

<http://www.bbc.co.uk/news/health-21799534>

Phages may be key in bacteria battle

They might look like sinister aliens, but these bacteria-munching viruses could be the next weapon in the fight against infectious diseases.

By Damien McGuinness and Deborah Cohen Health Check, BBC World Service

At the Eliava Institute in Tbilisi, Georgia, patients are treated for all kinds of bacterial infections with viruses called phages. In most places in the world antibiotics are given for these infections. One patient says he regularly uses phages to treat a recurring eye infection. "I've tried everything. I've even had operations on my eye but nothing helped. But this does help," he says.

Phages are naturally occurring viruses that kill bacteria. Once they get into bacterial cells the phages' DNA replicates until it kills the host.

Doctors in Georgia, and in other countries that were in the former USSR, have been using this therapy for 90 years. But medics and drug regulatory bodies in most places in the developed world have been reluctant to accept that it works. Now that more and more bacteria have become resistant to antibiotics, the pharmaceutical industry is showing an interest in phage therapy.

The director of the Eliava Institute, Dr Revaz Adamia, explains: "In 2008 I had six letters from people in the West asking for help, but now in the last two months I've probably had about 150. "People want to be cured because they are desperate that they cannot be cured with antibiotics. Now they are looking at what they can do and they are coming to us."

Viral broth

Dr Martha Clokie, a microbiologist at the University of Leicester, carries out research into phages that could treat *Clostridium difficile* infections. She has tried therapy at the Eliava Institute. "When I was in Tbilisi one winter I had tonsillitis, and every six hours I was given broth containing phages, which I gargled. Back in the UK my husband and child had the infection too and they were prescribed antibiotics. We all got better at the same time."

The institute also has some prepared phage solutions that it has worked out will kill the bacteria that cause common diseases, such as *E.coli*, which causes stomach upsets. The therapy can be injected, sprayed on to the site of infection or swallowed. Each solution contains many types of phages, although usually just one attacks the bacteria.

Refrigerators

Dr Naomi Hoyle is an American who has trained to be a doctor in Georgia and now works at the institute. She is married to the grandson of Dr Liane Gachechiladze, one of the scientists who kept the place going during the civil wars and economic chaos of the 1990s, following the collapse of the Soviet Union.

Dr Gachechiladze remembers: "We used to get a lot of power cuts in this neighbourhood which was a problem because phages have to be stored cold in refrigerators. "But in the part of town where I lived, we would still often have electricity. So I bought an old fridge, and I used to take all the phages home and keep them safe in my kitchen."

Dr Hoyle says that one of the advantages of the viruses over antibiotics is that they target only the harmful bacteria. "It doesn't have the side-effects or the negative aspects of antibiotics, like diarrhoea, because of its high specificity. It's not the silver bullet that antibiotics are, but it has its advantages as it works well on chronic infections. It enters the site and continues to do its work even after application."

Dr Martha Clokie says we may see the use of phage therapy outside the former Soviet Union in the next decade. "Large companies have done phase one and two clinical trials and are now finding ways to do phase three clinical trials, in which they will be seeing if the treatment works in patients. "In the future we may see phages used to treat minor bacterial infections, and antibiotics kept for the serious life-threatening conditions."

Analysis
James Gallagher Health and science reporter, BBC News
<i>The need for new treatments for bacterial infections is desperate.</i>
<i>From tuberculosis to E. coli, Klebsiella to gonorrhoea, resistance to antibiotics is rising fast.</i>
<i>Health officials around the world have warned that we may be entering a post-antibiotic era.</i>
<i>It could mean deadly diseases become untreatable while surgery and cancer therapies would carry enormous risks of patients catching untreatable infections.</i>
<i>Phages are one of the options that are often suggested as a possible new weapon against bacterial infection.</i>
<i>It is an appealing idea - the enemy of my enemy is my friend. However as far as mainstream medicine is concerned it is just an idea.</i>
<i>The field has not had the same level of funding as drug development. It means the big questions of effectiveness and safety still remain largely unanswered.</i>

http://www.eurekalert.org/pub_releases/2013-03/wuis-soe031513.php

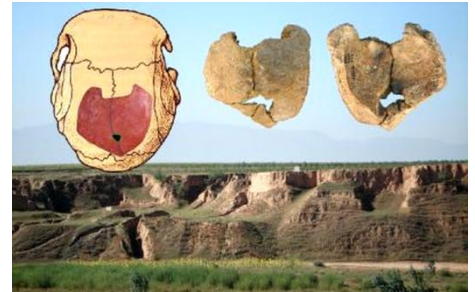
Skulls of early humans carry telltale signs of inbreeding, study suggests

Skull pieces of an early human from northern China exhibit a deformation indicating inbreeding may have been common among our ancestors

Buried for 100,000 years at Xujiayao in the Nihewan Basin of northern China, the recovered skull pieces of an early human exhibit a now-rare congenital deformation that indicates inbreeding might well have been common among our ancestors, new research from the Chinese Academy of Sciences and Washington University in St. Louis suggests.

The skull, known as Xujiayao 11, has an unusual perforation through the top of the brain case -- an enlarged parietal foramen (EPF) or "hole in the skull" -- that is consistent with modern humans diagnosed with a rare genetic mutation in the homeobox genes ALX4 on chromosome 11 and MSX2 on chromosome 5.

These specific genetic mutations interfere with bone formation and prevent the closure of small holes in the back of the prenatal braincase, a process that is normally completed within the first five months of fetal development. It occurs in about one out of every 25,000 modern human births.



This is a view of the Xujiayao site (below) and internal and external view of the Xujiayao 11 skull piece with its position indicated on the drawing of a complete skull (above). Erik Trinkaus/WUSTL

Although this genetic abnormality is sometimes associated with cognitive deficits, the older adult age of Xujiayao 11 suggests that any such deficits in this individual were minor. Traces of genetic abnormalities, such as EPF, are seen unusually often in the skulls of Pleistocene humans, from early Homo erectus to the end of the Paleolithic.

"The probability of finding one of these abnormalities in the small available sample of human fossils is very low, and the cumulative probability of finding so many is exceedingly small," suggests study co-author Erik Trinkaus, the Mary Tileston Hemenway Professor of Anthropology in Arts & Sciences at Washington University in St. Louis.

"The presence of the Xujiayao and other Pleistocene human abnormalities therefore suggests unusual population dynamics, most likely from high levels of inbreeding and local population instability." It therefore provides a background for understanding populational and cultural dynamics through much of human evolution.

Published March 18 in the journal PLOS ONE, the study is co-authored by Xiu-Jie Wu and Song Xing of the Institute of Vertebrate Paleontology and Paleoanthropology, Beijing. Its findings are based on the analysis of the fossilized partial skull of an adult late archaic human from the Xujiayao site, in the Nihewan Basin of northern China.

http://www.eurekalert.org/pub_releases/2013-03/sp-dgc031813.php

Does Greek coffee hold the key to a longer life?

