already conducted several studies on the biochemistry of various bacteria and developed his interest in marine biology. ZoBell's first position was as Instructor of Marine Microbiology at the Scripps Institute of Oceanography. He was made a full-time professor in 1948 after conducting research in environmental biology. While at the Scripps Institute, ZoBell left his research in medical microbiology in favor of pursuing his interests in marine life. He was among the first generations of modern marine biologists.

He was the father of marine microbiology. He pioneered research on effect on microorganism in relation to chemical, geological and biological process. His scientific publication numbers nearly 300, including the excellent book entitled Marine Microbiology. For his scientific accomplishments he received many citations and awards which include the Galetha Medal (by King Frederick IX of Denmark), the citation from the Third World Congress of Petroleum Geologists, the Oceanology Medal of the USR Academy of Science, U.S. Congressional citation for his service to the Petroleum Engineers Environmental Control Development program, and the Hatai Medal of the Pacific Science Association. Utah State University presented him with distinguished Service Award and an honorary D.Sc. He was also retained as a consultant to many companies and corporations. Throughout his scientific carrier he was aided by his wife. Jean, who was also a microbiologist. Her loving care and devotion greatly aided the field of marine microbiology. Dr. ZoBell never neglected the nonscientific aspects of society. He devoted much time to the San Diego Zoo, Board of Directors of the La Jolla Visiting Nurses Association. He died of cardiac arrest when he was 84 on Monday at Scripps Memorial Hospital in La Jolla.

Sylvia Alice Earle

RUVIZA MUSKAN | BTCZ 2ND YEAR

"Look at the bark of a redwood, and you see moss. If you peer beneath the bits and pieces of the moss, you'll see toads, small insects, a whole host of life that prospers in that miniature environment. A lumberman will look at a forest and see so many board feet of lumber. I see a living city."

Sylvia Alice Earle is an American marine biologist oceanographer, explorer, author, and lecturer. Born in New Jersey on August 30th 1935, Earle moved to Florida when she was 12, where she became fascinated by the ocean. “I had a chance to get acquainted with spiky sea urchins. Little tiny seahorses that live in the grass meadows,” she recalls. And so, she tried scuba-diving. “The weightlessness was so entrancing that they had to practically haul me out of the water.”

Embarking on her first research voyage in 1964, five years later Earle applied for Nasa’s ambitious Tektite project, which was going to send scientists down to live on the seafloor for weeks at a time. Despite having racked up more hours underwater than the male scientists who applied, she was rejected—the organizers couldn’t envisage the concept of men and women cohabiting in isolation for so long. Refusing to accept defeat, Earle came up with an alternative. In the summer of 1970, she led Tektite II, Mission 6 an all-female expedition of aquanauts, who spent two weeks on the seafloor, living close to a coral reef. Recording observations and snapping photographs, their findings were subsequently published.

The more instantaneous result though, was the public’s reaction to the Mission. When Earle and her colleagues returned, they were celebrities whose fame reverberated far beyond the spheres of the scientific community. Showered with attention, awards and accolades, they were even given a reception at the White House, and Earle realized that she could use her unique platform to inspire women and galvanize the public into caring about conservation and the ocean. Bold and varied, Earle’s work over the following decades has reflected that mission. In 1979, she walked, untethered, 1250ft below sea level on the floor of the Pacific Ocean—the lowest any human had gone. In the 1980s, she founded a company aimed at making technologically-advanced submersible vehicles;

In the 90s, she became she first female chief scientist at the National Oceanographic and Atmospheric Administration, where she was responsible for monitoring the health of the ocean.

"Life in the ocean is endlessly fascinating. Imagine what it's like to go where you have a mile of water over your head. It's dark, but it's beautiful," she says.

Today, and now in her eighth decade, Earle is National Geographic's Explorer-in-Residence, the founder of Deep Ocean Exploration and Research, and works with Google Earth Ocean. Awarded a prize, Earle used the money to launch her Mission Blue foundation, whose objectives are neatly encapsulated in her acceptance speech: "Use all means at your disposal films, expeditions, the web, new submarines to create a campaign to ignite public support for a global network of marine protected areas," she urged. Soon afterwards, Netflix made Mission Blue, a documentary about Earle's efforts, which probes the environmental impact of practices like harvesting shark fins and oil pollution, and juxtaposes them against brilliant, sweeping underwater cinematography.

Throughout her career, Earle has authored more than 200 publications, lectured in more than 80 countries, and led more than 100 marine expeditions (totaling over 7,000 hours under water). She has received 27 honorary degrees and more than 100 honors from around the world. Some of the most notable awards include Time magazine's first Hero for the Planet (1998), the United Nations Champion of the Earth (2014), and the 2009 TED Prize.

Credits: www.vogue.fr

UP NEXT

NEWS BRIEFING

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

Read on to find out the latest in

| HUMAN & MEDICAL BIOTECHNOLOGY |

| ANIMAL BIOTECHNOLOGY |

| PLANT & AGRICULTURAL BIOTECHNOLOGY |

| INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY |

Is HIV Immortal, Or Is It?!

Moderna's mRNA technology could help in the decades- long search for HIV vaccine

AMARA NICODEMUS AND SHIFA |BTCZ 3RD YEAR

20 AUG 2021

Moderna - Pharmaceutical and Biotechnology Company, Cambridge Massachussetts

In this crazy yet fast-paced world of ever-expanding tech savvy beings, we have managed to face off probably what was the most unforeseen set of circumstances, where the world had suddenly plunged into the darkness of a deadly disease. Yes, we are referring to the covid crisis that is yet to pass. But thanks to the quick response by scientists all over the world, along with unexpected collaborations between various companies and countries to purge this virus, the *mRNA vaccine* was developed. So, what is this magical cure that has got everyone's attention?

mRNA, or messenger RNA, is a molecule very much similar to DNA. But unlike DNA, RNA is single-stranded. It is the genetic material of many bacteria and viruses which undergo a process called "reverse transcription", make use of the host's body cells to make more copies of themselves, and hence cause infection. mRNA is the 1st product of protein synthesis where DNA gets transcribed to an mRNA. This mRNA then gets converted to proteins through a few more steps which are essential to our body, or in the microbe's case, their survival.

