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ENVIS Newsletter on 'Microorganisms and Environment Management', a quarterly publication, brings out original research articles, reviews, reports, research highlights, news-scan etc., related to the thematic area of the ENVIS Centre. In order to disseminate the cutting-edge research findings to user community, ENVIS Centre on Microorganisms and Environment Management invites original research and review articles, notes, research and meeting reports. Details of forthcoming conferences / seminars / symposia / trainings / workshops also will be considered for publication in the newsletter.

The articles and other information should be typed in double space with a maximum of 8 - 10 typed pages. Photographs/line drawings and graphs need to be of good quality with clarity for reproduction in the newsletter. For references and other details, the standard format used in refereed journals may be followed.

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Cover page : Severe Acute Respiratory Syndrome(**SARS**) **coronavirus**. This is sometimes shortened to SARS-CoV, is the virus that causes severe acute respiratory syndrome (SARS)

ENVIS Newsletter
on
Microorganisms and Environment Management

Contents

Dear Readers,

Enzymes are biocatalysts of a specific biochemical reaction and are highly specific in their action on substrates. Certain enzymes are of special interest and are utilized as organic catalysts in numerous processes on an industrial scale due to their environmental friendly nature, high specificity, wide diversity of reactions etc. Microbial enzymes are known to be superior enzymes obtained from different microorganisms and they can be manipulated genetically to obtain desired characteristics of a biocatalyzer. Additionally, the substrates used in the cultural medium are sustainable and industrial residuals can be used to produce value-added products. Various molecular techniques have also been applied to improve the quality and performance of microbial enzymes for their wider applications in many industries such as food, textile, leather, pharmaceutical, cosmetics, fine chemicals, energy, biomaterials, paper etc.

The enzymes also have good capability of remediation of many compounds that are unfriendly to the present environmental condition. A large number of enzymes from bacteria, fungi, and plants have been reported to be involved in the biodegradation of toxic organic pollutants. Research pertaining to this topic would contribute towards developing advanced bioprocess technology to reduce the toxicity of the pollutants.

In this issue, a review article on microbial enzyme technology for pollution abatement in leather industry, reports on the formulation of ultra-stable enzyme, malaria-blocking mosquitoes and other information are included.

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Prof. N. Munuswamy

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SCIENTIFIC ARTICLE

Microbial Enzyme Technology for pollution abatement in Leather Industry

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Abstract

It is well known that environmental pollution has been a major irritant to industrial development. Chemical and chemical based industries are the prime targets of environmentalists for their crusade against pollution and leather industry is not left out of the reckoning. The chemicals mainly responsible for pollution in pre-tanning processes are lime, sulphide and caustic soda apart from common salt and degreasing chemicals. In fact, one third of the pollution caused by leather industries results from the wastes generated during dehairing operations. The wastes are let out into the drains which in turn empty into the main sewerage causing hazard to those who use this water. Many tanneries have been forced to close down because of their noncompliance with the standards laid down. In a short span of time, Indian Leather Industry has faced serious challenges such as German ban on pentachlorophenate, certain azo dyes, formaldehyde etc. on one hand and court orders imposing strict compliance of environmental regulations on the other. The attention of tanners is focused towards revamping the processing methods, recovery systems and effluent treatment techniques to make leather processing ecofriendly. Intensive efforts have been taken up to use a viable alternative technology viz. microbial enzyme technology in pre-tanning processes and this could be one of the ways of solving the industrial pollution problems caused by tannery effluents.

Introduction

The raw skin goes through a series of chemical treatments before it turns into a flattering leather. This includes soaking, liming, dehairing, deliming, degreasing and pickling. During all these steps, the chemicals used are quite toxic. Naturally, these pre-tanning operations make leather processing one of the worst offenders of the environment.

Enzyme is a biological catalyst with clear cut specificity. An important enzyme used in pre-tanning processes belongs to the group of proteolytic enzymes, also known as proteases which act on proteins. Although enzymes from plant, animal and microbial sources have been used, large scale use of microbial enzymes received a boost only in 1960s following the introduction of fermentation technology. The enzymes or enzymatic formulations need not be pure but must be cheap as compared to that of commercial chemicals used in leather industry. Animal proteases and microbial proteases from bacteria and fungi are used in the pre-tanning processes of leather manufacture. The animal proteases are mixtures of trypsin, chymotrypsin and various peptidases which may contain amylase or lipase as secondary enzymes. Mainly for economic reasons, enzymes from microorganisms have come to play a significant role in recent years and enzymatic products of microbial origin are already being produced on a wide scale.

Use of microbial enzymes in pre-tanning processes

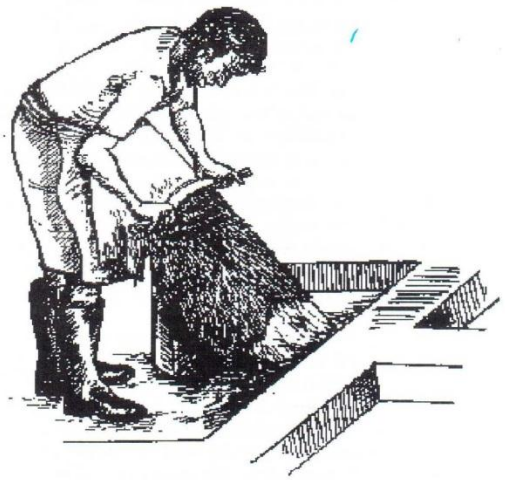
The important stages in which microbial enzymes used in pre-tanning processes are: soaking, dehairing, bating and degreasing. Soaking is the first operation in the tannery in which the skins are treated with water for making them clean and soft. Wet salted or freshly slaughtered skins do not require any chemical agent for their proper soaking. Soaking is necessary for solubilization and elimination of salts and globular proteins contained within the fibrous structure of skins. Soaking is carried out under alkaline conditions at low temperature in water containing sodium hypochlorite, sodium pentachlorophenate, formic acid etc. and it is accelerated by some of the nonionic detergents and additives such as sodium sulfide or sodium tetrasulfide.

The advantages of enzymatic soaking include loosening of the scud, initiation of the opening up of the fibre structure, production of leather with less wrinkled grain and a decrease in soaking time. Enzymes from *Aspergillus parasiticus*, *A. flavus*, *A. oryzae* and *Bacillus subtilis* are used alone or in mixtures. Soaking is usually performed with a combination of proteolytic enzymes that are optimally active in the neutral or alkaline pH range.

