CHARUTAR VIDYA MANDAL'S

NATUBHAI. V. PATEL COLLEGE OF PURE AND APPLIED SCIENCES

SPECTRUM

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The measure of progress

INSIDE THIS ISSUE :

From The Chief Editor's Desk
By: **Dr. Basudeb Bakshi**

I am extremely elated to state that with all new hopes and hues we are ready to release the tenth issue of our college e-magazine **SPECTRUM-** ***the measure of progress*** which will surely unfold the flair of our fervent young writers. The hard work and innovative ideas explored by our youngsters will surely bring new and interesting findings in science. I feel glad to express my considerable appreciation to all the student authors in this issue for their curiosity to travel around science and put them into their own perception in their articles. I am sure that all the readers will find this issue interesting and would prove vital in motivating our young and endowed scientists. I am delighted to release this issue and to acknowledge the kind support and encouragement of all those who could sail it to the shore of publication. **Wish you all a very Happy Deepawali and New Year.**

Best of luck to all my dear students for their forthcoming Semester Examinations.

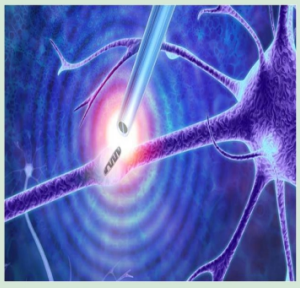
NANO-TWEEZERS FOR MOLECULAR BIOLOGY

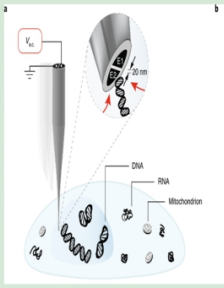
By: Dhyey Rabadiya
TYBSc Genetics

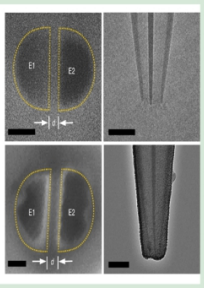
A new set of tools can pull individual molecules out of a living cell without killing it. Normally, sampling what's in a cell requires breaking it open. "You basically kill the cell to get access," Because the new technique is so gentle, it can be used on the same cell over and over. That could show how a cell responds to growth or to things in its environment. And it might help people better understand how healthy cells work, and what goes wrong inside sick cells.

The researchers used their tweezers to extract molecules from different types of cells.

First the team stained its cells with dyes. These glowed when the dyes glommed onto particular targets, such as DNA. Those target molecules would now stand out when researchers viewed them under a microscope. And that helped them guide their tweezers to extract the desired substance.







WORKING: This tool is a sharp, glass rod. Its thin tip is less than 100 nanometers across. That's about a tenth the diameter of a red blood cell. At the end of this rod are two *electrodes*. Each is made of a carbon-based material, such as graphite.

An electric voltage to the tweezers, a powerful electric field develops around the electrodes. This attracts and traps small molecules within about 300 nanometers of the rod's tip. Once in this electric net, molecules stay put until the voltage is turned off. Only then can the molecules drift away.

IDEONELL SAKAIENSIS --BACTERIA FOR RECYCLING OF PLASTIC

By: Shruti Thacker
TYBSc Biotechnology

We manufacture over 300 tons of plastic each year for use in everything from packaging to clothing. Their resilience is great when you want a product to last long. But once discarded, plastics linger in the environment, in the streets, fields and oceans alike. Every corner of our planet has been blighted by our addiction to plastic. Burning of plastic in the open air, leads to air pollution due to the release of poisonous chemicals. The studies reveal that around 12.7 million tons of plastic waste are washed into ocean every year. Plastic in oceans affects creatures large and small. Some researchers suggest that by 2050 there could be more plastic in the ocean than the fishes.