The answer to longevity may be far simpler than we imagine; it may in fact be right under our noses in the form of a morning caffeine kick.

Los Angeles, CA - The elderly inhabitants of Ikaria, the Greek island, boast the highest rates of longevity in the World, and many scientists turn to them when looking to discover the 'secrets of a longer life'. In a new study in Vascular Medicine, published by SAGE, researchers investigating cardiovascular health believe that a cup of boiled Greek coffee holds the clue to the elderly islanders' good vascular health.

Only 0.1% of Europeans live to be over 90, yet on the Greek island of Ikaria, the figure is 1%. This is recognized as one of the highest longevity rates anywhere – and the islanders tend to live out their longer lives in good health.

Christodoulos Stefanadis and Gerasimos Siasos, professors at the University of Athens Medical School, Greece set out with their team to find out whether the elderly population's coffee drinking had an effect on their health. In particular, the researchers investigated links between coffee-drinking habits and the subjects' endothelial function. The endothelium is a layer of cells that lines blood vessels, which is affected both by aging and by lifestyle habits (such as smoking). The team homed in on coffee because recent studies suggest that moderate coffee consumption may slightly reduce the risks of coronary heart disease, and that it may also have a positive impact on several aspects of endothelial health.

From a sample of 673 Ikarrians aged over 65 who lived on the island permanently, the researchers randomly selected 71 men and 71 women to take part in the study. Medical staff used health checks (for high blood pressure, diabetes, etc.) and questionnaires to get more detail on the participants' medical health, lifestyles and coffee drinking, in addition to testing their endothelial function.

The researchers investigated all types of coffee taken by participants – but interestingly more than 87% of those in the study consumed boiled, Greek coffee daily. More importantly, subjects consuming mainly boiled Greek coffee had better endothelial function than those who consumed other types of coffee. Even in those with high blood pressure, boiled Greek coffee consumption was associated with improved endothelial function, without worrying impacts on blood pressure.

“Boiled Greek type of coffee, which is rich in polyphenols and antioxidants and contains only a moderate amount of caffeine, seems to gather benefits compared to other coffee beverages,” Siasos concludes.

Taking into consideration the beneficial effects of Mediterranean diet and physical activity on cardiovascular health, the new study provides a new connection between nutritional habits and cardiovascular health. Given the extent of coffee drinking across the world, and the fact that even small health effects of at least one type of coffee could have an impact on public health, this study provides an interesting starting point. However, further studies are needed to document the exact beneficial mechanisms of coffee on cardiovascular health.

“Consumption of a boiled Greek type of coffee is associated with improved endothelial function: The Icaria Study” by Gerasimos Siasos, et al, published XX March 2013 in *Vascular Medicine*.

The article will be available to download for free for a limited time at <http://vmj.sagepub.com/content/early/recent>

http://www.eurekalert.org/pub_releases/2013-03/uoc--ao031813.php

An oxygen-poor 'boring' ocean challenged evolution of early life

UC Riverside-led research team provides the first comprehensive view of early ocean chemistry and its relationship to early organisms

RIVERSIDE, Calif. - A research team led by biogeochemists at the University of California, Riverside has filled in a billion-year gap in our understanding of conditions in the early ocean during a critical time in the history of life on Earth. It is now well accepted that appreciable oxygen first accumulated in the atmosphere about 2.4 to 2.3 billion years ago. It is equally well accepted that the build-up of oxygen in the ocean may have lagged the atmospheric increase by well over a billion years, but the details of those conditions have long been elusive because of the patchiness of the ancient rock record.

The period 1.8 to 0.8 billion years ago is of particular interest because it is the essential first chapter in the history of eukaryotes, which are single-celled and multicellular organisms with more complex cellular structures compared to prokaryotes such as bacteria. Their rise was a milestone in the history of life, including that of animals, which first appear around 0.6 to 0.7 billion years ago.

The most interesting thing about the billion-year interval is that despite the rise of oxygen and eukaryotes, the first steps forward were small and remarkably unchanging over a very long period, with oxygen likely remaining low in the atmosphere and ocean and with marine life dominated by bacteria rather than diverse and large populations of more complex eukaryotes. In fact, chemical and biological conditions in this middle age of Earth history were sufficiently static to earn this interval an unflattering nickname - 'the boring billion.' But lest it be thought that such a 'boring' interval is uninteresting, the extraordinary circumstances required to maintain such biological and chemical stasis for a billion years are worthy of close study, which is what motivated the UC Riverside-led team.

By compiling data for metals with very specific and well-known chemical responses to oxygen conditions in the ocean, emphasizing marine sediments from this critical time interval from around the world, the researchers revealed an ancient ocean that was oxygen-free (anoxic) and iron-rich in the deepest waters and hydrogen sulfide-containing over limited regions on the ocean margins.

"Oxygen, by contrast, was limited, perhaps at very low levels, to the surface layers of the ocean," said Christopher T. Reinhard, the first author of the research paper and a former UC Riverside graduate student.

"What's most unique about our study, however, is that by applying numerical techniques to the data, we were able to place estimates, for the first time, on the full global extent of these conditions. Our results suggest that most of the deep ocean was likely anoxic, compared to something much less than 1 percent today."

Study results appear online this week in the *Proceedings of the National Academy of Sciences*.

"A new modeling approach we took allowed us to build on our past work, which was mostly limited to defining very localized conditions in the ancient ocean," Reinhard said. "The particular strength of the method lies in its ability to define chemical conditions on the seafloor that have long since been lost to plate tectonic recycling." Reinhard, now a postdoctoral fellow at Caltech and soon to be an assistant professor at Georgia Institute of Technology, explained that chromium and molybdenum enrichments in ancient organic-rich sedimentary rocks, the focus of the study, actually track the amount of the metals present in ancient seawater. Critically, those concentrations are fingerprints of global ocean chemistry.

Beyond the utility of chromium and molybdenum for tracking oxygen levels in the early ocean, molybdenum is also a bioessential element critical in the biological cycling of nitrogen, a major nutrient in the ocean.

"Molybdenum's abundance in our ancient rocks is also a direct measure of its availability to early life," said Timothy W. Lyons, a professor of biogeochemistry at UCR and the principal investigator of the research project. "Our recent results tell us that poor supplies of molybdenum and their impact on nitrogen availability may have limited the rise of oxygen in the ocean and atmosphere and the proliferation of eukaryotic life. There is more to do, certainly, but this is a very tantalizing new read of a chapter in Earth history that is anything but boring."

Reinhard and Lyons were joined in the study by UCR alum Noah J. Planavsky, now at Caltech; Leslie J. Robbins and Kurt O. Konhauser at the University of Alberta, Canada; Camille A. Partin and Andrey Bekker at the University of Manitoba, Canada; UCR alum Benjamin C. Gill, now at the Virginia Institute of Technology; and Stefan V. Lalonde at the Université de Bretagne Occidentale, France. The research was supported by a NASA Exobiology grant to Lyons.