Due to the complexity of the novel coronavirus strain, scientists couldn't fathom how one could stop the virus from multiplying at the rate it was. They had to come up with a way that would stop its cycle before it even began to infect the person, and so the answer came from a very unexpected source. Scientists discovered that bacteria had been using the mRNA method of defense against pathogens for as long as they existed and decided to give it a try in humans.

SO, WHAT IS MRNA VACCINE AND HOW EXACTLY DOES IT HELP US?

Vaccines work by training the body to recognize and respond to the proteins produced by pathogens. Usually this means that the person is given a weak, live form of the microbe, or a dead one, which provokes the body's immune system into mounting a response. The mRNA vaccine, however, tricks the body into producing some of the viral proteins itself.

The mRNA vaccine was produced synthetically in laboratories, a version of the mRNA that a virus uses to build its infectious proteins. This

Credits: nytimes.com

mRNA was delivered into the human body, whose cells read it as instructions to build the viral protein (the protein coat or in the case of HIV, the spike proteins that are on the surface of the virus) and therefore create some of the virus's molecules themselves. These proteins are solitary, so they do not assemble to form a virus. The immune system then detects these viral proteins and starts to produce a defensive response to them.

One of the biggest obstacles scientists had to solve was getting modified RNA into cells without creating an immune response. A part of the mRNA molecule was alerting the immune system and just by tweaking the structure of one of those molecules that caused an immune response, scientists were able to sneak in the mRNA into the cell.

Scientists at the university of Pennsylvania were able to create mRNA that could get past cells but still be recognized by the ribosome (protein factory of the cell).

Since the mRNA is fragile and would be chopped into pieces by natural enzymes in our body it cannot be directly injected. Therefore, Moderna wraps the mRNA molecule in oily bubbles made of lipid nanoparticles.

Now that we have the basic understanding of what an mRNA is and how it works, let's see how it has been theorized to help cure HIV

WHAT IS HIV?

HIV or human immunodeficiency virus, is a virus that attacks the body's immune cells that help the body fight infections, making a person more vulnerable to other infections and diseases. It is spread through contact of bodily fluids of a person infected with HIV, most commonly during unprotected sex, or through sharing injections- drug equipment, blood transfusion etc. HIV indefinitely leads to AIDS (acquired immunodeficiency syndrome).

AIDS is the late stage of HIV infection that occurs when a person's immune system is badly damaged because of the virus. There have been medications developed by big corporate medical companies to help battle HIV, but these are just temporary, and only prolong the person from developing AIDS. Hence, it is imperative that we find a cure for this disease.

WHY HAVEN'T SCIENTISTS BEEN ABLE TO FIND A VACCINE FOR HIV?

HIV is probably one of the few diseases from the pre-tech world (era?) that still is yet to be vanquished. This is because of its ever-mutating form, as its main survival mechanism. It constantly keeps creating new strains at a rapid rate, meaning that a vaccine targeting a single surface protein wouldn't work, hence the many vaccines produced against it being deemed useless, leading to an ineffective drug, and a superbug. The biological properties that HIV has evolved make development of a successful vaccine very, very difficult. First and foremost is the continuous unrelenting viral replication. For a vaccine to be effective against HIV, it will likely need to provide an absolute sterilizing barrier and not just halt or prolong viral replication. HIV has evolved an ability to generate and tolerate many mutations in its genetic material due to which an enormous amount of variation among strains of the virus

not only from one individual to another but even within a single individual exist.

HIV has also evolved an incredible ability to shield itself from recognition by antibodies.

MODERNA's MRNA VACCINE FOR HIV IS STARTING HUMAN TRIALS

Covid was the first disease mRNA therapeutics tackled, and given the success of the Pfizer and Moderna vaccines at preventing severe cases of the virus, it won't be the last.

Moderna has launched trials of its experimental mRNA-based HIV vaccine called mRNA-1644. In addition to the initial version of the vaccine, Moderna also developed a variant called mRNA-1664-v2-core.

PHASE 1 TRIAL

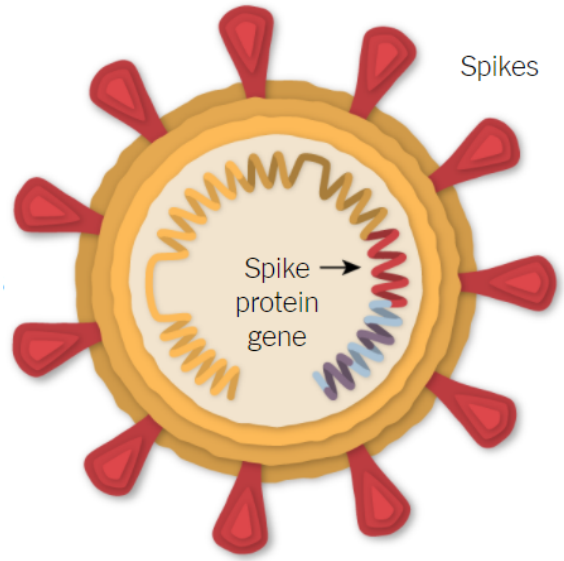
The phase 1 trial will consist of giving the vaccine to 56 adults who don't have HIV, with the primary goals being to evaluate its safety and monitor the development of an immune response in participants. The trial will be split into four different groups, with one group getting mRNA-1644, a second group getting mrna-1644-v2, and the remaining 2 groups getting a mix of both versions. rather than a blind trial, where people don't know what they're receiving, participants will be informed of what they're being given. The phase 1 trials are scheduled to take around 10 months.

24 to 48 hours after getting a shot of the vaccine, the recipient's cells start to manufacture the spike protein. The body tags it as an invader and launches an immune response.

BROADLY NEUTRALIZING ANTIBODIES (bNAbs)

The HIV virus is more complicated. It creates new strains at a rapid rate, meaning that a vaccine targeting a single surface protein would not work. Instead, this vaccine's aim will be to generate broadly neutralizing antibodies (bNAbs) that can recognize and block many types of HIV from entering healthy cells and which may also activate other immune cells to help destroy HIV infected cells.

If it is ultimately successful, the HIV vaccine could be particularly helpful in countries or areas where people do not have easy access to antiretroviral and pre-exposure prophylaxis drugs (PrEP).