Plastics are polymers, long chain of monomers. These are crossed linked to each other to form a mesh like structure. Most plastics are made up of carbon base. So in theory they are good source of bacteria like *Ideonell sakaiensis* has the ability to decompose plastic by breaking down and consuming the plastic poly(ethylene terephthalate) (PET) as a sole carbon and energy source. This bacteria produces two enzymes which hydrolyze PET to yield its monomers ethylene glycol and terephthalic acid. This is a new approach to plastic recycling and decomposing. At presence most plastic bottles are not truly recycled. They are either melted or reformed. Packaging companies typically prefer freshly made plastic that are created from chemical. Bacteria break down it into the easy to handle chemicals. These could then be used to make fresh plastics, producing true recycling systems. Plastic decomposing and recycling by

bacterial use is an innovative approach on the global problem. An innovative new product that meets market requirements and customer expectations offers an existing or new business, new market territory without competition for so long as it retains its innovative advantage.

Now a day waste management is great deal for government. Natural decomposition of plastic takes long time. Burning plastic or dumping into oceans is not permanent solution. Trending plastic recycling plants generate some harmful gases to environment.

Bacterial decomposing of the plastic is environment friendly. They produce glycol and terephthalic acid. These are easy to handle chemicals which are raw material to make fresh plastic, producing true recycling system. By this we can save the air from the harmful chemicals generated by burning plastics and we can make our oceans away from plastics, safe and clean.

DRUG RESISTANCE IN BACTERIA: A NEW THREAT TO MANKIND

By: **Priya A. Patel**
TYBSc Microbiology

Antibiotics have been used for millennia to treat infections, although until the last century or so people did not know the infections were caused by bacteria. The management of microbial infections in ancient Egypt, Greece, and China is well-documented. The modern era of antibiotics started with the discovery of penicillin by Sir Alexander Fleming in 1928. Since then, antibiotics have transformed modern medicine and saved millions of lives. Almost eight decades after the first large scale production of the antibiotics was started and patients treated, bacterial infections are becoming a threat. Antibiotics were first prescribed in the 1940s to treat the serious infections. Penicillin was a very successful in treating the infections in World War II. However, shortly thereafter, penicillin resistance became a substantial clinical problem and in response, new beta-lactam antibiotics were discovered, developed, and deployed, restoring confidence. The resistance to antibiotic has been attributed to the overuse and misuse of medication as well as lack of new drug development by the pharma industry due to reduced economic incentives and challenging regulatory. Antibiotics have not only saved patients' lives, they have played a pivotal role in achieving major advances in medicine and surgery. As early as 1945, **Sir Alexander Fleming raised the alarm regarding antibiotic overuse when he warned that the "public will demand [the drug and] … then will begin an era … of abuses." Sir Fleming said "The time may come when penicillin can be bought by anyone in the shops**. Then there is the danger that the ignorant man may easily under dose himself and by exposing his microbe to the non –lethal quantities of the drug, make them resistant. The overuse of antibiotics clearly drives the evolution of resistance. Epidemiological studies have demonstrated a direct relationship between antibiotic consumption and the emergence and dissemination of resistant bacteria strains. Antibiotics have started to fail. Resistant bacteria already cause more than 750,000 deaths every year and is expected to go up to 10 million per year by 2050. This number is predicted to rise dramatically if radical actions are not taken. Antibiotic resistance has become one of the greatest threats to global health. Antibiotic resistance is not only a future threat; it is present right here and now. The picture depicted shows 10 most deadly bacteria. The complete WHO priority pathogens list is as follows: *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Enterobacteriaceae*, *Enterococcus faecium*, *Staphylococcus aureus*, *Helicobacter pylori*, *Campylobacter spp.*, *Salmonellae*, *Neisseria gonorrhoeae*, *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Shigella spp.*

Antibiotic resistance **threatens to** undermine major medical advances **such as surgeries, treatment of cancer patients and care of preterm babies.**

…threatens our **ability to reach global health goals** such as reduction of child mortality and improvement of maternal health.

- every year from blood infections (sepsis) caused by resistant bacteria – represents at least 30% of all sepsis deaths in newborns.
- **Antibiotic resistance spreads silently across the world.** More than 60% of the populations in some areas carry multidrug-resistant bacteria in their normal bacterial flora.
- **Antibiotic resistance is costly.** It is estimated that the median overall increased cost to treat a resistant bacterial infection is around 700 USD, equal to over one year's wages of a rural worker in India. Novel treatments for multidrug-resistant infections can cost up to tens of thousands of dollars, making them unaffordable for many.
- **Antibiotic resistance is here now.** Resistance has already developed to the last-line antibiotics for gonorrhea, which in some cases is nearly untreatable. With 106 million new cases/year, the consequences of total resistance would be devastating.