Dehairing of skins and hides using microbial enzymes

The most important operation in which enzyme is used in leather processing is dehairing. Five methods of dehairing are generally adopted viz.(i) Clipping process (ii) Scalding process (iii) Chemical process (iv) Sweating process and (v) enzymatic

process. The conventionally practiced method of dehairing is the chemical process using lime and sodium sulfide. However, the use of high concentration of lime and sodium sulphide creates an extremely alkaline environment resulting in the pulping of hair and its subsequent removal. While the efficacy of this process cannot be questioned, it has some major disadvantages. About 75% of the organic waste from a tannery comes from the pretanning yard and 70% of this waste is from hair which is rich in nitrogen. This illustrates the contribution made by the lime and sulphide process towards pollution. Sulphide is highly toxic and has an obnoxious odour and if left untreated, it can cause major problems in the sewers. The severe alkaline condition is a health hazard for the workers.

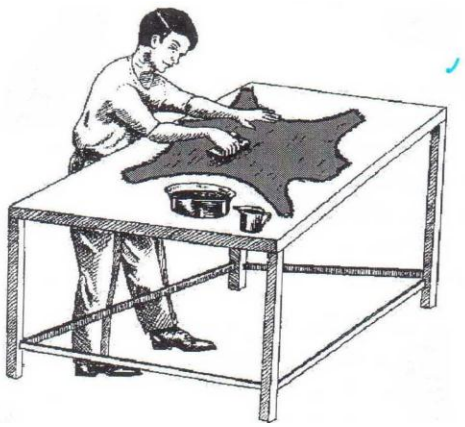


Conventional dehairing

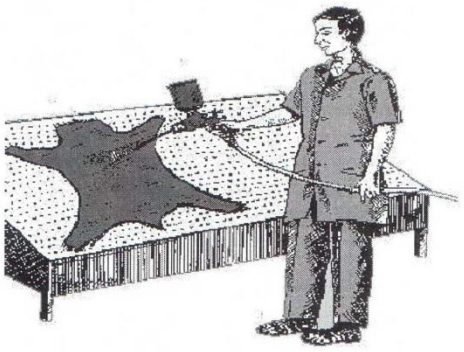
What are the advantages of enzymatic dehairing? Enzymatic dehairing is suggested as an environmentally friendly alternative to the conventional chemical process. Hair of good quality and strength with a good saleable value is recovered. An ecologically conducive atmosphere for the workers is created. A significant nature of the enzymatic dehairing process is the time factor involved. The lime-sulfide process takes about 16h whereas the enzymatic dehairing would be completed between 8h and 20h.

Proteolytic enzymes are of great commercial importance contributing to more than 40% of the world's commercially produced enzymes. Approximately 50% of the enzymes used as industrial process aids are proteolytic enzymes. Proteolytic enzymes are more efficient in enzymatic dehairing than amylolytic enzymes. Proteolytic enzymes from plant, animal and microbial sources are used for dehairing. Microbial proteases, because of their inherent advantages, are preferred in modern practice.

Three methods of application are commonly used in the enzymatic dehairing process: a) Paint method, b) dip method and c) drum method. In the paint method, the enzyme solution is mixed with an inert material like kaolin, made into a thin paste, adjusted to the required pH and applied on the flesh side of skins. In the dip method of enzymatic dehairing, the skins are kept immersed in the enzyme solution at the required pH in a pit or tub. In addition, drum method is also followed.



Application of enzymes by paint method



Application of enzymes by spraying technique

Bating using microbial enzymes

Another application of Microbial enzyme technology in pretanning process is known as bating. The concept of softening skins by treating them in a warm infusion of animal dung has been termed as "bating" and the product used for such process is known as a bate. The main object of bating is to remove some of the non leather forming proteinous materials such as albumins, globulins and mucoids from skins and to allow splitting of collagen fibres.

The principal materials which a bate contains are proteolytic enzymes, a suitable carrier for the enzyme and a deliming agent such as ammonium chloride or sulphate. Pancreatic enzymes are found to be the best for use in bating. Alternatively, microbial enzymes could be used for bating.

Degreasing using microbial enzymes

Another major operation where enzyme is used is known as degreasing and it is the process of removal of excess natural fat from greasy skins. The presence of natural grease in certain skins, especially woolly sheep skins, results in various defects. During the degreasing operation in the pretanning process, the fat or grease is removed from the interfibrillary spaces of the skins to facilitate the uniform penetration of tanning materials, fat liquors etc.

Degreasing is carried out after pickling and conventionally, it is carried out by either aqueous emulsification using detergents or by solvent extraction. It is well known that organic solvents like kerosene, petrol, perchlorethylene and trichloroethylene are highly unsafe and hazardous to the workers and heavily pollute the environment. The detergents, though not hazardous while handling and storing, cause serious pollution problems. These detergents and solvents add to the BOD (Biological Oxygen Demand) load of the pickling effluent and the chlorinated hydrocarbons and solvents add to the toxicity of the effluent.

Enzymatic degreasing is suggested as a viable alternative to combat the pollution problems caused by the use of solvents and detergents. Lipases catalyse the breakdown of fats and can be obtained from animal, microbial and plant sources. The advantages of using enzymes for degreasing are the elimination of solvents, reduction in surfactants and possible recovery of valuable byproducts.

Byproducts utilization

Microbial enzymes have a role in byproducts utilization. They could be used in the treatment of fleshings from the tannery. A combination of hydrolytic enzymes viz. proteases, carbohydrases and lipases might be ideal for this use.

Conclusion

Tanneries in future will use a combination of enzymatic and chemical processes. The potential for use of microbial enzyme technology in leather processing lies mainly in areas in which pollution causing chemicals such as sodium sulfide, lime and solvents are being used. Future might witness ecolabelled leather products emerging as niche products by the use of microbial enzyme technology and the experience gained by the Indian Leather Industry in this area might greatly help to emerge as a global leader.

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RESEARCH REPORTS

Gut microbes signal to the brain when they're full

Don't have room for dessert? The bacteria in your gut may be telling you something. Twenty minutes after a meal, gut microbes produce proteins that can suppress food intake in animals, reports a study published in *Cell Metabolism*. The researchers also show how these proteins injected into mice and rats act on the brain reducing appetite, suggesting that gut bacteria may help control when and how much we eat.

The new evidence coexists with current models of appetite control, which involve hormones from the gut signalling to brain circuits when we're hungry or done eating. The bacterial proteins--produced by mutualistic *E. coli* after they've been satiated--were found for the first time to influence the release of gut-brain signals (e.g., GLP-1 and PYY) as well as activate appetite-regulated neurons in the brain.

"There are so many studies now that look at microbiota composition in different pathological conditions but they do not explore the mechanisms behind these associations," says senior study author Sergueï Fetissov of Rouen University and INSERM's Nutrition, Gut & Brain Laboratory in France. "Our study shows that bacterial proteins from *E. coli* can be involved in the same molecular pathways that are used by the body to signal satiety, and now we need to know how an altered gut microbiome can affect this physiology."