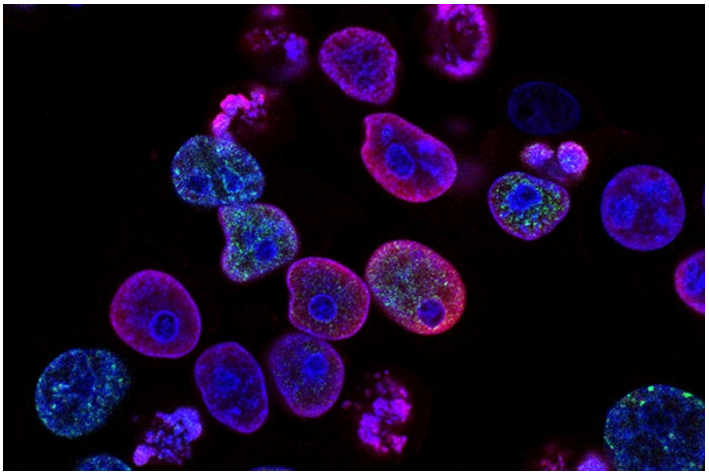
Credits: nytimes.com

Nano-clay For Cancer Therapy

Bio-compatible magneto particles will help deliver drugs to diseased cells

VINAYA KRISHNAN | BTCB 2ND YEAR

Cochin University of Science and Technology (Cusat)



Credits: NCI Centre for Cancer Research

Researchers at Cochin University of Science and Technology (Cusat) have developed a method to target cancerous genes with the help of functional nanoparticles*. These flake-like magnetic nano clays have a unique property that can be used for targeted cancer therapy with minimal side effects.

The principal investigator, Dr. Sailaja G. S worked in the lab of Manoj Raama Varma, Chief Scientist, CSIR's National Institute for Interdisciplinary Science and Technology, who is the co-investigator of the project along with Anjana K, a Ph.D. student and project fellow.

The particles of this method are bio-compatible and tumor cells take up the particles, and when external magnetic field is subjected to the area they get heated up and increase their temperature to 40 degrees within 10 minutes (in the presence of alternating magnetic fields).

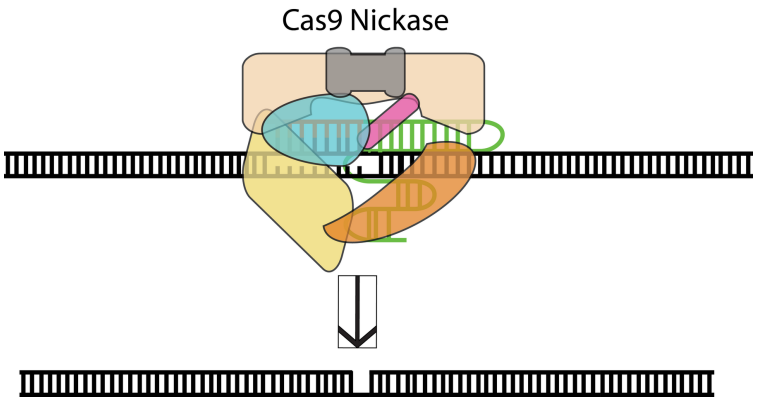
This method aids in loading up clinically used chemotherapeutic* drugs in between the layers which subsequently confers a dual therapy with minimum side effect to the subject.

Improvement of disease resistance in livestock; application of CRISPR/Cas 9 technology

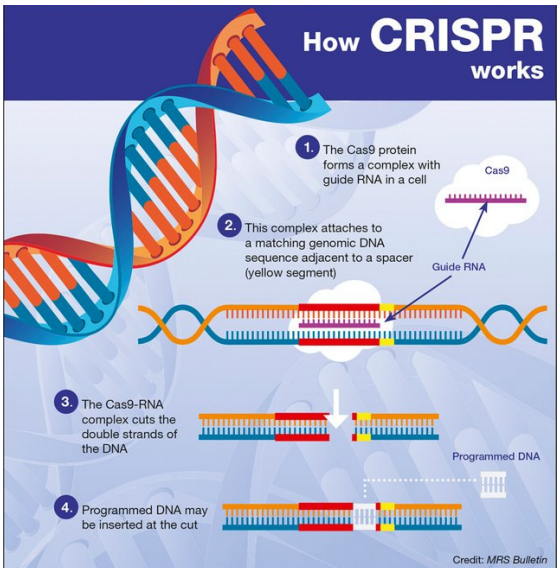
NIKHILA MOHAN | BTCZ 2ND YEAR

Bangladesh Agricultural University

Disease occurrence adversely affects livestock production and animal welfare, and have an impact on both human health and public perception of food animal production. Combined efforts from farmers, animal scientists, and veterinarians have been continuing to explore the effective disease control approaches for the production of safe animal originated food. Disease resistant animals can be produced by molecular breeding by introducing the genomic marker responsible for disease resistance or immunocompetence. Bovine tuberculosis(bTB) is a chronic bacterial disease which is caused by myobacterium bovis in cattle. This infection can be transmitted to humans mainly through the ingestion of unpasteurized milk products resulting in a 10-15 percent prevalence of human TB. In order to produce bTB resistant cattle, natural resistance to infection with intracellular pathogen 1(NRAMP1) gene has been proven to be a strong candidate. The clustered regulatory interspaced short palindromic repeats (CRISPR/CRISPR-associated protein 9(Cas9)) system is one of the latest genomic editing tools that has been widely used in livestock. Cas9 nickase (nCas9) is used to insert NRAMP1 into genome of the bovine fetal fibroblast. These engineered fibroblast cells are then used as donor cells in somatic cell nuclear transfer, where the NRAMP1- containing donor cells are inserted into cow's ovum. The inserted gene shows high degree of resistance to bovine TB infection. The Cas 9 mediated genome editing, is a breakthrough tool for improving disease resistance in livestock due to its high precision. Minimizing the risk of off-target mutations would restore the animal welfare standard and increase consumer acceptance of food products derived from genome edited livestock.