From basic healthcare to advanced technology supported medicine, antibiotics have become indispensable. However, antibiotic resistance erodes antibiotic efficiency and the cornerstones have started to crumble. In addition, microbiologists and infectious-disease specialists have advised restraint regarding antibiotic use. Therefore, once a new antibiotic is marketed, physicians—rather than prescribing it immediately—often hold this new agent in reserve for only the worst cases due to fear of promoting drug resistance, and they continue to prescribe older agents that have shown comparable efficacy. Therefore, new antibiotics are often treated as "last-line" drugs to combat serious illnesses

Rapidly emerging resistant bacteria threaten the extraordinary health benefits that have been achieved with antibiotics. This crisis is global, reflecting the worldwide overuse of these drugs and the lack of development of new antibiotic agents by pharmaceutical companies to address the challenge. Antibiotic-resistant infections place a substantial health and economic burden on the countries. Coordinated efforts to implement new policies, renew research efforts, and pursue steps to manage the crisis are greatly needed.

Chemists create molecular 'leaf' that collects and stores solar power without solar panels.

By: **Kesha Shah**
TYBSc Chemistry

A team of Chemist has invented a molecule that uses light or electricity to convert the greenhouse gas, carbon-dioxide into carbon-monoxide more efficiently than any other method of carbon reduction. This is a great achievement in order to recycle carbon-dioxide in the Earth's atmosphere into carbon-neutral fuels and other materials.

This process is reported in the Journal of the American Chemical Society.

Chemist Li said "If you can create an efficient enough molecule for this reaction it will produce energy which is free and storable in the form of fuel."When carbon monoxide produces carbon dioxide it releases energy. Turning back carbon dioxide into fuel requires at least the same amount of energy. So, chemists find a way to decrease this energy needed.

The molecule, a nanographene rhenium complex connected via organic compound which is known as bipyridine triggers highly efficient reaction that converts carbon dioxide into carbon monoxide. It is due to the molecule's versatility.

Carbon monoxide is an important raw material in lot of industrial processes. It is a way to store energy as carbon-neutral fuel since no anymore carbon is putting back into the atmosphere. It is simply re-releasing the solar power which is used to make it.

This molecule is common form of carbon and dark in color. So it will absorb a large amount of sunlight. So chemists take advantage of light absorbing power of nanographene, to make reaction that uses sunlight in the wave length up to 600 nanometers i.e. a large portion of the visible light spectrum.

Chemist Li said, molecule acts as two part system.

1) Nanographene - It works as "energy collector" that absorbs energy from sunlight.

2) Atomic rhenium - It works as "engine" that produces carbon monoxide.

The energy collector drives a flow of electron to rhenium atom, which repeatedly binds and converts the carbon dioxide to carbon monoxide.

Now chemists plan for this reaction without use of solar cells and with the use of light absorbing quality of nanographene alone. They are also working to replace the rhenium atom with more common and less expensive metal. Source: Indiana University, USA

Reon Pocket - A wearable Air Conditioner!

By: **Gurvindersingh J Dinger**
MSc IT

The **Reon Pocket** is a small pocket Bluetooth device which fits inside your shirt ,it uses a Peltier element to heat and cool the system efficiently. Such elements are mostly used for car and wine coolers as it consumes less power. SONY company has announced an official make a start-up and launched a crowd funding campaign to develop this particular device.

Now currently it is marketed particularly for those executives/businessmen who wear suits in daily routine, the designers hope to make it public by offering the Reon Pocket to more types of customers also but for now it is in the developing phase. The size of the device is as small as a wallet, so it is very easy to carry it anywhere at any place, portable, and it is designed with a special silicon-material which can holds the device in place, on the back just near the neck. These project leaders say the Reon Pocket can cool down the temperature by 23 degrees Fahrenheit as -5 degrees in Celsius, and can make warm up to by 14 degrees Fahrenheit as -10 degrees in Celsius to them who wears the device, thus helps to get relief not only from the steaming hot summers but also from the cold winters.