<http://bit.ly/Yq7PID>

The radioactive legacy of the search for plutopia

Cold war dreams of producing nuclear bombs fuelled shocking radiation experiments by US and Soviet governments, reveals Kate Brown's Plutopia

Rob Edwards, contributor

MAKING plutonium for nuclear bombs takes balls, but not in the way you might think. In 1965, scientists at the Hanford nuclear weapons complex in Washington state wanted to investigate the impact of radiation on fertility - and they weren't hidebound by ethics.

In a specially fortified room in the basement of Washington State Penitentiary in Walla Walla, volunteer prisoners were asked to lie face down on a trapezoid-shaped bed. They put their legs into stirrups, and let their testicles drop into a plastic box of water where they were zapped by X-rays.

The experiments, which lasted for a decade and involved 131 prisoners, came up with some unsurprising results. Even at the lowest dose - 0.1 gray - sperm was damaged, and at twice that dose the prisoners became sterile. They were paid \$5 a month for their trouble, plus \$25 per biopsy and \$100 for a compulsory vasectomy at the end so they didn't father children with mutations.

The testicle tests are just one of many disturbing details Kate Brown has unearthed from the official archives in her fascinating nuclear history. She also tells how tunnels created by muskrats undermined one of Hanford's storage ponds, causing 60 million litres of radioactive effluent to pour into the Columbia river.

And there is the scary tale of how Hanford scientists conducted one of their riskiest experiments, later dubbed the "green run". For 7 hours, they processed highly radioactive "green" fuel that had not been allowed to decay for as long as usual - and showered 407,000 gigabecquerels of radioactive iodine over nearby cities.

The green run is said to have been an attempt to mimic what the US thought the Soviet Union was doing to boost plutonium production at its Mayak nuclear weapons plant at Ozersk, in the Urals.

It is the looking-glass links between Hanford and Mayak, and the communities that host them, that form the central theme of Brown's book. They were two secretive citadels, dedicated to producing as much plutonium as possible to fuel the cold war arsenals of the world's two opposing superpowers. They both conferred wealth and privilege on their elite staff, copying each other to create what Brown styles as a "plutopia".

But the two vast, creaking, nuclear complexes also deliberately discharged huge amounts of radioactivity into the environment, cut corners and caused countless accidents and leaks. Brown estimates that during their existence they each released at least 7.4 billion gigabecquerels, four times the amount released by the accident at the Chernobyl nuclear plant in Ukraine in 1986.

The rivers that drain the two sites, the Columbia and the Techa, have both been called the most radioactive in the world, and many thousands of people who live downstream and downwind say the contamination has made them sick.

These are, says Brown, "slow motion disasters" created and covered up by state machines.

Brown argues that the US and the Soviet Union both subverted science to maintain the plutopia.

The most shocking example was the US Atomic Energy Commission's takeover of seminal Japanese research into the health impacts of the atomic bombs dropped on Hiroshima and Nagasaki.

This was necessary, according to a senior AEC official in 1955, to ensure that "misleading and unsound reports" were "kept to a minimum".

Brown's account is unique, partisan and occasionally personal in that she includes some of her thoughts about interviews she conducted: for example, she recounts how she ended up becoming friends with one interviewee. But because she is open and thorough about her sources, those are strengths to be celebrated, not weaknesses to be deplored. It also means her book is engaging, honest and, in the end, entirely credible.

<http://bit.ly/Y91GcQ>

Farming has deep roots in Chinese ice age

New analysis suggests it took 12,000 years to go from eating wild plants to farming in what is now China

Some ideas need time to take root. A new analysis suggests it took up to 12,000 years for people in what is now China to go from eating wild plants to farming them. Agriculture elsewhere also took time to flower.

Li Liu of Stanford University and colleagues studied three grinding stones from China's Yellow River region. They bear residues showing that they were used to process millet and other grains, as well as yams, beans and roots. The stones date from 23,000 to 19,500 years ago, late in the last ice age. But the earliest archaeological evidence for crop cultivation in China is 11,000 years old, suggesting that farming was slow to emerge from ancient traditions of plant use.

That fits with a wider pattern, says Robin Allaby of the University of Warwick, UK. In the Middle East "we also have evidence of cereals at that 23,000-year point", he says – which is long before people were farming them. "Although this period is around the late glacial maximum, there is a blip at 23,000 years during which time it was milder." Millet and the other food plants could have flourished in the warmth, tempting people to start exploiting them.

Some of the plants, like the snakegourd root, are still used in traditional medicines. Karen Hardy at the Catalan Institution for Research and Advanced Studies in Barcelona, Spain, says she would not be surprised if ancient peoples "knew how to select plant food that benefited their health". Last year she reported evidence that Neanderthals used medicinal plants.

"We can never know for certain why a plant was ingested, but I think these early people probably had a detailed knowledge of the plants they selected and used," Hardy says. "This is likely to have included their medicinal as well as their nutritional qualities." *Journal reference: PNAS, DOI: 10.1073/pnas.1217864110*

www.eurekalert.org/pub_releases/2013-03/tf-uci031913.php

US company identified as manufacture of lead paint in Africa

House paint containing dangerous concentrations of lead is being sold in Cameroon by an American company – and the company is refusing to remove the paint from store shelves.

SAN FRANCISCO, CA - "There is an immediate need for regulations to restrict the lead content of paint in Cameroon to protect public health," said Perry Gottesfeld, Executive Director of Occupational Knowledge International (OK International) and co-author of a new research study about this lead hazard.

"The levels of lead are extraordinarily high, and these products have been banned in the U.S. for more than 30 years," Gottesfeld said. The study, in the May issue of the Journal of Occupational and Environmental Hygiene revealed lead concentrations are as high as 50 percent by weight in household paint being sold by Cameroon's largest paint company, Seigneururie – a subsidiary of the U.S. Company PPG. This concentration is more than 5,000 times the allowable limit in the U.S.

Lead is added to paint because it is inexpensive way to add color, resist corrosion, or to improve the drying. The research was jointly conducted by OK International and the Research and Education Centre for Development (CREPD) and involved samples from dozens of stores. Results showed that two-thirds (66%) of new paints in Cameroon made by more than ten companies had hazardous lead levels in excess of 90 parts per million (ppm). The researchers also found that none of the lead paints surveyed in stores had any hazard warnings while only 8% of the paints had labels identifying any of the ingredients. The new study is the first one which provides the names of paint companies and the lead concentrations for all 61 paints tested.

"This is the ultimate case of a company operating with double standards as they sell hazardous products in developing countries that have been banned in the U.S. since the 1970s," Gottesfeld added.

As a result of this research, consumers in Cameroon are being warned to avoid purchasing paints unless the cans are labeled with as having no added lead. Most of the paint available in the market contains hazardous levels of lead that causes birth defects, brain damage, high blood pressure, and other health effects in both children and adults.

CREPD is issuing a warning following the results of a recent survey showing that most of the new paints being sold in stores still contain lead at excessive levels despite pledges by some paint companies to reformulate.