Credits: sites.tuft.edu



Credits: sites.tuft.edu

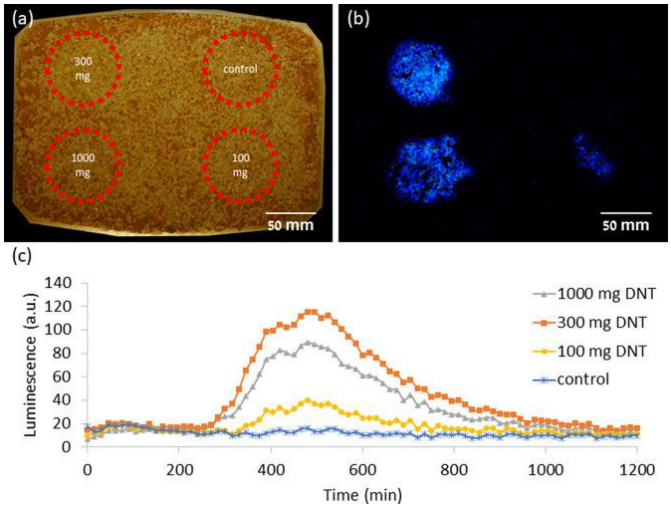
Microbial Biodetection Of Trace Explosives

Escherichia Coli azoR promoter as a new sensing element

MALEEHA AFAQ | BTCZ 2ND YEAR

Studied by : Y.Henshke, B.Shemer, S.Belkin

DNT (2,4-dinitrotoluene), a volatile impurity found in military grade TNT-based explosives, is a potential tracer for the detection of buried landmines and other explosive devices. Previously DNT bioreporter* strains , based on a fusion between the Escherichia coli yqjF gene promoter* to either a bacterial luxCDABE luminescence gene cassette or to the green fluorescent protein gene gfp, were described . However, the azoR gene promoter has been demonstrated to be strongly induced by DNT as an alternative sensing element for this compound.



Credits: www.news.asu.edu.com

An E. coli bioreporter strain harbouring a plasmid-borne fusion of the azoR promoter region to Photorhabdus luminescens luxCDABE displayed stronger bioluminescent responses to DNT than the yqjF-based bioreporter. The azoR promoter was induced not directly by DNT but by its degradation products; the most potent inducer was 2,4,5-trihydroxytoluene (THT). This reaction was positively regulated by YhaJ, a member of the LysR family of transcriptional regulators*, and was significantly amplified in a yhaK mutant. Also, DNT degradation in E. coli involves glutathione, which plays a vital role in azoR gene promoter activation.

Recombinant DNA Technology & Transgenic Animals

Genetically Modified "Glofish"

MALEEHA AFAQ | BTCZ 2ND YEAR

A transgenic or genetically modified organism is one that has been altered through recombinant DNA technology, which involves either the combining of DNA from different genomes or the insertion of foreign DNA into a genome. GloFish are a type of transgenic zebrafish (Danio rerio) that have been modified through the insertion of a green fluorescent protein (gfp) gene. Not all GloFish are green, however. Rather, there are several gfp gene constructs, each encoding a different colored phenotype*, from fluorescent yellow to fluorescent red.

Currently, GloFish is the only recombinant*-DNA animal that has been approved for human "use" by the U.S. Food and Drug Administration. They were specially bred to help environmental pollutants.

The long-term goal for the scientists was to detect toxins in water so that polluted waterways could be identified and could protect the local communities using those waterways.

Credits: prnewswire.com

Credits: tankfacts.com

“The first step was to make them fluoresce all the time,” explains Alan Blake, co-founder, and CEO of Texas-based Yorktown Technologies, which introduced GloFish to the home aquarium market in 2003. “The eventual goal was that they would selectively fluoresce in the presence of toxins,” he said.

Sustainable Coffee From Cell Culture

State-owned Finnish sustainable research company VTT succeeds at first lab cultured coffee

RUPASHRI BALARAMAN | BTCZ 3RD YEAR

15 SEPT 2021

VTT Technical Research Centre of Finland, Oulu, Finland.

Sustainable coffee has been successfully produced from laboratory cell cultures* of plant cells, marking the start of what could be a new market product alongside traditional coffee as we know it now. It isn't surprising that this new and exciting success comes from none other than Finland, a country that is known to drink the most coffee per capita.

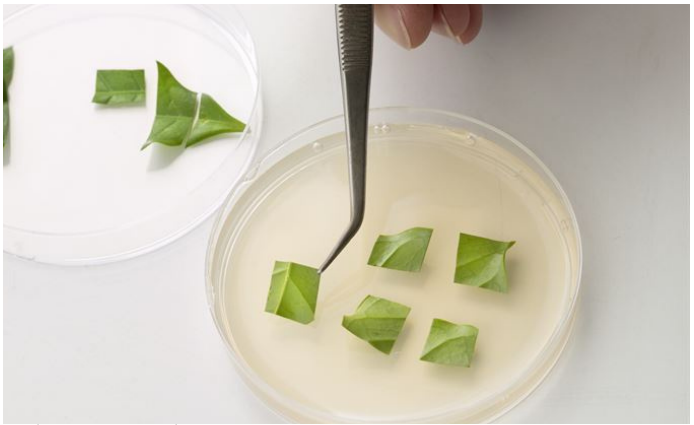
The VTT Technical Research Centre of Finland produced coffee cells in a bioreactor through cellular agriculture. They were elated to find that the first batches produced in their laboratory smell and taste like conventional coffee.

The idea for cell cultured coffee isn't entirely new, and was birthed as far back as in the 1970's by P.M.Townsley, whose paper on the same was published in the Canadian Institute of Food Science and Technology Journal in January, 1974. It took several years to perfect the process, with failures in the design, the hormones used, defective consistency of the cell culture and the inability to produce uniform coffee aroma and likeness in all cultures. And so it is a rather exciting success that we've currently reached after years of methodical and patient trials!

Suspension cultures of *Coffea arabica* were initiated and cell lines* were established. Then, they were transferred to bioreactors* where they began to produce biomass. A roasting process was developed to roast the biomass* after analyses, and the coffee would be finally evaluated for its success in terms of smell, taste and safety.

With increasing demand and numerous sustainability challenges concerning coffee agriculture, there has been an existing need for alternative methods. In sensitive rainforest areas, coffee agriculture can lead to severe deforestation, plummeting us further towards an environmental crisis, especially considering there seems to be no decline in the demand for coffee all over the globe.

Dr. Heiko Rischer, who was Team Leader for this endeavour estimated that it would take another four years before coffee produced in the laboratory is approved by the FDA* and production is commercially ramped up.