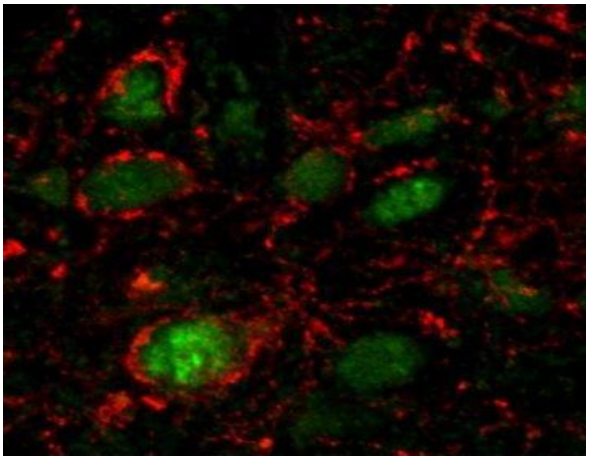
Mealtime brings an influx of nutrients to the bacteria in your gut. In response, they divide and replace any members lost in the development of stool. The study raises an interesting

theory: since gut microbes depend on us for a place to live, it is to their advantage for populations to remain stable. It would make sense, then, if they had a way to communicate to the host when they're not full, promoting host to ingest nutrients again.

In the laboratory, Fetissov and colleagues found that after 20 minutes of consuming nutrients and expanding numbers, *E. coli* bacteria from the gut produce different kinds of proteins than they did before their feeding. The 20 minute mark seemed to coincide with the amount of time it takes for a person to begin feeling full or tired after a meal. Excited over this discovery, the researcher began to profile the bacterial proteins pre- and post-feeding.

They saw that injection of small doses of the bacterial proteins produced after feeding reduced food intake in both hungry and free-fed rats and mice. Further analysis revealed that "full" bacterial proteins stimulated the release of peptide YY, a hormone associated with satiety, while "hungry" bacterial hormones did not. The opposite was true for glucagon-like peptide-1 (GLP-1), a hormone known to simulate insulin release.

The investigators next developed an assay that could detect the presence of one of the "full" bacterial proteins, called ClpB in animal blood. Although blood levels of the protein in mice and rats detected 20 minutes after meal consumption did not change, it correlated with ClpB DNA production in the gut, suggesting that it may link gut bacterial composition with the host control of appetite. The researchers also found that ClpB increased firing of neurons that reduce appetite. The role of other *E.coli* proteins in hunger and satiation, as well as how proteins from other species of bacteria may contribute, is still unknown.



These are neurons (c-fos, green) in the rat central amygdala activated by *E. coli* proteins in stationary phase and surrounded by nerve terminals (calcitonin gene-related peptide, red) originating from anorexigenic brainstem projections.
(Image Credit: *J. Breton, N. Lucas & D. Schapman***)**

"We now think bacteria physiologically participate in appetite regulation immediately after nutrient provision by multiplying and stimulating the release of satiety hormones from the gut," Fetisov says. "In addition, we believe gut microbiota produce proteins that can be present in the blood longer term and modulate pathways in the brain."

Source: www.sciencedaily.com

New information about bacterial enzymes to help scientists develop more effective antibiotics, cancer drugs

Scientists studying the biosynthesis and production of microbial natural products now have a greater insight into the process. This research was conducted at the U.S. Department of Energy's Argonne National Laboratory in collaboration with scientists from the Scripps Research Institute and Rice University.

Armed with this new information, researchers can use it to manipulate nature's biosynthetic machinery to produce more effective antibiotics and cancer-fighting drugs.

Streptomyces are Gram-positive bacteria that live in soil. These bacteria possess a complex metabolism and are known to naturally produce clinically useful compounds.

One large class of natural products, known as polyketides, includes many drugs such as erythromycin (antibacterial) and rapamycin (immunosuppressive), as well as promising drug leads such as migrastatin and oxazolomycin reported in the current study, which show important antibacterial, antitumor, and anti-human immunodeficiency virus activity.

These antibiotics are synthesized by a set of enzymes that are orchestrated into assembly-line-like biosynthetic machinery. Researchers in this study focused on understanding the enzymes specificity, which is responsible for generating the vast chemical structural diversities known for migrastatin, oxazolomycin and other polyketides.

Andrzej Joachimiak works in the biosciences division at Argonne and was one of the authors of a paper published on the topic in *The Proceedings of the National Academy of Sciences of the United States of America*.

"If we understand the specificity of these processes, we will be able to engineer the enzymes to accept other chemical molecules, opening the door to new treatments for some of our most challenging diseases," said Joachimiak, Director of the

Department of Energy's Structural Biology Center, which is located at Argonne.

Antibiotics are made up of a set of multiple enzymes that perform consecutive actions.

Scientists seek to modify these molecules chemically to create new drugs with improved therapeutic properties.

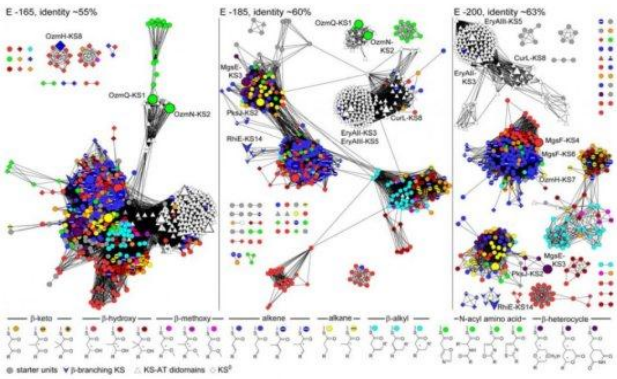
"In order to do that we need to understand the specificity of this "enzymatic assembly line," Dr. Ben Shen of the Scripps Research Institute said. "We need to know which part we need to place, and do it in a rational and specific manner, to synthesize the designer compounds."

Manipulating enzymes that catalyze complex reactions that alter natural product structures to create diverse novel compounds with new biological activities is a key.

This work was done with the help of the Advanced Protein Characterization Facility, which has greatly aided medical and biomedical research by automating the production of protein and protein crystals -- two key steps in solving the structure of proteins, understanding how they operate and ultimately helping to identify new and more effective drug treatments.

Proteins are long molecular chains that fold on themselves in complex ways with many of those folds serving as docking sites where other molecules, including those from pathogens, can attach.

In protein structure research, snippets of the DNA code for a protein are cloned. The clones are used to produce the proteins that are isolated and exposed to various chemical environments with the hope that one of them will cause the protein molecules to form a crystal.



Researchers at Argonne, Scripps Research Institute and Rice University provide greater insight into the process of manipulating nature's biosynthetic machinery to produce more effective antibiotics and cancer fighting drugs.

(Image Credit: *Joachimiak et, al.***)**

This can take days, weeks or even months. But when it happens, the protein molecules align to form a repeating array. That repetitive configuration allows X-rays from the Advanced Photon Source, a DOE Office of Science User Facility located at Argonne, to analyze the three-dimensional structure of the molecules by means of their different signatures using crystallographic techniques.