"The problem we are seeing is that the older paint is still in stores because none of the companies have recalled products with hazardous levels of lead," said Gilbert KUEPOUO, Coordinator of CREPD. "As a result, we are asking consumers to look for labels that indicate that lead levels are less than 90 parts per million (PPM) as required in the U.S., China, and other countries."

PPG sent a letter to some of the distributors offering to exchange some products, but few responded. CREPD recently interviewed the managers of the 11 stores that sell Seigneururie paints and identified only three that had

returned products based on the companies offer. There are no regulations regarding the lead content of new paints in Cameroon.

The World Health Organization estimates that 240 million people around the world are overexposed to lead contamination and 99 percent of those most severely exposed reside in developing countries. Lead paint in housing contributes significantly to children's exposure resulting in brain damage, mental retardation, lower educational performance, and a range of other health effects.

The complete article in the Journal of Occupational and Environmental Hygiene has been made available for a free download here: <http://www.tandfonline.com/doi/abs/10.1080/15459624.2013.768934>

http://www.eurekalert.org/pub_releases/2013-03/rci-mpf031913.php

Max Planck Florida Institute study points to major discovery for Alzheimer's disease

Study potentially identifies a cause of Alzheimer's disease

FLORIDA - The Journal of Neuroscience has published a study led by researchers at the Max Planck Florida Institute for Neuroscience, the first and only U.S. extension of the prestigious Max Planck Society, that may hold a stunning breakthrough in the fight to treat Alzheimer's disease. The study potentially identifies a cause of Alzheimer's disease - based on a newly-discovered signaling pathway in cellular models of Alzheimer's disease - and opens the door for new treatments by successfully blocking this pathway. The Institute, which recently opened in December 2012, focuses solely on basic neuroscience research that aims to analyze, map, and decode the human brain - the most important and least understood organ in the body.

"This study transforms our understanding of the direct cause of Alzheimer's disease," said Principal Investigator Dr. Ryohei Yasuda. "With further research, we may open up an entirely new avenue for treatments to combat this disease."

The scientific community so far has widely accepted that Alzheimer's disease is caused by the accumulation of a peptide called Amyloid beta. When Amyloid beta is applied to neurons, neuronal morphology becomes abnormal and synaptic function is impaired. However, how Amyloid beta causes dysfunction is unknown. The MPFI research indicates that the presence of Amyloid beta triggers increased levels of a signaling protein, called centaurin-1 (CentA1), that appears to cause neuronal dysfunction – a potentially groundbreaking discovery that uncovers an important intermediary step in the progression of the disease.

As part of the research, the scientists were able to identify CentA1 and measure its negative effects on neurons. Utilizing an RNA silencing technique, they turned down the cellular production of CentA1, and showed that affected neurons, exposed to Amyloid beta and exhibiting Alzheimer's related symptoms, returned to normal morphology and synaptic function, even with the continued presence of Amyloid beta. They further found that increased CentA1 activates a series of proteins, and these proteins form a signaling pathway from CentA1 to neuronal dysfunction. Thus, inhibiting other proteins in the pathway also "cured" affected neurons.

The initial tests reported were conducted on rat brain slices. MPFI has already started to expand their studies to mouse models of Alzheimer's disease and preliminary experiments show promising results. Ultimately, targeting the components of this newly identified signaling pathway has the potential to open the door for new pharmacological and gene therapies in treatment of Alzheimer's disease. Dr. Yasuda also anecdotally reports that the effects of CentA1 knock down were observed to be sustained over several weeks and an avenue for future study will be to examine how long the positive effects on neurons are sustained which may indicate the potential impact of treatments derived from this research. The full study will be available at <http://www.jneurosci.org/> on March 20, 2013.

http://www.eurekalert.org/pub_releases/2013-03/epfd-ffm031913.php

Fantastic flash memory combines graphene and molybdenite

Graphene and molybdenite have been combined into a very promising flash memory prototype

EPFL scientists have combined two materials with advantageous electronic properties -- graphene and molybdenite -- into a flash memory prototype that is very promising in terms of performance, size, flexibility and energy consumption.

After the molybdenite chip, we now have molybdenite flash memory, a significant step forward in the use of this new material in electronics applications. The news is even more impressive because scientists from EPFL's Laboratory of Nanometer Electronics and Structures (LANES) came up with a truly original idea: they combined the advantages of this semiconducting material with those of another amazing material – graphene. The results of their research have recently been published in the journal ACS Nano.

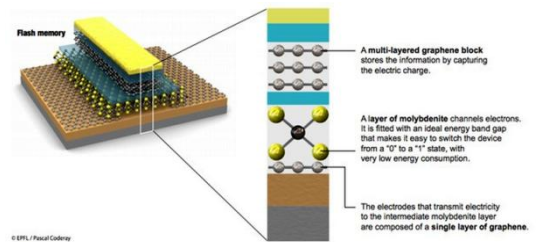
Two years ago, the LANES team revealed the promising electronic properties of molybdenite (MoS₂), a mineral that is very abundant in nature. Several months later, they demonstrated the possibility of building an efficient molybdenite chip. Today, they've gone further still by using it to develop a flash memory prototype –

that is, a cell that can not only store data but also maintain it in the absence of electricity. This is the kind of memory used in digital devices such as cameras, phones, laptop computers, printers, and USB keys.

An ideal "energy band"

"For our memory model, we combined the unique electronic properties of MoS₂ with graphene's amazing conductivity," explains Andras Kis, author of the study and director of LANES.

Molybdenite and graphene have many things in common. Both are expected to surpass the physical limitations of our current silicon chips and electronic transistors. Their two-dimensional chemical structure – the fact that they're made up of a layer only a single atom thick – gives them huge potential for miniaturization and mechanical flexibility.



EPFL scientists have combined two materials with advantageous electronic properties - graphene and molybdenite - into a flash memory prototype that is promising in terms of performance, size, flexibility and energy consumption.

EPFL

Although graphene is a better conductor, molybdenite has advantageous semi-conducting properties. MoS₂ has an ideal "energy band" in its electronic structure that graphene does not. This allows it to switch very easily from an "on" to an "off" state, and thus to use less electricity. Used together, the two materials can thus combine their unique advantages.

Like a sandwich

The transistor prototype developed by LANES was designed using "field effect" geometry, a bit like a sandwich. In the middle, instead of silicon, a thin layer of MoS₂ channels electrons. Underneath, the electrodes transmitting electricity to the MoS₂ layer are made out of graphene. And on top, the scientists also included an element made up of several layers of graphene; this captures electric charge and thus stores memory.

"Combining these two materials enabled us to make great progress in miniaturization, and also using these transistors we can make flexible nanoelectronic devices," explains Kis. The prototype stores a bit of memory, just a like a traditional cell. But according to the scientist, because molybdenite is thinner than silicon and thus more sensitive to charge, it offers great potential for more efficient data storage.

http://www.eurekalert.org/pub_releases/2013-03/w-sbm031913.php

Sex between monogamous heterosexuals rarely source of hepatitis C infection

Individuals infected by the hepatitis C virus (HCV) have nothing to fear from sex in a monogamous, heterosexual relationship.