At present it is available only in Japan and the device comes in two variants, the **Reon Pocket Standard** and **Reon Pocket Lite**. The main difference in them is that the Standard has Apple and Android supported Bluetooth whereas, the Lite version is to be operated manually. The device is not meant for all-day use, considering the device takes about two hours to charge but has a battery life of about 90 minutes. The device uses thermoelectric cooling and heating technology, which is to utilize the Peltier effect (Part of Thermoelectricity) which describes heating or cooling that occurs when a current is made to flow through a junction between two different kinds of conductors.

ALGEBRAIC TOPOLOGY

By: **Nikhil Pathar**
TYBSc Mathematics

Algebraic topology is a branch of mathematics that uses tools from abstract algebra to study topological spaces. The basic goal is to find algebraic invariants that classify topological spaces up to homeomorphism, though usually most classify up to homotopy equivalence.

Although algebraic topology primarily uses algebra to study topological problems, using topology to solve algebraic problems is sometimes also possible. Algebraic topology, for example, allows for a convenient proof that any subgroup of a free group is again a free group.

Main Branches of Algebraic Topology:

Homotopy groups: In mathematics, homotopy groups are used in algebraic topology to classify topological spaces.

Homology: In algebraic topology and abstract algebra, homology is a certain general procedure to associate a sequence of abelian groups or modules with a given mathematical object such as a topological space or a group.

Cohomology: In homology theory and algebraic topology, cohomology is a general term for a sequence of abelian groups defined from a co-chain complex.

Manifolds: A manifold is a topological space that near each point resembles Euclidean space. Examples include the plane, the sphere, and the torus, which can all be realized in three dimensions, but also the Klein bottle and real projective plane which cannot be realized in three dimensions, but can be realized in four dimensions.

Knot theory: Knot theory is the study of mathematical knots. While inspired by knots that appear in daily life in shoelaces and rope, a mathematician's knot differs in that the ends are joined together so that it cannot be undone. In precise mathematical language, a knot is an embedding of a circle in 3-dimensional Euclidean space,

Complexes: 1. **A simplical complex**: A simplicial complex is a topological space of a certain kind, constructed by "gluing together" points, line segments, triangles, and their *n*-dimensional counterparts.

2. A CW complex: A CW complex is a type of topological space introduced by J. H. C. Whitehead to meet the needs of homotopy theory.

Are soap bars home to bacteria?

By: Dixi Gandhi
SYBSc Biotechnology

Well, every morning we are bathing and cleaning our body but have anyone of us thought that if cleanliness is our motto than soap bars are right choice for it ? Soap bars sit idly for alone in bathroom for hours and hours which makes them vulnerable to the germs and if they contain germs than are we rubbing soap or tons of bacteria all over ourselves? Probably soaps contain germs in it , but it doesn't make us sick otherwise we would have been sick all time and because of this reason some people prefer liquid soap rather than soap bars. Some people also use liquid soap because they think using same soap bar can cause infection but this myth was eradicated by a group of scientist.

Washing our hands may *get* rid of *germs* but that doesn't mean that our *soap* is clean. Bacteria lives quite happily in the "slime" of bar soap. This was studied by scientist in 1965. They conducted experiment in which, intentionally contaminated their hands with five billion bacteria which contained disease causing strains such as E. Coli and Staphylococcus. The scientist than washed their hands with a bar of soap and had a second person wash with the same bar of soap and concluded that bacteria weren't transferred to the second user .

Again in 1988, scientist employed a manufacturing company to confirm this findings. They inoculated soaps with pathogenic bacteria such as *E. coli* and *Psuedomonas* and had 16 subjects wash their hands with inoculated bar . After washing none of the bacteria has been detected on their hands. Hence the concluded it's safe to use soap bars on regular basis.

Basically soaps actually work on germs. They contain compound called surfactant to remove germs and debris as soon as you add water . Some soap bars are labelled with antibacterial soap but it has no additional health effect. Both plain and antibacterial soap work in same manner.