This helps Joachimiak and his team to solve age-old problems.

"This work would not be possible without the technology and equipment available here at Argonne," he said.

Source: www.sciencedaily.com

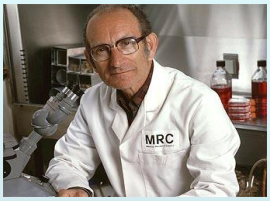
ONLINE REPORTS ON MICROORGANISMS

Scientists create genetically modified malaria-blocking mosquitoes

Using a groundbreaking gene editing technique, University of California scientists have created a strain of mosquitoes capable of rapidly introducing malaria-blocking genes into a mosquito population through its progeny, ultimately eliminating the insects' ability to transmit the disease to humans.

This new model represents a notable advance in the effort to establish an antimalarial mosquito population, which with further development could help to eradicate a disease

KNOW A SCIENTIST



Dr. Cesar Milstein was an Argentinian biochemist - nationalized British - in the field of antibody research. Milstein shared the **Nobel Prize in Physiology or Medicine in 1984** with Niels Kaj Jerne and Georges J. F. Köhler for developing the **hybridoma technique for the production of monoclonal antibodies.** This discovery led to an enormous expansion in the exploitation of antibodies in science and medicine.

"The hybridoma technology was a by-product of basic research. Its success in practical applications is to a large extent the result of unexpected and unpredictable properties of the method. It thus represents another clear-cut example of the enormous practical impact of an investment in research which might not have been considered commercially worthwhile, or of immediate medical relevance. It resulted from esoteric speculations, for curiosity's sake, only motivated by a desire to understand nature."

that sickens millions worldwide each year.

To create this breed, researchers at the Irvine and San Diego campuses inserted a DNA element into the germ line of *Anopheles stephensi* mosquitoes that resulted in the gene preventing malaria transmission being passed on to an astonishing 99.5 percent of offspring. *A. stephensi* is a leading malaria vector in Asia.

The study underlines the growing utility of the Crispr method, a powerful gene editing tool that allows access to a cell's nucleus to snip DNA to either replace mutated genes or insert new ones. Results appear in the online edition of *Proceedings of the National Academy of Sciences.*

"This opens up the real promise that this technique can be adapted for eliminating malaria," said Anthony James, Distinguished Professor of Molecular biology & Biochemistry and Microbiology & Molecular genetics at UCI.

For nearly 20 years, the James lab has focused on engineering anti-disease mosquitoes. His anti-dengue fever models have been tested in cage trials in Mexico, and in 2012, he helped to show that antibodies that impair the parasite's biology adapted from the immune systems of mice, can be introduced into mosquitoes. This trait, though, could only be inherited by about half of the progeny.

Earlier this year, UC San Diego biologists Ethan Bier and Valentino Gantz working with fruit flies announced the development of a new method for generating mutations in both copies of a gene. This mutagenic chain reaction involved using the Crispr-associated Cas9 nuclease enzyme and allowed for transmission of mutations through the germ line with an inheritance rate of 95 percent.

The two groups collaborated to fuse Bier and Gantz's method with James' mosquitoes. Gantz packaged antimalaria genes with a Cas9 enzyme (which can cut DNA) and a guide RNA to create a genetic "cassette" that, when injected into a mosquito embryo, targeted a highly specific spot on the germ line DNA to insert the antimalaria antibody genes.

To ensure that the element carrying the malaria-blocking antibodies had reached the desired DNA site, the researchers included in the cassette a protein that gave the progeny red fluorescence in the eyes. Almost 100 percent of offspring, 99.5 percent, to be exact, exhibited this trait, which James said is an amazing result for such a system that can change inheritable traits.

He added that further testing will be needed to confirm the efficacy of the antibodies and that this could eventually lead to field studies. "This is a significant first step," said James, a National Academy of Sciences member. "We know the gene works. The mosquitoes we created are not the final brand, but we know this technology allows us to efficiently create large populations."

Bier, a Professor of Biology at UC San Diego, also noted that "the ability of this system to carry large genetic payloads should have broad applications to the future use of related Crispr-based 'active genetic' systems.“

An *Anopheles stephensi* mosquito obtains a blood meal from a human host through its pointed proboscis. A known malarial vector, the species can found from Egypt all the way to China.

(Image Credit: *Jim Gathany / CDC***)**

Malaria is one of the world's leading health problems. More than 40 percent of the world's population live in areas where there is a risk of contracting the disease. According to the Centers for Disease Control & Prevention, 300 million to 500 million cases of malaria occur each year, and nearly 1 million people die of the disease annually - largely infants, young children and pregnant women, most of them in Africa.

Source: www.sciencedaily.com

Cockroaches communicate via bacteria in their feces

Like people, cockroaches like to hang out together, especially when they have nothing else to do. Now, researchers know why. Gut bacteria pooped along with their feces emit odours that the cockroaches find attractive. When those bacteria are missing, cockroaches tend to go it alone, researchers have discovered. Gut microbes in other organisms may likewise influence behavior in ways we have yet to appreciate.

“We don’t know whether microbes are generally important in mediating chemical communications, but my best guess is that it’s widespread,” says Angela Douglas, who studies microbes and their animal hosts at Cornell University and was not involved with the work. Eavesdropping on microbe-cockroach conversations could lead to better ways to control this common household pest.

Insects typically communicate using odours called pheromones; those that attract males to females are well-studied. Since the 1970s, entomologists have also known that so-called aggregation pheromones encourage cock roaches to stick close to one another. But researchers never could agree on what those pheromones really are. Some suggested they were waxy substances in the outer skin; others argued they were nitrogen-rich compounds in the feces; and a third group insisted that fatty acids—building blocks for fat—were involved, although which ones exactly was under debate.

Coby Schal, an entomologist at North Carolina State University (NC State) in Raleigh wondered whether the conflicting results meant that different cockroaches depend on different aggregation chemicals because of variation in their environments, food, or gut microbes. So Schal and his team, including NC State entomologist Ayako Wada-Katsumata sterilized German cockroaches, *Blattella germanica*, and raised them in germ-free cages, so their feces would be germ-free. Usually cockroaches are attracted to their neighbors’ feces, **but they tended to avoid the germ-free stuff**.

About 80% to 100% of young cockroaches tested preferred feces over sterile water, and although the difference in attraction was not as clear-cut between extracts of germ-free and normal feces, there were significantly more cockroaches aggregating by the normal feces extract, the researchers report online today in the *Proceedings of the National Academy of Sciences*. Without the microbes in the feces, the cockroaches no longer banded together very much. “The aggregation properties decline tremendously,” Schal says.

When Wada-Katsumata isolated feces bacteria and fed them to the germ-free cockroaches, the roaches once again tended to form groups. Sophisticated chemical analyses of normal roach poop and germ-free poop showed that the latter lacked many of the usual fatty acids that evaporate from the feces once it is exposed to air; the researchers conclude these volatile fatty acids may be the missing aggregation pheromones. Synthetic versions of these compounds also cause cockroaches to aggregate.