Transmission of HCV from an infected partner during sex is rare according to new research published in the March issue of *Hepatology*, a journal published by Wiley on behalf of the American Association for the Study of Liver Diseases (AASLD).

Experts estimate that HCV affects up to 4 million Americans, most of whom are sexually active. Medical evidence shows HCV is primarily transmitted by exposure to infectious blood, typically through intravenous (IV) drug use. However, there are conflicting reports regarding sexual activity and HCV transmission with some studies suggesting that exposure to infected blood during sex - through bodily fluids such as vaginal secretions, semen or saliva - may carry a minimal infection risk.

"Generally the risk for transmitting HCV to sex partners is very low," explains lead study author Dr. Norah Terrault with the University of California, San Francisco. "Yet, lack of quantitative data about the risk of HCV transmission with sexual activity remains a limitation for doctors counseling their patients on safe sex practices."

To specifically quantify the risk HCV transmission from a chronically infected individual to their sex partner, researchers recruited 500 anti-HCV-positive individuals, who were negative for the human immunodeficiency (HIV), and their long-term heterosexual partners. Couples were surveyed about lifetime risk factors for HCV infection, sexual practices of the couple, and sharing of personal items. The team analyzed blood samples to determine the presence or absence of active virus in the blood and compared the HCV strains in those couples with HCV present.

The majority of HCV infected individuals who participated in the study were non-Hispanic whites, had a median age of 49 years, and sexual activity with their partners ranging from 2 to 52 years. HCV prevalence among partners was 4%, with 9 couples having similar viral strains and viral samples from 3 couples were highly related which is consistent with HCV transmission between the partners.

The maximum incidence rate of HCV transmission by sex was 0.07% per year or roughly 1 per 190,000 sexual contacts that researchers based upon 8377 person-years of follow-up. The team did not identify any specific

sexual practices linked to HCV infections among the couples. "Our study provides clinicians with important information for counseling chronic HCV patients in long-term sexual relationships, supporting the current recommendations that couples not change their sexual practices if they are in a monogamous heterosexual relationship," concludes Dr. Terrault.

To request a copy of the study, please contact sciencenewsroom@wiley.com

Full citation: "Sexual Transmission of HCV Among Monogamous Heterosexual Couples: The HCV Partners Study." Norah A. Terrault, Jennifer L. Dodge, Edward L. Murphy, John E. Tavis, Alexi Kiss, T.R. Levin, Robert Gish, Michael Busch, Arthur L. Reingold, Miriam J. Alter. *Hepatology*; (DOI: 10.1002/hep.26164); Print Issue Date: March, 2013.

URL: <http://doi.wiley.com/10.1002/hep.26164>

<http://www.sciencedaily.com/releases/2013/03/130319124221.htm>

Brain Tumor Cells Killed by Anti-Nausea Drug

New research from the University of Adelaide has shown for the first time that the growth of brain tumors can be halted by a drug currently being used to help patients recover from the side effects of chemotherapy.

The discovery has been made during a study looking at the relationship between brain tumors and a peptide associated with inflammation in the brain, called "substance P."

Substance P is commonly released throughout the body by the nervous system, and contributes to tissue swelling following injury. In the brain, levels of substance P greatly increase after traumatic brain injury and stroke.

"Researchers have known for some time that levels of substance P are also greatly increased in different tumor types around the body," says Dr Elizabeth Harford-Wright, a postdoctoral fellow in the University's Adelaide Centre for Neuroscience Research. "We wanted to know if these elevated levels of the peptide were also present in brain tumor cells, and if so, whether or not they were affecting tumor growth. Importantly, we wanted to see if we could stop tumor growth by blocking substance P."

In laboratory studies for her PhD, Dr Harford-Wright found that levels of substance P were greatly increased in brain tumor tissue. Knowing that substance P binds to a receptor called NK1, Dr Harford-Wright used an antagonist drug called Emend® to stop substance P binding to the receptor. Emend® is already used in cancer clinics to help patients with chemotherapy-induced nausea. The results were startling.

"We were successful in blocking substance P from binding to the NK1 receptor, which resulted in a reduction in brain tumor growth -- and it also caused cell death in the tumor cells," Dr Harford-Wright says.

"So preventing the actions of substance P from carrying out its role in brain tumors actually halted the growth of brain cancer. "This is a very exciting result, and it offers further opportunities to study possible brain tumor treatments over the coming years."

This research has been funded by the NeuroSurgical Research Foundation (NRF), which is celebrating 50 years of supporting neurosurgical research in Australia and at the University of Adelaide.

http://www.eurekalert.org/pub_releases/2013-03/uov-bbp032013.php

Baffling blood problem explained

60-year-old health mystery solved by Vermont and French research team

In the early 1950's, a 66-year-old woman, sick with colon cancer, received a blood transfusion. Then, unexpectedly, she suffered a severe rejection of the transfused blood. Reporting on her case, the French medical journal *Revue D'Hématologie* identified her as, simply, "Patient Vel."

After a previous transfusion, it turns out, Mrs. Vel had developed a potent antibody against some unknown molecule found on the red blood cells of most people in the world - but not found on her own red blood cells. But what was this molecule? Nobody could find it. A blood mystery began, and, from her case, a new blood type, "Vel-negative," was described in 1952.

Soon it was discovered that Mrs. Vel was not alone. Though rare, it is estimated now that over 200,000 people in Europe and a similar number in North America are Vel-negative, about 1 in 2,500.

For these people, successive blood transfusions could easily turn to kidney failure and death. So, for sixty years, doctors and researchers have hunted - unsuccessfully - for the underlying cause of this blood type.

But now a team of scientists from the University of Vermont and France has found the missing molecule - a tiny protein called SMIM1 - and the mystery is solved.

Reporting in the journal *EMBO Molecular Medicine*, UVM's Bryan Ballif, Lionel Arnaud of the French National Institute of Blood Transfusion, and their colleagues explain how they uncovered the biochemical and genetic basis of Vel-negative blood. "Our findings promise to provide immediate assistance to health-care professionals should they encounter this rare but vexing blood type," says Ballif. The pre-publication results were presented online, March 18, 2013, and the finalized report will be published, as an open-access article, in the next edition of the journal.

(Last year, Ballif and Arnaud identified the proteins responsible for two other rare blood types, Junior and Langeris, moving the global count of understood blood types or systems from 30 to 32. Now, with Vel, the number rises to 33.)

Before this new research, the only way to determine if someone was Vel-negative or positive was with tests using antibodies made by the few people previously identified as Vel-negative following their rejection of transfused blood. Not surprisingly, these antibodies are vanishingly rare and, therefore, many hospitals and blood banks don't have the capacity to test for this blood type.