Credits: www.vttresearch.com

Credits: www.vttresearch.com

Microbial Molecule Turns Plants Into Zombies!

Discovery of manipulation mechanism used by parasitic bacteria to slow down plant aging, offers novel ways to protect disease threatened food crops

ANANYA KALLIANPUR | BTCZ 3RD YEAR

17 SEPT 2021

John Innes Centre of Research Norwich, England.

Witches' brooms, and a curse that lead to a cure! We often hear about how crop disease decimates food crops and how that affects the food supply and food security. Today, it is estimated that up to 12.5% of global crop losses are because of bacteria that are carried by insects. Now, a study on the very same pathogens that destroy the food crop, has ensured possible protection of plants from disease.

Parasites manipulate the organisms they live off to meet their requirements. When under the control of a parasite, some plants undergo drastic changes such as cessation of reproduction to only serve as habitat and host for the pathogenic parasites, as such the infected plants can be referred to as zombies. Until now, there has been little to no understanding of how this takes place at a molecular level.

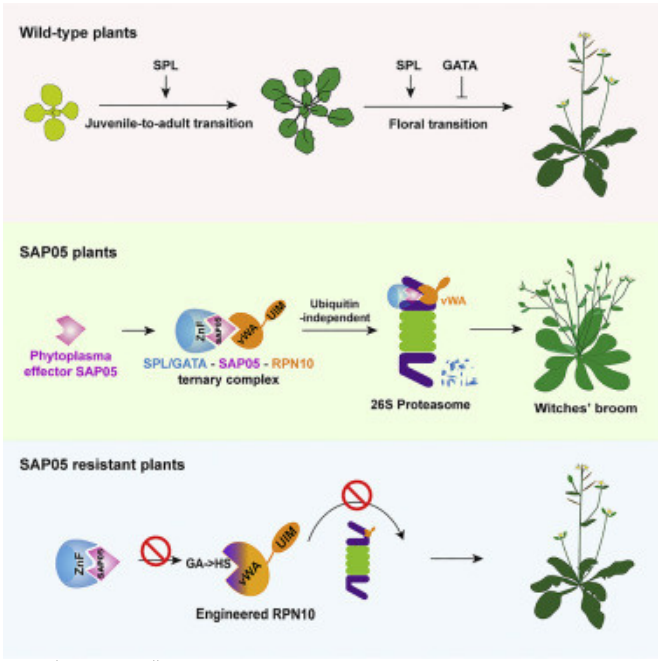
The Hogenhout group at John Innes Centre has published their study, which identifies a manipulation molecule produced by Phytoplasma* bacteria to hijack plant development and growth. When inside the plant, this protein causes key growth regulators GATA and SPL to be degraded, triggering abnormal growth. This group of bacteria is notoriously responsible for the 'witch broom'* seen in trees, where an excessive number of branches grow near each other. These bushy outgrowths are a result of 'zombie' or vegetative state* the plant is forced into. These microbes frequently cause crop disease, which causes devastating loss in yield in grains and leafy crops like lettuce, carrots, and cereals.

The new findings show that the microbial protein SAP05* takes advantage of the proteasome machinery* in the plant. The proteasome machinery is normally used to degrade proteins that are no longer required by the plant cell. When this mechanism is commandeered by the microbes, it effectively throws out vital growth and developmental proteins.

Credits: sciencedirect.com

Without these special proteins, the plant's aging is paused and it regresses into the vegetative state alongside the growth of witch-brooms,
Through genetic experiments on the model organism Arabidopsis thaliana, scientists discovered the function of SAP05-protein.
They found that SAP05 binds to both plant growth proteins and the proteasome.

Normally, the proteins, prior to degradation by proteasome, are labelled with ubiquitin molecule* but the process via SAP05 is ubiquitin-independent. Gene editing tools were used to change two amino acids* in the plant growth proteins to resemble that of insect proteins. The plant developmental proteins are similar to proteins found in animals but structurally different enough that the SAP05 was rendered unable to bind to the genetically modified plant proteins. This effectively conferred durable resistance against phytoplasma and the effects of SAP05. This finding shows much promise in protecting food crops against diseases like Aster yellow* which leaves the crops inedible.



Credits: www.cell.com

Credits: www.cell.com

Cultured Meat On It's Way To Become A Commerializable Product

Companies collaborate to develop affordable growth media for culturing edible meat

JANHAVI A | BTCB 2ND YEAR

14 SEPT 2021

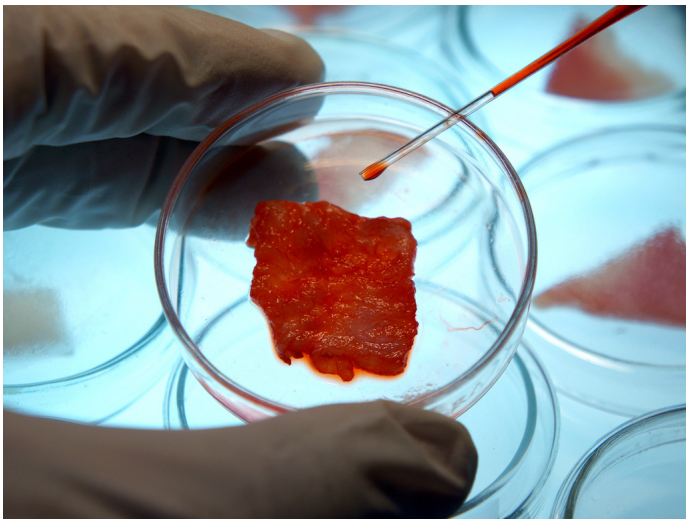
DSM Biotechnology Center, Heerlan, Netherlands

Meatable , the cultivated meat startup ,is being backed up by the Royal DSM, a multinational corporation ,active in the fields of health, nutrition and materials, to develop a more cost effective growth media. The two Dutch companies have agreed for the joint development project which not only reduces the price of growth media but also seeks to make meat identical in texture taste and quality to that of real meat.

Currently the growth media accounts for about 50-90% of the production cost of the culture meat, so by reducing the amount of money spent on the media, the cultivated meat can become affordable.

”With traditional animal farming alone, we will not be able to meet the growing demand for meat worldwide; we need breakthrough solutions. Cultivated meat has the potential to provide the growing world population with the protein source many people love – meat – using an efficient and sustainable production process that respects animal health and welfare,” says Krijn de Nood, CEO and co-founder of Meatable.