“This study explains how different studies in the past have yielded different results,” Douglas says. “It all depends on the microorganisms.” This may be why fatty acid advocates couldn’t agree on which fatty acids were important. Schal says that other candidate aggregation substances, in high concentrations, also seem to help bring the insects together, but these bacteria-produced compounds are much more potent and may be the most important drivers, Coby says.

Other researchers have shown that a specific microbe hosted by desert locusts helps induce crowding behavior in that species. And in 2012, researchers suggested that bacteria living in hyenas' scent glands impart the odors that help these animals tell kin from nonkin or pick out group members. “There’s the potential for this to be widespread,” Schal says.

May Berenbaum, an entomologist at the University of Illinois, Urbana-Champaign, who was not involved with the work agrees. "It has become abundantly clear that insects partner with a tremendous diversity of microbial [associates]—bugs are bug-infested, as it were," she points out. And in cockroaches, they "produce a beautiful story of biological cooperation."

And how about people? What we eat affects the bacteria in our guts, which in turn can affect what we smell like. But although the resulting foul body odour may deter contact, “there’s no evidence the bacteria play a positive role in communication among humans,” Schal says.

Cockroaches’ gut microbes may make the insects stick together.

He is now studying whether every population of cockroaches (even the ones living in your kitchen versus the ones in your basement) makes its own special aggregation pheromone. Schal and his colleagues hope to develop a synthetic aggregation pheromone that works for all German

cockroaches. Such a compound would help lure roaches to insecticides, baits, and traps, Douglas says: “If we can understand the chemistry of cockroach aggregation and its plasticity better, we can devise better strategies for control.”

Source: www.sciencemag.org

NEWS

A new class of ultra-stable enzyme formulations for industrial applications

It's no secret that extremophiles, or microbes that live in places like polar glaciers and toxic waste pools, may hold treasures worth billions to modern industry. For years, researchers and biotech companies have been "gene prospecting" in extremophiles, looking for DNA they can exploit to make enzymes for everything from laundry detergent to renewable biofuels. Yet when it came to heat and acid resistant enzymes, results have been wanting—until now.

Basic biology research at Lawrence Berkeley National Laboratory (Berkeley Lab) has led to the formation of Cinder Biological, or CinderBio, a startup company producing a new class of enzymes made from microbes that thrive in hot volcanic waters. Co-founded by Berkeley Lab scientists Steve Yannone and Jill Fuss, CinderBio will first target the food processing industry, where its enzymes can significantly reduce the vast amounts of chemicals and water used to clean equipment. Eventually it expects to formulate enzymes for the biofuels, paper, and textile industries, and possibly even more.

"Our enzymes are unique—they can operate in conditions that nobody else's can, so this opens up a lot of previously unexplored applications," said Fuss, a molecular biologist and the company's chief technology officer. "They're made from microbes that come from Yellowstone and live in hot acidic pools, so they thrive in nearly boiling acid. We've been able to take gene sequences and make them into enzymes that are extraordinarily stable."

CinderBio won a cash prize in the 2014 FLoW DOE National Clean Energy Business Plan Competition at Caltech. It was also one of the eight technologies selected to be a project for the Fall 2013 UC Berkeley Haas School of Business Cleantech to Market program that seeks to translate cleantech research into market opportunities.

This year, with a SBIR (Small Business Innovation Research) Phase 1 grant from the National Science Foundation, CinderBio tested its technology at a local creamery. The cleaning of dairy and other food processing equipment is normally a multi-step process. "They use a lot of base, then they wash, then acid, then wash, then sanitizer," said Fuss. "It takes a lot of time and uses a lot of chemicals and water. The microbes in the equipment can be hard to get rid of, so in some areas they've started to use harsher chemicals to combat those biofilms.“

Novel enzyme to give you guilt-free sugar cravings

Scientists including an Indian-origin researcher have discovered a key enzyme that can stop the toxic effects of sugar in various organs of the body.

This enzyme, named glycerol 3-phosphate phosphatase (G3PP), plays a central role in controlling glucose and fat utilisation.

Led by Dr. Marc Prentki and Dr. Murthy Madiraju from the University of Montreal Hospital Research Centre (CRCHUM), the team demonstrated that G3PP is able to detoxify excess sugar from the cells.

The discovery can lead to the development of therapeutics for obesity and Type 2 diabetes.

It is extremely rare since the 1960s that a novel enzyme is discovered at the heart of metabolism of nutrients in all mammalian tissues.

Novel enzyme to give you guilt-free sugar cravings (Getty Image)

"We identified the enzyme while looking for mechanisms enabling beta cells to get rid of excess glucose as glycerol," said Dr. Madiraju.

This mechanism has also been found to be operating in liver cells, and this enzyme is present in all body tissues, he added.

"We found that G3PP is able to breakdown a great proportion of excess glycerol phosphate to glycerol and divert it outside the cell, thus protecting the insulin producing beta cells of pancreas and various organs from toxic effects of high glucose levels," explained Dr. Prentki, principal investigator at the CRCHUM.

"By diverting glucose as glycerol, G3PP prevents excessive formation and storage of fat and it also lowers excessive production of glucose in liver, a major problem in diabetes," noted Dr. Madiraju.

The work offers a new therapeutic target for obesity, type 2 diabetes and metabolic syndrome.

The findings were published in the journal Proceedings of the National Academy of Sciences.

Source: www.sciencedaily.com

In the field trials, using CinderBio's enzymes to do the cleaning in place of chemicals, Yannone, a named inventor and the company's CEO, said he was amazed at how successful they were. "I came back after our first trials and recalculated everything because I thought we had moved a decimal point," he said. "We reduced water usage by almost 30 percent and our enzymes removed contaminants much faster and much more effectively than we had expected. The managers and owner at the creamery were all very excited by our results."

CinderBio's enzymes come from extremophiles found in hot volcanic waters, like this thermal pool in Yellowstone National Park.

Enzymes are naturally occurring molecules that act as catalysts to activate or speed up biochemical reactions; their use in industry is commonplace and usually beneficial to the environment since they can replace or reduce the use of chemicals or allow processes to take place at lower temperatures, lowering energy use.

CinderBio's technology comes from extremophilic microbes that grow naturally in thermal pools and have been studied for many years. The Berkeley Lab team was able to exploit aspects of the biology of these extreme microbes to turn them into enzyme-making machines. They developed a set of genetic tools that allow them to introduce naturally occurring genes into these microbes to produce enzymes that are more heat- and acid- stable than what has been available.

"Historically scientists have thought that all the information needed to make an active enzyme is entirely encoded in the DNA sequence," said Yannone. "Some of our revelations center on the idea that that's not true, that there are other components in a microbe making an enzyme that's stable and works in hot acid other than just the DNA sequence."