Conflict wasn't only between plain soap or antibacterial soap, but was also between soaps and hand sanitizer. To prove that both soap and sanitizer can remove germs, experiment was conducted by scientist in university of Maryland where they intentionally put some bacteria on hands of students and made them wash with the soap, liquid soap and sanitizer. After each wash sample were taken on special incubation plates.after 3 days it was concluded that sanitizers can kill bacteria whereas soaps can remove bacteria along with dirt.

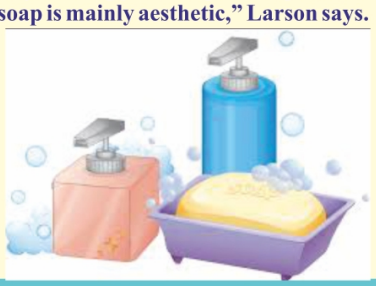
So a series of experiments were conducted to test whether soaps contain bacteria or remove bacteria?

Conclusion is stated that soaps too have bacteria but they doesn't have any negative impact on people.They should be used wisely and by following some precaution such as:

1) Wet the soap then work up a lather for at least 15 seconds
2) Apply your bar soap directly instead of using some wash cloth
3) Aim to keep your bar soap dry between uses.consider using a soap holder with drainage salts and try to keep it away from spray of water
4) Avoid using same soap if someone is suffering from common cold or flu as this can be transmitted easily
5) Rinse your hands properly with soap for almost 30 seconds and scrub all around your palms and nails to remove germs and bacteria

You can be extra cautious: If your roommate, partner, or family member is sick with the flu, diarrhea, or some other infectious bug. In that case, maybe consider switching to liquid soap.

The bottom line, however, is that if you're healthy, you shouldn't worry about catching bugs by sharing your soap. "The problem with bar soap is mainly aesthetic," Larson says.



STABLE CYCLOCARBON RING OF 18 CARBON ATOMS

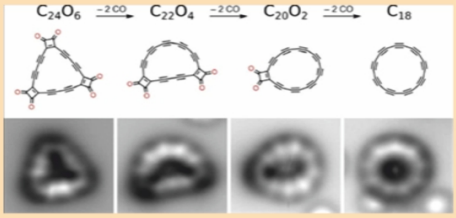
By: **S. Jainesh Kumar Mehta**
TYBSc Chemistry

A team of scientists from Oxford University and IBM Research has managed to make and image a ring of 18 carbon atoms for the first time, which is a carbon allotrope-- cyclocarbon (C18).

The smallest cyclocarbon made from 18 carbon atoms, which is predicted to be a thermodynamically stable carbon ring. Advanced microscopy techniques have provided images of the same to prove the structure.

How they managed to make this possible?

Researchers were able to produce the C_{18} compound by eliminating carbon monoxide from a cyclocarbon oxide molecule $C_{24}O_6$– the triangular cyclocarbon oxide compound where 18 carbon atoms are bonded to six carbon monoxide. They used atom manipulation as they transferred this concoction to a layer of sodium chloride (NaCl) on a copper plate (Cu), chilled in a vacuum chamber at 5 Kelvin.



Starting from a precursor molecule ($C_{24}O_6$) and gradually went through intermediates before reaching the final product — The Cyclocarbon (C_{18}).

This provided an inert surface that kept the structure stable where the compound was formed by eliminating carbon monoxide (CO) molecules off the structure, leaving just the ring of carbon atoms behind with a polyynic structure of carbon atoms with an alternating triple and single bonds.

Removing the scaffolding to make the ring is not so simple as it sounds. "We removed all six CO moieties from $C_{24}O_6$, with 13 per cent yield, typically resulting in circular molecules," the researchers wrote in their paper.

Why a stable ring of cyclocarbon big achievement?

Carbon can be arranged in a number of configurations and one such form is cyclo[n]carbon, which is a ring of carbon atoms bonded to each consisting only of carbon atoms. Carbon through allotropy, the property of elements to exist in two or more forms in the same physical state, can exist as diamond, graphite, fullerene and other forms with different physical and chemical properties.