Credits: www.foodingredientsfirst.com



Credits: www.greenqueen.com

Microbial Chain Elongation

Microbial chain elongation, an initiative towards environmental clean-up

MEENA LALITHA CHANDAR | BTCB 3RD YEAR
Arizona State University, Tempe, Arizona

A plethora of solvents are used extensively in construction, rubber and textile industries. Their use was largely unregulated and lead to groundwater contamination, with chlorinated solvents being especially problematic.

In an effort to clean up, Arizona State University researchers have employed a novel technique known as microbial chain elongation.

Microbial chain elongation is a metabolic process through which microorganisms take small simple substrates, such as acetate and ethanol and they build them up into larger compounds while also releasing hydrogen gas during that elongation process.

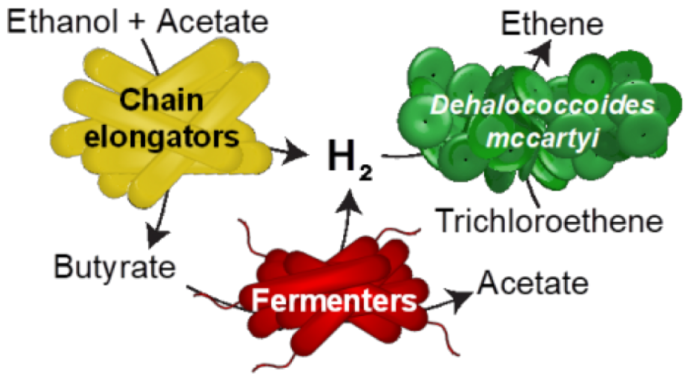
Special microbes called 'reductive de-chlorinators' use hydrogen as a source of energy. They help in the decontamination process by removing the chlorines from the chlorinated solvents and converting them into ethene, a non-toxic product.

This process takes place in fermenters, where the reductive chlorinating microorganisms are accompanied by fermenting microbes. They partner up and enable the breakdown of food waste which produces acetate (a substrate for chain elongation) and also release hydrogen gas.

Hydrogen can then fuel the dechlorinating microorganisms to clean up contaminants by converting them to ethene, which is non-toxic.

This process of chain elongation can also be used to make alternative fuels.

Given below is the schematic representation of how chain elongating and fermenting microorganisms provide hydrogen to the bacterial strain Dehalococcoides mccartyi. The hydrogen is the energy source for a process to detoxify chlorinated solvents.



Credits: www.news.asu.edu.com

Bio-Based Process To Facilitate Better Cleaning Of Chlorinated Solvents

"Hailey And Aldrich", an environmental and geotechnical engineering consulting company, interested in applying the new remediation technology to use.

JANHAVI A | BTCB 2ND YEAR
Arizona State University, Tempe, Arizona

The researchers at the Arizona State University have developed an innovative method for eliminating chlorinated solvents Jthat have been contaminating the water bodies for decades. These solvents were simply disposed of in the ground, poured down drains or accidentally leaked from storage systems.

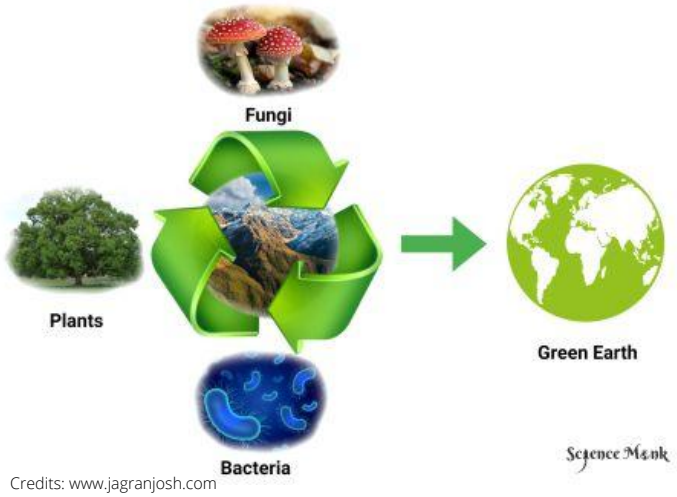
Chlorinated compounds like perchloroethylene and trichloroethylene ,were used extensively in dry cleaning and metal degreasing processes,one of which (Trichloroethylene) is a carcinogen — a cancer-causing substance — and many of the places containing such chlorinated solvents are groundwater aquifers that serve as sources of drinking water, or water designated for agricultural and industrial uses.

Delgado and the paper's co-authors — Aide Robles, Sayalee Joshi and Srivatsan Mohana Rangan, graduate students in the civil, environmental and sustainable engineering program, along with undergraduate student Theodora Yellowman — have been working on a chlorinated solvent treatment solution that harnesses the ability of microorganisms to activate a biotechnological process called chain elongation.

The team's research paper describes ways in which naturally occurring microorganisms can be directly stimulated in the soil and groundwater, or be grown in the lab, and then applied at contaminated sites to perform bioremediation — using microorganisms to treat contaminants.The process involves the addition of various food sources, such as vegetable oil, molasses and lactic acid, for the fermenting microorganisms that already exist in soil or groundwater.

Reductive dechlorinating microorganisms partner with fermenting microorganisms, enabling the fermenters to break down the food sources to produce hydrogen gas. Hydrogen can then fuel the dechlorinating microorganisms to clean up contaminants by converting them to ethene.

This is where microbial chain elongation comes into the picture, Delgado explains. The chain elongation process is an alternative to fermentation and may be the more effective decontaminant, depending on how hydrogen is utilized to fuel the process.



Credits: www.jagranjosh.com

Vertical Farming

Vertical farming, a practice of growing food crops on vertically stacked layers.

MEENA LALITHA CHANDAR | BTCB 3RD YEAR

Vertical farming is an innovative way of farming where crops are grown indoors, under artificial conditions of light and temperature.There a variety of advantages. It requires smaller spaces and soil-less methods such as hydroponics, aquaponics and aeroponics. It also uses significantly less water and pesticides than traditional agricultural methods. Being indoors, the crops aren't subject to seasons and hence give high productivity year-round. This allows crops to be grown anywhere! It will also diminish transport costs and carbon footprint. Lettuces, tomatoes and green crops can be produced through this practice.This is regarded as the future of farming and Japan has been one of the pioneers.Biotechnology can certainly aid in the success. Research is ongoing to identify thegenes and discover the perfect day length, light level, light colour, CO2 concentration,humidity and temperature for each plant to thrive.The main hurdle is the high cost due to its novelty.The earth is in desperate need of restoration and this might be the answer. Forests can regrow without the demand for more agricultural land.