"Vel- blood is one of the most difficult blood types to supply in many countries," the scientists write, "This is partly due to the rarity of the Vel- blood type, but also to the lack of systematic screening for the Vel-type in blood donors."

In response, the UVM and Paris researchers developed two fast DNA-based tests for identifying Vel-negative blood and people. These tests can be easily integrated into existing blood testing procedures - and can be completed in a few hours or less. "It's usually a crisis when you need a transfusion" says Ballif. "For those rare Vel-negative individuals in need of a blood transfusion, this is a potentially life-saving time frame."

To make their discovery, Arnaud and coworkers in Paris used some of the rare Vel-negative antibody to biochemically purify the mystery protein from the surface of human red blood cells. Then they shipped them to Ballif in Vermont.

The little protein didn't reveal its identity easily. "I had to fish through thousands of proteins," Ballif says. And several experiments failed to find the culprit because of its unusual biochemistry - and pipsqueak size. But he eventually nabbed it using a high-resolution mass spectrometer funded by the Vermont Genetics Network. And what he found was new to science. "It was only a predicted protein based on the human genome," says Ballif, but hadn't yet been observed. It has since been named: Small Integral Membrane Protein 1, or SMIM1.

Next, Arnaud's team in France tested seventy people known to be Vel-negative. In every case, they found a deletion - a tiny missing chunk of DNA - in the gene that instructs cells on how to manufacture SMIM1. This was the final proof the scientists needed to show that the Vel-negative blood type is caused by a lack of the SMIM1 protein on a patient's red blood cells.

Today, personalized medicine - where doctors treat us based on our unique biological makeup - is a hot trend. "The science of blood transfusion has been attempting personalized medicine since its inception," Ballif notes, "given that its goal is to personalize a transfusion by making the best match possible between donor and recipient."

"Identifying and making available rare blood types such as Vel-negative blood brings us closer to a goal of personalized medicine," he says. "Even if you are that rare one person out of 2,500 that is Vel-negative, we now know how to rapidly type your blood and find blood for you - should you need a transfusion."

<http://phys.org/news/2013-03-hidden-magma-layer-scientists-lubricant.html>

Hidden magma layer: Scientists discover 'lubricant' for Earth's tectonic plates

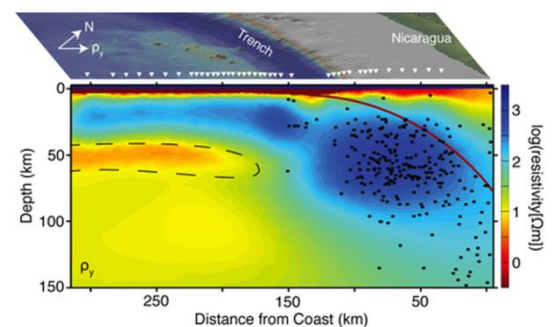
Scientists at Scripps Institution of Oceanography at UC San Diego have found a layer of liquefied molten rock in Earth's mantle that may be acting as a lubricant for the sliding motions of the planet's massive tectonic plates.

Phys.org - The discovery may carry far-reaching implications, from solving basic geological functions of the planet to a better understanding of volcanism and earthquakes.

The scientists discovered the magma layer at the Middle America trench offshore Nicaragua. Using advanced seafloor electromagnetic imaging technology pioneered at Scripps, the scientists imaged a 25-kilometer- (15.5-mile-) thick layer of partially melted mantle rock below the edge of the Cocos plate where it moves underneath Central America. The discovery is reported in the March 21 issue of the journal Nature by Samer Naif, Kerry Key, and Steven Constable of Scripps, and Rob Evans of Woods Hole Oceanographic Institution.

The orange colored area enclosed by a dashed line denotes a magma layer that scientists believe is facilitating the motion of the Cocos plate off Nicaragua. The blue areas represent the Cocos plate sliding across the mantle and eventually diving beneath the Central American continent, while the black dots signify earthquake locations. The discovery was made by analyzing data collected by an array of seafloor electromagnetic instruments, shown as inverted triangles.

The new images of magma were captured during a 2010 expedition aboard the U.S. Navy-owned and Scripps-operated research vessel Melville. After deploying a vast array of seafloor instruments that recorded natural



electromagnetic signals to map features of the crust and mantle, the scientists realized they found magma in a surprising place.

"This was completely unexpected," said Key, an associate research geophysicist in the Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics at Scripps. "We went out looking to get an idea of how fluids are interacting with plate subduction, but we discovered a melt layer we weren't expecting to find at all - it was pretty surprising."

For decades scientists have debated the forces and circumstances that allow the planet's tectonic plates to slide across the earth's mantle. Studies have shown that dissolved water in mantle minerals results in a more ductile mantle that would facilitate tectonic plate motions, but for many years clear images and data required to confirm or deny this idea were lacking.

"Our data tell us that water can't accommodate the features we are seeing," said Naif, a Scripps graduate student and lead author of the paper. "The information from the new images confirms the idea that there needs to be some amount of melt in the upper mantle and that's really what's creating this ductile behavior for plates to slide."

The marine electromagnetic technology employed in the study was originated by Charles "Chip" Cox, an emeritus professor of oceanography at Scripps, and in recent years further advanced by Constable and Key. Since 2000 they have been working with the energy industry to apply this technology to map offshore oil and gas reservoirs.

The researchers say their results will help geologists better understand the structure of the tectonic plate boundary and how that impacts earthquakes and volcanism. "One of the longer-term implications of our results is that we are going to understand more about the plate boundary, which could lead to a better understanding of earthquakes," said Key. The researchers are now seeking to find the source that supplies the magma in the newly discovered layer.

http://www.eurekalert.org/pub_releases/2013-03/wt-fsd031513.php

Follow-up study describes declining efficacy of malaria vaccine candidate over 4 years *Efficacy of a malaria vaccine candidate, RTS,S, wanes over time and varies with exposure to the malaria parasite*

Long-term follow-up of a phase II study from KEMRI-Wellcome Trust Research Programme and Oxford University researchers in Kenya shows that the efficacy of a malaria vaccine candidate, RTS,S, wanes over time and varies with exposure to the malaria parasite.

The findings will help to inform which populations are likely to benefit most from the vaccine candidate. They also have important implications for the design of future clinical trials of this and other vaccine candidates and highlight the importance of long-term follow-up studies for assessing vaccine efficacy.

The study involved 447 children in Kilifi, Kenya, who had been part of an earlier phase II trial to assess the safety and efficacy of the vaccine candidate. Of the 447 children, 320 completed four years of follow-up. The analysis, which was published today in the 'New England Journal of Medicine', was designed to look at how well the vaccine candidate protects against malaria over time.

Initial results from larger ongoing phase III studies showed that the candidate RTS,S vaccine reduced malaria over 12 months of follow-up by approximately half in young children and one-third in infants. The new findings on long-term follow-up of an earlier phase II study reveal that the vaccine efficacy dropped from 43.6 per cent protection against malaria in the first year to zero by the fourth year after vaccination.