Yannone and Fuss first started studying the microbe about 10 years ago, looking for the fundamental biological processes that allowed it to thrive in such extreme conditions. Although scientists are still investigating what exactly confers such extreme stability on the microbe, Fuss was able to characterize the structural biochemistry of one of the enzymes. And Yannone, working with his undergraduate student then technician, Adam Barnebey, developed the molecular biology system that led to the formation of CinderBio.

Their invention was patented by Berkeley Lab, and Barnebey was the company's first employee. They are under consideration for a Phase 2 SBIR grant and next year may seek additional outside funding. They plan to further refine the platform and scale up production while seeking practical feedback from the food processing industry, a vast market.

"We think a lot about what we eat and how our food is grown, but we don't think about what happens in the middle," Fuss said. "Our technology helps make food processing more sustainable and could be used for any food product that goes in a container and ends up on a shelf."

Besides saving water and time, use of CinderBio's enzymes would also cut down on chemical waste. Chemical wastewater cannot be reclaimed and instead often has to be trucked off-site. Replacing these chemicals with biodegradable CinderBio enzymes makes that wastewater reclaimable, of particular importance given the ongoing drought in California.

"It's great when Berkeley Lab scientists are able to transform their fundamental research into an innovative technology that not only solves industry challenges but also contributes to our country's energy and environmental challenges," said Elsie Quaite-Randall, Berkeley Lab's Chief Technology Transfer Officer.

Source: www.phys.org

Chennai floods due to climate change?

Extreme events are increasing due to global warming.

The recent heavy record deluge of rainfall over Chennai was due to above normal sea surface temperatures in the Bay of Bengal, presence of monsoon trough close to Chennai, prevailing easterly waves and strong easterly winds. The 2015 *El Nino* phenomenon weakened South west monsoon winds which in turn led to less churning and upwelling in the Bay of Bengal and Arabian Sea and resulted in higher sea surface temperatures(SSTs) due to less mixing of cold waters with warm surface waters. This had a warming effect in Bay of Bengal. During the post-NW monsoon withdrawal period (later part of October and November) a monsoon trough prevailed around 13N latitude (latitude of Chennai) over peninsular India and Bay of Bengal.

The monsoon trough is a large area of low pressure that can move in any direction and carry convective winds with it. The high SSTs moistened the boundary layer (the lowest layer of the atmosphere in touch with the ocean surface) by evaporation. This moist air was lifted high up in the atmosphere by easterly waves emanating some distance from the coast at Chennai. Easterly waves are an atmospheric phenomenon wherein the wind moves in a wave like motion with the distance from crest to crest being as much as 2000 km (with a forward and rear sections of 1000 km each) and the period about two to three days. "Therefore it can be believed that the phenomenon might have persisted for 3 -4 days with spatial scales of approximately 500-1000km,"said Dr. J.R. Kulkarni, Team Expert, World Meteorological Organization, Ex-Adviser, IITM, Pune, to this Correspondent with whom he was in telephone and email contact.

The upward motion of the winds in the wave is called divergence and the downward, convergence. The divergence lifted moisture bearing air with it and carried it high up into the atmosphere as rain bearing clouds, and the easterly winds drove these clouds towards Chennai where they precipitated as rain. The continuous formation of clouds over Bay of Bengal, their transformation into deep convective clouds, their movement towards land and to Chennai city provided continuous heavy rainfall over land and the Chennai area. These clouds provided very heavy rainfall of the order of 150 mm/hour. If the rainfall is more than 100 mm/hour, then it is termed as a cloud burst.

For converting water into vapour, energy is required to provide to the water molecules. This energy is called latent heat of vaporization. As the water vapor goes up it cools due to ambient cooler atmosphere. It becomes saturated. The water vapor turns into water droplets. In this process, the energy stored in the water vapor is released to the atmosphere. This heats the cloud air. The cloud air becomes warm and light. The cloud air gets acceleration in upward direction because of receiving of latent heat. Temperature in the atmosphere decreases with height. At about 5 km above the ground, temperature becomes 0°C. This is called freezing level. The cloud drops freeze and become ice above freezing level. In the freezing process heat is released which is called latent heat of freezing. The cloud droplets and ice particles get additional upward motion by getting this energy. This way the cloud grows to a very high altitude.

Studies have shown that south west and north east monsoons have negative correlation. North east monsoon during the 2009 *El Nino* year was stronger than normal. Rainfall in 2009 north east monsoon was 12 per cent more than long term normal (IMD Departmental website Chennai). This year's high north east monsoon rainfall performance is consistent with earlier findings of negative correlation between the two monsoons in the *El Nino* years. The higher than normal sea surface temperatures are the real fuel of such deep convection. Climatologically these anomalies weaken in the December. Therefore it may be conjectured that heavy rainfall activity may weaken in December. "Radar data are required to check movement of clouds, their transformation

A new green power source

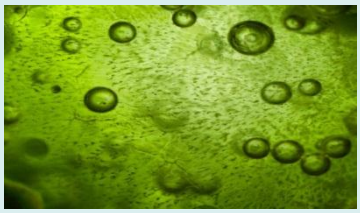
As world leaders prepare to gather in France for the 2015 United Nations Conference on Climate Change next week, global warming -- and how to stop it -- is a hot topic.

To limit climate change, experts say that we need to reach carbon neutrality by the end of this century at the latest. To achieve that goal, our dependence on fossil fuels must be reversed. But what energy source will take its place? Researchers from Concordia University in Montreal just might have the answer: blue-green algae.

In a study published in the journal *Technology*, a team led by Concordia engineering professor Muthukumaran Packirisamy describe their invention: a power cell that harnesses electrical energy from the photosynthesis and respiration of blue-green algae.

"Both photosynthesis and respiration ... involve electron transfer chains. By trapping the electrons released by blue-green algae during photosynthesis and respiration, we can harness the electrical energy they produce naturally," says Packirisamy.

Why blue-green algae? Because it's everywhere.



Blue-green algae (stock image).

Also known as cyanobacteria, blue-green algae are the most prosperous microorganisms on earth, evolutionarily speaking. They occupy a broad range of habitats across all latitudes. And they've been here forever: the planet's early fauna and flora owe their makeup to cyanobacteria, which produced the oxygen that ultimately allowed higher life forms to flourish.

"By taking advantage of a process that is constantly occurring all over the world, we've created a new and scalable technology that could lead to cheaper ways of generating carbon-free energy," says Packirisamy.

He notes that the invention is still in its early stages. "We have a lot of work to do in terms of scaling the power cell to make the project commercial."

Currently, the photosynthetic power cell exists on a small scale, and consists of an anode, cathode and proton exchange membrane. The cyanobacteria or blue green algae are placed in the anode chamber.