When each of carbon atoms in the ring is bonded to three other carbon atoms, it's relatively soft graphite, whereas, with the addition of just one more bond, it becomes one of the hardest minerals known– diamond. When 60 carbon atoms are bonded together in a soccer ball shape, you get Bucky balls

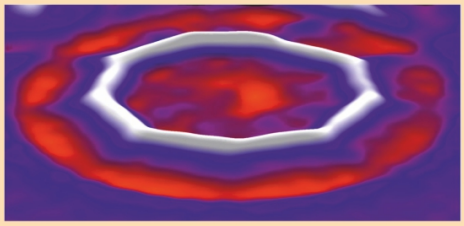


Image of a carbon-18 ring made with an atomic force microscope.

A Paratransgenic control of vector born disease - Malaria

By: **Neera Sharma**
TYBSc Biotechnology

Anopheles, *Aedes* and *Culex*, are the major mosquito genera, transmit respectively malaria, dengue and lymphatic filariasis. Malaria--a vector borne disease is life-threatening mosquito-borne blood disease caused by a Plasmodium parasite. Vector borne disease are substantial portion of the global disease burden; One of the most deadliest of this Malaria causing almost 4,30,000 deaths. Vector control strategies have been hindered by the mosquito and pathogen resistance and population alteration approaches using transgenic mosquito. Still have many hurdles to overcome before they can be implemented. A Paratransgenic control strategy in which genetically modified bacteria capable of colonizing a wide range of mosquito are used. Microbiota of *Anopheles stephensi* was engineered to produce an antiplasmodial effector, causing mosquito to become refractory to *Plasmodial berghei.*

This engineered mosquito causes sterility or death to achieve population reduction or are refractory to pathogen infection causing alteration . However the process has been challenging due to difficulties spreading and sustaining the transgenes throughout the large population of mosquito. This could be related to the fitness of transgenic mosquito which may be decreased due to factors such as extra energy costs to confer resistance any mutation due to introduction of exogenous gene.

Since plasmodium has a very complex life cycle which involves mosquito as vector and human as host. Importantly a severe population bottle neck occurs at oocyte stage of plasmodium life cycle within mosquito midgut reducing the number of parasites to as much as 1% of original number ingested. Paratrangenes to reduce frequency of malaria transmission seek to close this bottle neck.

Several bacterial species have been proposed for antiplasmodial paratrangenesis that were recovered from vector themselves. A particularly attractive species *Asaia bogorensis* is transmitted from mother to offspring persist into adulthood and density population the female midgut larval gut and reproduction organ of anopheles mosquito. Potentially pathogen inhibition engineered in this bacterium could be used to control a variety of vector borne disease. *Asaia sp.SF2.1* was genetically modified previously to express antiplasmodial effector molecule that were secreted into midgut. However constitutive production of these proteins is deleterious to fitness of these bacterial strains. Strains of *Asaia* should be as fit as possible if they are expected to persist and spread throughout the mosquito population.

It is believed that producing antiplasmodial effectors molecule only when plasmodium is present inside the midgut should lead to increase fitness when compared to strains that accomplished in the study by involving the promoter that are activated by influx of nutrients found in the blood meal were after referred to as blood meal induced(BMI) promoters.

To uncover the BMI promoter from *Asaia spSF2.1* the sequenced genome was searched for genes homologous to those known to be induced by blood meal like condition in other bacterial species. Many of these important genes in pathogens is of infectious bacteria are used for iron homeostasis. Promoter region of these genes are cloned into pGLR1 plasmid and used to induce expression of dual GFP-lux operon.

Finally the relative ability of these strains to colonize the transgenic bacteria was fed to the mosquitoes. After 2 days ten midguts carrying each strain were dissected homogenize in PBS and paratransgenic CFU's were enumerated. ACG18.HlyA had highest rate of colonization in the midgut followed by ACG18.HF.

Ultimately paratransgenesis offer the possibility to bypass these roadblocks by utilizing bacteria to alter the disease transmission phenotype of mosquito vector. Several bacterial species have been developed for use of antiplasmodial paratransgensis including ones that are naturally antiplasmodial. Thus, using Paratransgenes diseases like Malaria and many more vector borne disease can be controlled. **Thanks to Biotechnology for making this possible!**