The study's senior author, Dr Phillip Bejon (Research Fellow at the KEMRI-Wellcome Trust Research Programme and the Centre for Tropical Medicine, University of Oxford), said: "Despite the falling efficacy over time, there is still a clear benefit to the vaccine candidate. Many of the children will experience multiple episodes of clinical malaria infection, but overall we found that 65 cases of malaria were averted over the four-year period for every 100 children vaccinated. We now need to look at whether offering a vaccine booster can sustain efficacy for longer."

The study also shows that relative vaccine efficacy declines with increasing exposure to malaria, from 45.1 per cent among children with below-average exposure to malaria to 15.9 per cent among children with above-average exposure to malaria. The relative efficacy describes the number of cases of malaria that were avoided by vaccination as a percentage of the total number of cases in that group: because there were many more cases of malaria at higher exposure, the cases averted per 100 children vaccinated actually increased from 62 at below-average exposure to 78 at above-average exposure.

The study's lead author, Dr Ally Olotu, a Wellcome Trust PhD student at the KEMRI-Wellcome Trust Research Programme and Oxford University, explains: "We need to consider whether relative efficacy or absolute

number of cases averted is the more informative measure. In any case, these are important findings that will help to inform which populations are likely to benefit most from the vaccine.

"The ongoing phase III study will provide further insights to the vaccine's efficacy in different settings of malaria exposure and includes an assessment of a booster dose to sustain efficacy over time."

Malaria remains an important cause of illness and death among children in sub-Saharan Africa, and there is currently no vaccine that offers complete protection against the disease. RTS,S is the most advanced candidate malaria vaccine and entered phase III clinical trials in Africa in 2009. The vaccine candidate seems to be well tolerated and has an acceptable safety profile, but it remains unclear which sub-groups of children might benefit most and what the duration of efficacy is.

Jimmy Whitworth, Head of International Activities at the Wellcome Trust, said: "This study indicates the durability of protection of a single initial course of this vaccine against malaria, and the variability of protection at different levels of exposure to malaria. These are key pieces of information required for us to understand how best to use this vaccine and the regimes of boosters that will be required to provide optimum protection."

Latest figures estimate that there are 1.44 billion people living in regions of stable malaria transmission worldwide. Most deaths occur among children living in Africa, where a child dies from malaria every minute.

http://www.eurekalert.org/pub_releases/2013-03/gumc-rlg031513.php

Researchers link Gulf War Illness to physical changes in brain fibers that process pain *Evidence that veterans who suffer from "Gulf War Illness" have physical changes in their brains not seen in unaffected individuals*

WASHINGTON - Researchers at Georgetown University Medical Center (GUMC) have found what they say is evidence that veterans who suffer from "Gulf War Illness" have physical changes in their brains not seen in unaffected individuals. Brain scans of 31 veterans with the illness, compared to 20 control subjects, revealed anomalies in the bundles of nerve fibers that connect brain areas involved in the processing and perception of pain and fatigue.

The discovery, published online March 20 in PLOS ONE, could provide insight into the mysterious medical symptoms reported by more than one-fourth of the 697,000 veterans deployed to the 1990-1991 Persian Gulf War, the researchers say. These symptoms, termed Gulf War Illness, range from mild to debilitating and can include widespread pain, fatigue, and headache, as well as cognitive and gastrointestinal dysfunctions.

Although these veterans were exposed to nerve agents, pesticides and herbicides, among other toxic chemicals, no one has definitively linked any single exposure or underlying mechanism to Gulf War Illness according to the scientists.

This is the first study to show veterans, compared to unaffected subjects, have significant axonal damage. Bundles of axons, which form the brain white matter, are akin to telephone wires that carry nerve impulses between different parts of the gray matter in the brain. The researchers found that damage to the right inferior fronto-occipital fasciculus was significantly correlated with the severity of pain, fatigue, and tenderness.

"This tract of axons links cortical gray matter regions involved in fatigue, pain, emotional and reward processing. This bundle also supports activity in the ventral attention network, which searches for unexpected signals in the surrounding environment that may be inappropriately interpreted as causing pain or being dangerous. Altered function in this tract may explain the increased vigilance and distractibility observed in veterans," says lead author Rakib Rayhan, a researcher in the lab of the study's senior investigator, James Baraniuk, MD, a professor of medicine at GUMC.

In this Department of Defense-funded study, the research team used a form of functional magnetic resonance imaging (fMRI) called diffusion tensor imaging. This imaging method examines patterns of water diffusion in the brain to look for changes in the integrity of white matter, which is not seen on regular MRI scans. "This provides a completely new perspective on Gulf War Illness," says Baraniuk. "While we can't exactly tell how this tract is affected at the molecular level - the scans tell us these axons are not working in a normal fashion." Although preliminary, "the changes appear distinct from multiple sclerosis, major depression, Alzheimer's disease and other neurodegenerative diseases," says Rayhan. "These novel findings are really exciting because they provide validation for many veterans who have long said that no one believes them."

The results must be replicated, say its authors, but for the first time a potential biomarker for Gulf War Illness may be on the horizon as well as a possible target for therapy aimed at regenerating these neurons.

"Pain and fatigue are perceptions, just like other sensory input, and Gulf War Illness could be due to extensive damage to the structures that facilitate them," says Rayhan. "Some of the veterans we studied feel pain when doing something as simple as putting on a shirt. Now we have something to tell them about why their lives have been so greatly affected."

Other study co-authors include Georgetown University Medical Center researchers Benson W. Stevens, Christian R. Timbol, Oluwatoyin Adewuyi, Brian Walitt, MD, and John W. VanMeter, PhD.

Support was provided by a Department of Defense Congressionally Directed Medical Research Program award W81-XWH-09-1-0526. This project has been funded in whole or in part with federal funds (grant # UL1TR000101, previously UL1RR031975) from the National Center for Advancing Translational Sciences, National Institutes of Health, through the Clinical and Translational Science Awards Program.

The article can be access on March 20 at <http://dx.plos.org/10.1371/journal.pone.0058493>.

http://www.eurekalert.org/pub_releases/2013-03/uoo-tfo032013.php

Thin films of nickel and iron oxides yield efficient solar water-splitting catalyst

Basic University of Oregon research shows promise in efforts to get hydrogen fuel from sunlight and water

EUGENE, Ore. - University of Oregon chemists say that ultra-thin films of nickel and iron oxides made through a solution synthesis process are promising catalysts to combine with semiconductors to make devices that capture sunlight and convert water into hydrogen and oxygen gases.

Researchers in the Solar Materials and Electrochemistry Laboratory of Shannon Boettcher, professor of chemistry, studied the catalyst material and also developed a computer model for applying catalyst thin films in solar water-splitting devices as a tool to predict the effectiveness of a wide range of catalyst materials for solar-hydrogen production. The project has resulted in two recent papers.