As they undergo photosynthesis, the cyanobacteria release electrons to the electrode surface. An external load is connected to the device to extract the electrons and harness power.

As Packirisamy and his team develop and expand the project, he hopes that the micro photosynthetic power cells will soon be used in various applications, such as powering cell phones and computers. And maybe one day they'll power the world.

Source: www.sciencedaily.com

into deep convective clouds, and their spatial and temporal scales. Modeling studies are required for examining various linkages in the proposed mechanism," said Dr. Kulkarni.

Sea surface temperatures were above normal.

(Image Credit: S.R. Raghunathan **)**

"Extreme weather events are indeed increasing due to global warming. This is because a warmer climate can hold more moisture in the atmosphere, leading to heavier rainfall when it does occur. However, it's difficult to say for certain that a particular extreme event – like the Chennai floods – is attributable to anthropogenic climate change," says Dr. Roxy Mathew Koll of The Indian Institute of Tropical Maeteorology, Pune.

Source: www.thehindu.com

Abstracts of Recent Publications

01. Applied Microbiology, 2015, Page: 121 - 154.

Microbial Enzymes and Their Industrial Applications. Sanjai Saxena

Department of Biotechnology, Thapar University, Patiala, Punjab, India.

Enzymes are biological catalysts produced in living cells. They are proteinaceous in nature, the exception being catalytic RNA, which are also referred to as ribozymes. The term 'en zyme' is derived from the Greek, meaning 'in sour dough'. E. Buchner (1897) experimentally proved that cell-free extract from yeast could produce alcohol from sugars, and he referred to it as "zymase". The unique characteristics that enzymes possess are that they (1) increase the rate of reaction they catalyze, without being consumed or lost; (2) act specifically with the substrate to produce the products; and (3) remain regulated from a state of low activity to high activity and vice versa. Enzymes have been grouped into six classes based on the types of reactions they catalyze. All cellular processes are controlled by a coordinated sequence of reactions that have specifically been catalyzed by a defined set of enzymes.

02. Reviews in Environmental Science and BioTechnology, 2015, **14(1)**, Page: 73- 92.

Microbial biotechnology for decolorization of textile wastewaters. Muhammad Imran, David E. Crowley, Azeem Khalid, Sabir Hussain, Muhammad Waseem Mumtaz, Muhammad Arshad.

Department of Environmental Sciences, University of Gujrat, Gujrat, 50700, Pakistan.

Wastewater originating from the textile industry is one of the major sources of pollution for surface and groundwater bodies in countries where textiles and other dye-products are produced. Along with dyes, textile wastewaters also contain varying amounts of metals/metalloids, salts and organic pollutants. Moreover, these wastewaters have high temperatures and varying pH value. Various physico-chemical and biological strategies have been devised to remove dye contaminants from such wastewaters. However, biotechnological approaches have attracted worldwide attention for their relative cost-effectiveness and environmentally friendly nature. Most biotechnological approaches rely on the use of microbes that have the potential to enzymatically degrade and decolorize dye-containing textile effluents. During recent years, several microbial cultures as well as microbial enzymes have been characterized and used for removal of dyes from simulated wastewaters having defined chemical compositions. However, there are still many challenges in scaling up microbial and enzymatic technologies for decolorization of raw textile wastewater that contain metals/metalloids, salts and other toxic compounds. The present review article summarizes the findings of recent studies conducted on decolorization of raw textile wastewaters. To the best of our knowledge, this is the only review reporting the biodegradation of azo dyes in raw textile effluents.

Keywords: Decolorization, Microbes, Textile effluents, Physico-chemical properties

E - Resources on Microorganisms

NATIONAL

Indian Type Culture Collection
http://www.iari.res.in/

MACS Collection of Microorganisms
http://www.aripune.org

National Bureau of Agriculturally Important Microorganisms
http://www.nbaim.org.in

Culture Collection, Microbiology and Cell Biology
http://mcbl.iisc.ernet.in/

INTERNATIONAL

Australian National Algae Culture Collection
http://www.csiro.au/ANACC

AWRI Microorganisms Culture Collection
http://www.awri.com.au/

BCCM/ULC Culture Collection of (sub) polar Cyanobacteria
http://bccm.belspo.be/index.php

Canadian Phycological Culture Centre
http://uwaterloo.ca/canadian-phycological-culture-centre/

EVENTS
Conferences / Seminars / Meetings 2016

Sensory Transduction in Microorganisms. January 17 - 22, 2016. **Venue:** Ventura Beach Marriott Ventura, **CA. Website:** http://www.grc.org/programs.aspx?id=12139

Human and Vertebrate Genomics: Bioinformatics Tools and Resources (Bangkok, Thailand). February 07 - 12, 2016 **Venue:** Bangkok, **Thailand. Website:** https://registration.hinxton.wellcome.ac.uk/events/item.aspx?e=544

EMBO Practical Course: Metabolomics Bioinformatics for Life Scientists. February 14 - 19, 2016. **Venue:** Cambridge, **UK. Website:** http://www.ebi.ac.uk/training/events/2016/embo-practical-course-metabolomics-bioinformatics-life-scientists-2

The 2nd Microbiome R and D and Business Collaboration Congress: Asia. February 29 - March 01, 2016. **Venue:** Kuala Lumpur, **Malaysia**. **Website:** http://www.globalengage.co.uk/microbiomeasia.html

New Antibacterial Discovery and Development (GRS). March 12 - 13, 2016. **Venue:** Ciocco Lucca (Barga), **Italy. Website:** http://www.grc.org/programs.aspx?id=17212

Climate change warming world's lakes at alarming rate

NEW DELHI: Freshwater lakes across the world are rapidly warming due to changing climate change, a new study supported by NASA has found. This could have serious impact on freshwater supplies and ecosystems.

The study used satellite temperature data and long-term ground measurements to monitor 235 lakes, representing more than half of the world's freshwater supply, for at least 25 years. It found lakes are warming an average of 0.61 degrees Fahrenheit (0.34 degrees Celsius) each decade. That's greater than the warming rate of either the ocean or the atmosphere, and it can have profound effects, the scientists say. The research is published in Geophysical Research Letters.

Algal blooms, which can ultimately rob water of oxygen, are projected to increase 20 percent in lakes over the next century as warming rates increase. Algal blooms that are toxic to fish and animals would increase by 5 percent. If these rates continue, emissions of methane, a greenhouse gas 25 times more powerful than carbon dioxide on 100-year time scales, will increase 4 percent over the next decade.

"Society depends on surface water for the vast majority of human uses," said co-author Stephanie Hampton, director of Washington State University's Center for Environmental Research, Education and Outreach in Pullman. "Not just for drinking water, but manufacturing, for energy production, for irrigation of our crops. Protein from freshwater fish is especially important in the developing world."

The temperature of water influences a host of its other properties critical to the health and viability of ecosystems. When temperature swings quickly and widely from the norm, life forms in a lake can change dramatically and even disappear.