Credits: www.conserve-energy-future.com

Advantages of Vertical Farming

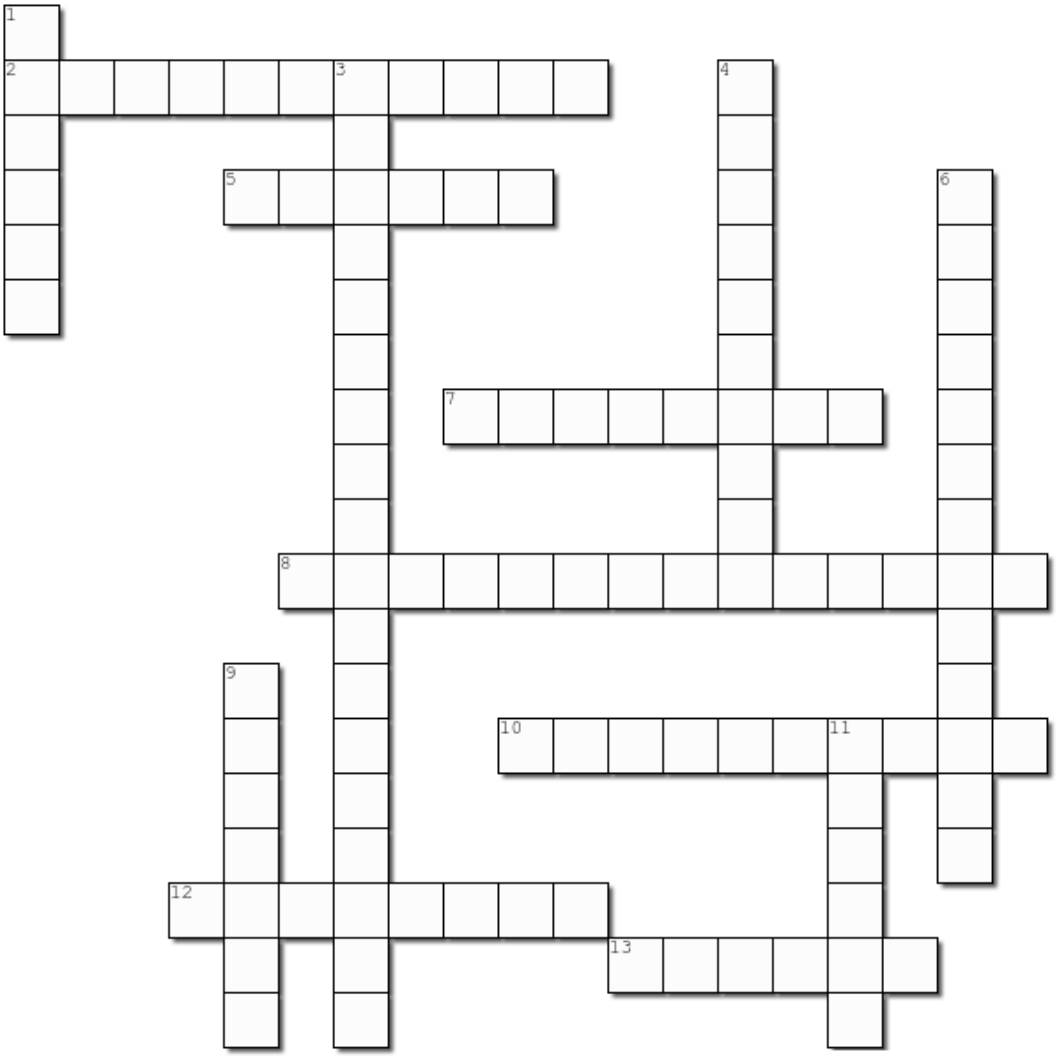
- Ensures consistent crop production.
- Uses space optimally.
- Reduces usage of water.
- Cuts down on transport cost.
- Less labour costs.
- Energy efficient.
- Doesn't involve chemicals or pesticides.
- Limits occupational hazards.

Disadvantages of Vertical Farming

- Less pollination.
- Requires advanced technology.
- May affect communities.

Crossword:

BULBUL SINGH & SHRUSTI SHENOY | BTCZ 2ND YEAR



ACROSS

2. Permanently dark zone of the ocean. (11)
5. Name for large kinds of shrimp (6)
7. Area of seafloor where gases and fluids are released but not hot water. (8)
8. Amphiphilic compounds produced in living surfaces. (14)
10. A yellow, red, and orange pigment found in the tissues of certain animals (10)
12. Birds adapted to live in marine environment are often called this. (8)
13. A fish that cannot produce Antifreeze Proteins (6)

DOWN

1. Animals that move around. (6)
3. Founder of Marine Biotechnology (18)
4. Organism containing genes from another organism through recombinant DNA technology. (10)
6. The use of microorganisms to consume and break down environmental pollutants (13)
9. Mound-shaped deposits of rock and sediment produced by marine organisms. (E.g. coral are reefs) (7)
11. An aquatic organism, like krill (euphausiid) that can swim powerfully enough to move against currents. (6)

(answers on pg 33 of this publication)

Marine Photography

P SHRUSTI SHENOY | BTCZ 2ND YEAR
BULBUL SINGH | BTCZ 2ND YEAR

The Marine Ecosystem as a Source of Cosmetics, PG 03, 04

1 Microalgae - microscopic algae that are not visible to the naked eye. They are usually found in freshwater or marine water

2 polyunsaturated fatty acids - a fatty acid containing more than one double bond (C=C). polyunsaturated fats help produce the skin's natural oil barrier, are critical in keeping skin hydrated, plumper, and younger looking

3 melanosomes - these are cell organelles were melanin is synthesized and stored

4 carotenoid - A yellow, red, and orange pigment found in the tissues of certain animals

5 Reactive oxygen species - A type of unstable molecule that contains oxygen and that easily reacts with other molecules in a cell. The excessive generation of reactive oxygen species leads to premature skin aging, inflammation, and skin carcinogenesis

6 photo aging - the combined harmful effects (such as wrinkles or dark spots) on skin that result from long-term exposure to sunlight and especially ultraviolet light.