"These results suggest that large changes in our lakes are not only unavoidable, but are probably already happening," said lead author Catherine O'Reilly, associate professor of geology at Illinois State University, Normal. Earlier research by O'Reilly has seen declining productivity in lakes with rising temperatures.

The researchers said various climate factors are associated with the warming trend. In northern climates, lakes are losing their ice cover earlier, and many areas of the world have less cloud cover, exposing their waters more to the sun's warming rays.

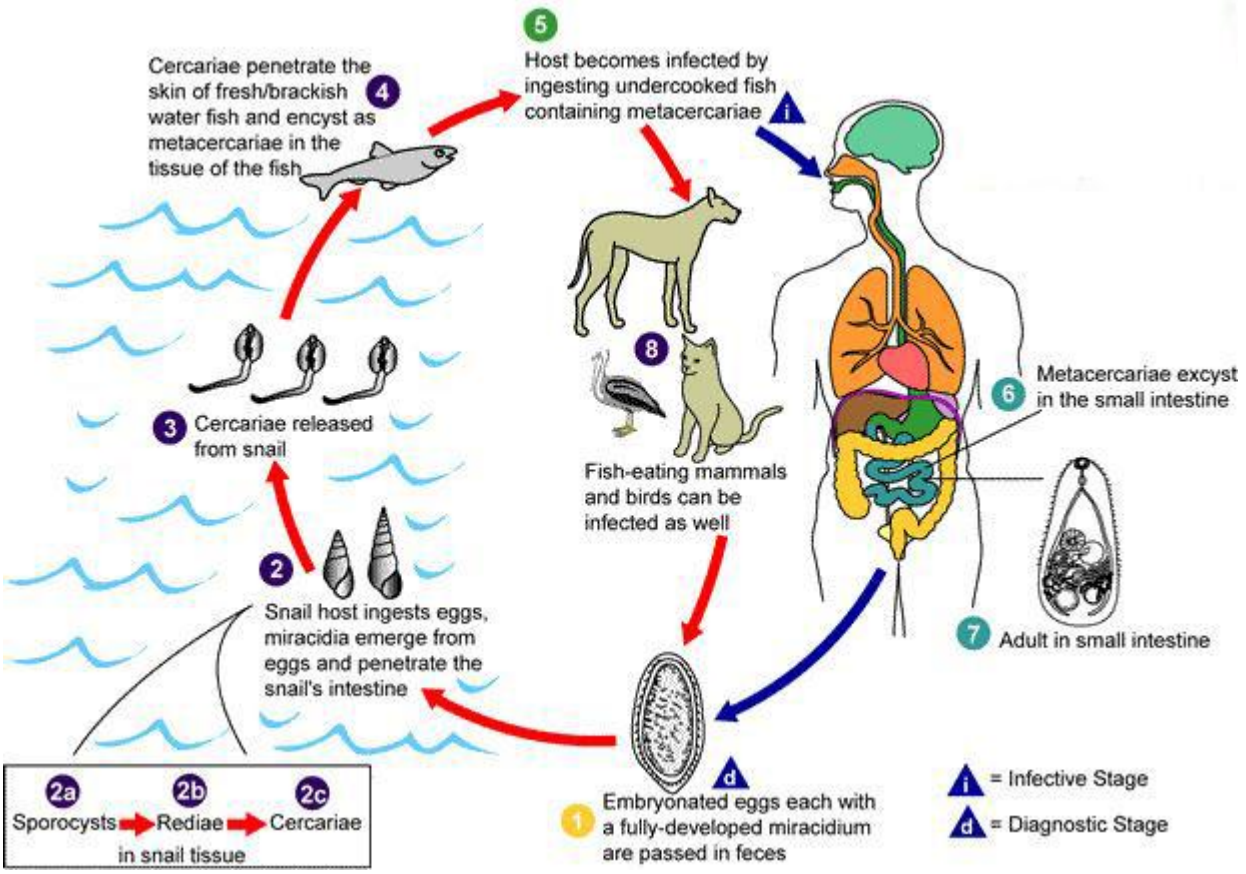
Previous work by Hook using satellite data indicated that many lake temperatures were warming faster than air temperature and that the greatest warming was observed at high latitudes, as seen in other climate warming studies. This new research confirmed those observations, with average warming rates of 1.3 degrees Fahrenheit (0.72 degrees Celsius) per decade at high latitudes.

Warm-water, tropical lakes may be seeing less dramatic temperature increases, but increased warming of these lakes can still have large negative impacts on fish. That can be particularly important in the African Great Lakes, where fish is an important source of food.

"We want to be careful that we don't dismiss some of these lower rates of change," said Hampton. "In warmer lakes, those temperature changes can be really important. They can be just as important as a higher rate of change in a cooler lake."

Source: www.thehindu.com

Candidiasis (*Candida* sp.)



Zika virus: the growing outbreak

The Zika virus is a mosquito-borne illness, first discovered in 1947 when it was isolated from a monkey found in Uganda's Zika Forest. The virus has been reported in humans in Asia and Africa since the 1950s, and was first found outside its usual geographic area in 2007, when there was an outbreak in Micronesia, a small cluster of islands in the western Pacific Ocean. The virus is primarily transmitted through the *Aedes aegypti* mosquito. Transmission occurs when this mosquito feeds on a person infected with Zika, and then spreads the virus by biting an uninfected person. According to the U.S. Centers for Disease Control and Prevention (CDC), there has been one possible case of transmission through blood transfusion and one possible case of transmission through sexual activity. So far there is limited evidence on whether Zika can be transferred from mother to child during pregnancy or at the moment of childbirth. But because of the rash of microcephaly cases in Brazil, which spiked after the first confirmed case of Zika, this maternal link is "strongly suspected" and **being closely studied**.

The most symptoms are mild, and include fever, rash, headache, muscle and joint pain, and conjunctivitis (red eyes). They can last for two to seven days. Most symptoms can be easily treated with rest and plenty of fluids. If symptoms worsen, a doctor should be consulted. There's no vaccine to prevent the Zika virus and no medication to treat it.

Zika is currently present in **24 countries and territories**, 22 of which are in the United States of America. Most of the countries affected by the virus are in Central and South America, according to the U.S.-based Centers for Disease Control and Prevention. (CBC)

Since the primary transmitter of Zika is the *Aedes* mosquito, efforts are being made to prevent reproduction by eliminating their breeding grounds. Another way to prevent transmission is to avoid mosquito bites. The use of mosquito repellent, clothing that covers most of the body, mosquito nets at night and screens on windows and doors will all help prevent bites. In Brazil, officials have vowed to soon mobilize some 220,000 troops to help eradicate the *Aedes* mosquito through door-to-door visits. Those efforts may be doubled again in August 2016, when the country plays host to the Olympic Games.