Antifreeze proteins and its significance, PG 05, 06

1 alpha helices- an alpha helix is a description of how a protein is arranged in space; it is a type of secondary structure

2 cryoprotective- a substance used to protect biological tissue from freezing damage.

3 freezing point- it is the temperature at which a liquid becomes solid at normal atmospheric pressure

4 Gene promoter sequences- a sequence of DNA to which proteins bind that initiate transcription of a single RNA from the DNA downstream of it

5 Oocytes -a cell in an ovary which may undergo meiotic division to form an ovum

6 Recombinant DNA - a technology that uses enzymes to cut and paste together DNA sequences of interest

7 Transcription - process by which information in a strand of DNA is copied into a new molecule of messenger RNA (mRNA)

8 Transgenic - an organism containing genes from another organism put into its genome through recombinant DNA techniques

9 Shelf life - the length of time that a commodity may be stored without becoming unfit for use, consumption or sale.

Genomic Characterization of the barnacle Balanus improvisus, PG 07, 08

1 biofouling - The fouling of underwater pipes and other surfaces by organisms.

2 epibiont - An organism living on the surface of another living organism.

3 De Novo assembly – A type of program that assembles short nucleotide sequences into longer ones without the use of a reference genome.

4 transcriptome sequencing – The process of determining the genetic codes contained in the transcriptome and the relative proportion.

5 antifouling agent – A substance which prevents or retards fouling or marine underwater growth on plants, rocks ships bottoms.

Biotechnological Solutions To Assess...Environment, PG 09, 10

1 Anthropogenic activities: processes, objects, or materials are those that are derived from human activities, as opposed to those occurring in natural environments without human influences.

2 Bioremediation: the use of either naturally occurring or deliberately introduced microorganisms to consume and break down environmental pollutants, in order to clean a polluted site.

3 Biosurfactants: amphiphilic compounds produced in living surfaces, mostly on microbial cell surfaces or excreted extracellular hydrophobic and hydrophilic moieties that confer the ability to accumulate between fluid phases, thus reducing surface and interfacial tension at the surface and interface respectively.

4 Detoxification: medical treatment of an alcoholic or drug addict involving abstention from drink or drugs until the bloodstream is free of toxins.

5 Metal-toxicity: the toxic effect of certain metals in certain forms and doses on life.

Nano-Clay for Cancer Therapy, PG 18

1 nanoparticles: It is a small particle that ranges between 1 to 100 nanometers in size

2 chemotherapeutics: They are chemical entities which are used to treat and cure cancer. These agents target critical processes for cell division in rapidly growing cancer cells.

Microbial Biodetection of Trace Explosives, PG 20

1 bioreporter: living microbial cells that have been genetically engineered to produce a measurable signal in response to a specific chemical or physical agent in their environment.

2 gene promoter: a sequence of DNA to which protein binds that initiates transcription of a single RNA from the DNA downstream of it.

3 transcriptional regulators: structures that regulate the conversion of DNA to RNA.

Recombinant DNA Technology & Transgenic Animals, PG 21

1 phenotype: an individual's observable traits, like hair colour, eye colour, and blood type.

2 recombinant: relating to or exhibiting genetic recombination (genetically engineered DNA)

Sustainable Coffee from Cell Culture, PG 22

1 cell cultures: plant or animal cells that are grown under controlled conditions in the laboratory, outside their natural environment by careful provision of nourishing media

2 cell lines: a cell culture developed and multiplied from a single cell, and therefore consisting of cells with uniform genetic make-up

3 bioreactors: A vessel designed for supporting a biologically active environment where organisms can multiply and produce biochemically active substances or products

4 biomass: any biological material derived from living organisms. In the case of a cell culture, the product of the plant cell cultures after multiple divisions

5 FDA: The United States, Food and Drug Administration Agency that controls and supervises food safety of products in the market for general public health

Microbial Molecule Turns Plants Into Zombies! PG 23

1 Phytoplasma: They are bacteria that are compulsorily parasites that occur in the plant tissue. They are transmitted by an insect as a vector.

2 Witch-broom: It is a symptom of plant disease, that occurs as an abnormal growth of branches as clusters.

3 Vegetative state: The condition during which the plant is not able to reproduce.

4 GATA AND SPL regulatory proteins: They are transcription factors. This means that they are involved in the production and cessation of growth hormones in plants

5 Proteasome machinery: It is a protein complex involved in a mechanism to remove unwanted proteins from the plant cell by degrading the proteins

6 Ubiquitin molecule: It is a very small protein molecule which is use to guide the protein degradation system by tagging the target protein.

7 SAP05: It is a protein molecule use to manipulate the host cell's growth regulatory mechanism

8 Amino acids: They are the tiny nitrogenous molecules that are the building blocks of proteins. These molecules are joined together in different orders and structures to form all the proteins used by living beings

9 Aster yellow: It is a plant disease that causes discoloration of leaves, reduced root system which affections nutrition and sometimes death of the plant.

ACROSS

2. Aphotic Zone - permanently dark zone of the ocean
5. Prawns - name for large kinds of shrimp
7. Cold Seep - Area of seafloor where gases and fluids are released but not hot water (hydrothermal vent)
8. Biosurfactants - amphiphilic compounds produced in living surfaces
10. Carotenoid - A yellow, red, and orange pigment found in the tissues of certain animals
12. Seabirds - Birds adapted to live in marine environment are often called this
13. Salmon - A fish that cannot produce Antifreeze proteins

DOWN

1. Vagile - Animals that move around.
3. Edward Forbes - Founder of Marine Biotechnology
4. Transgenic - Organism containing genes from another organism through recombinant DNA technology
6. Bioremeditation - the use of either naturally occurring or deliberately introduced microorganisms to consume and break down environmental pollutants
9. Bioherm - Mound-shaped deposits of rock and sediment produced by marine organisms. Coral reefs and Halimeda banks are well-known examples.
11. Nekton - An aquatic organism, such as whales, turtles, fish, squid, and krill (euphausiids) that can swim powerfully enough to move against currents.