The first, detailed last September in the Journal of the American Chemical Society, showed that films of a nickel-iron mixed oxide with an atomic structure similar to naturally occurring minerals show the highest catalytic activity for forming oxygen from water, based on a side-by-side comparison of eight oxide-based materials targeted in various research efforts. The second paper, just published in the Journal of Physical Chemistry Letters, details the performance of the catalyst thin films when combined with semiconductor light absorbers, showing that the nickel-iron oxide catalyst was most effective with a film just 0.4 nanometers thick. Boettcher's lab, located in the UO's Materials Science Institute, studies fundamental materials chemistry and physical concepts related to the conversion of solar photons (sunlight) into electrons and holes in semiconductors that can then be used to drive chemical processes such as splitting protons off water to make hydrogen and oxygen gases. Multiple labs across the country are seeking effective and economical ways of taking sunlight and directly producing hydrogen gas as an alternative sustainable fuel to replace fossil fuels.

"When you want to pull the protons off a water molecule to make hydrogen gas for fuel, you also have to take the leftover oxygen atoms and make oxygen gas out of them," Boettcher said. "It turns out that the slowest, hardest, most-energy-consuming step in the water-splitting process is actually the oxygen-making step. We've been studying catalysts for making oxygen. Specifically, we're seeking catalysts that reduce the amount of energy it takes in this step and that don't use expensive precious metals."

The iron-nickel oxides, he said, have higher catalytic activity than the precious-metal-based catalytic materials that have been thought to be the best for the job. "What we found is that when we take nickel oxide films that start out as a crystalline material with the rock-salt structure like table salt, they absorb iron impurities and spontaneously convert into materials with a layered structure during the catalysis process," Boettcher said.

Lena Trotochaud, a doctoral student and lead author on both papers, studied this process and how the films can be combined with semiconductors. "The semiconductors absorb the light, generating electron-hole pairs which move onto the catalyst material and proceed to drive the water-splitting reaction, creating fuel," Boettcher said. The computer modeling was used to understand how the amount of sunlight that the catalyst blocks from reaching the semiconductor can be minimized while simultaneously speeding up the reaction with water to form oxygen gas. This basic discovery remains a lab accomplishment for now, but it could advance to testing in a prototype device, Boettcher added.

"We're now looking at the fundamental reasons why these materials are good," Trotochaud said. "We are trying to understand how the catalyst works by focusing on the chemistry that is happening, and then also recognizing how that fits into a real system. Our research is fundamentally guiding how you would take these catalysts and incorporate them into something that is useful for everyone in society."

One such place the material could land in a prototype for testing is at the U.S. Department of Energy's Joint Center for Artificial Photosynthesis, an Energy Innovation Hub. The DOE supported Boettcher's research done in the second study through a Basic Sciences Energy grant (DE-FG02-12ER16323).

"This research holds great potential for the development of more efficient, more sustainable solar-fuel generation systems and other kinds of transformative energy technology," said Kimberly Andrews Espy, vice president for research and innovation and dean of the graduate school. "By seeking to advance carbon-neutral energy technology, Dr. Boettcher and his team are helping to establish Oregon as an intellectual and economic leader in fostering a sustainable future for our planet and its people."

The research reported in the first paper in JACS was funded by the Center for Sustainable Materials Chemistry, a \$20 million National Science Foundation-funded center co-based at the UO and Oregon State University in Corvallis (CHE-1102637). Co-authors with Trotochaud and Boettcher were James K. Ranney, an undergraduate student in chemistry, and Kerisha N. Williams, who participated under the NSF-funded Undergraduate Catalytic Outreach and Research Experiences (UCORE) program.

Funding for the research detailed in the second paper also came, in part, from the Center for Sustainable Materials Chemistry. The DOE grant to Boettcher also supported co-author Thomas J. Mills, a UO graduate.

http://www.eurekalert.org/pub_releases/2013-03/ntu-nsd032013.php

NTU scientist develops a multi-purpose wonder material to tackle environmental challenges

A new wonder material that can generate hydrogen, produce clean water and even create energy.

Science fiction? Hardly, and there's more - It can also desalinate water, be used as flexible water filtration membranes, help recover energy from desalination waste brine, be made into flexible solar cells and can also double the lifespan of lithium ion batteries. With its superior bacteria-killing capabilities, it can also be used to develop a new type of antibacterial bandage.

Scientists at Nanyang Technological University (NTU) in Singapore, led by Associate Professor Darren Sun have succeeded in developing a single, revolutionary nanomaterial that can do all the above and at very low cost compared to existing technology.

This breakthrough which has taken Prof Sun five years to develop is dubbed the Multi-use Titanium Dioxide (TiO₂). It is formed by turning titanium dioxide crystals into patented nanofibres, which can then be easily fabricated into patented flexible filter membranes which include a combination of carbon, copper, zinc or tin, depending on the specific end product needed.

Titanium dioxide is a cheap and abundant material, which has been scientifically proven to have the ability to accelerate a chemical reaction (photocatalytic) and is also able to bond easily with water (hydrophilic).

More than 70 scientific papers on Prof Sun's work in titanium dioxide has been published in the last five years, the latest being papers published in Water Research, Energy and Environmental Science, and Journal of Materials Chemistry.

Prof Sun, 52, from NTU's School of Civil and Environmental Engineering, said such a low-cost and easily produced nanomaterial is expected to have immense potential to help tackle ongoing global challenges in energy and environmental issues. With the world's population expected to hit 8.3 billion by 2030, there will be a massive increase in the global demand for energy and food by 50 per cent and 30 per cent for drinking water (Population Institute report, titled 2030: The "Perfect Storm" Scenario).

"While there is no single silver bullet to solving two of the world's biggest challenges: cheap renewable energy and an abundant supply of clean water; our single multi-use membrane comes close, with its titanium dioxide nanoparticles being a key catalyst in discovering such solutions," Prof Sun said. "With our unique nanomaterial, we hope to be able to help convert today's waste into tomorrow's resources, such as clean water and energy."

Prof Sun's multi-use titanium dioxide can:

concurrently produce both hydrogen and clean water when exposed to sunlight

be made into a low-cost flexible filtration membrane that is anti-fouling

desalinate water as a high flux forward osmosis membrane

recover energy from waste desalination brine and wastewater

be made into a low-cost flexible solar cell to generate electricity

doubles battery life when used as anode in lithium ion battery

kill harmful microbial, leading to new antibacterial bandages

How the wonder material was found

Prof Sun had initially used titanium dioxide with iron oxide to make anti-bacterial water filtration membranes to solve biofouling - bacterial growth which clogs up the pores of membranes, obstructing water flow.

While developing the membrane, Prof Sun's team also discovered that it could act as a photocatalyst, turning wastewater into hydrogen and oxygen under sunlight while still producing clean water. Such a water-splitting effect is usually caused by Platinum, a precious metal that is both expensive and rare.

"With such a discovery, it is possible to concurrently treat wastewater and yet have a much cheaper option of storing solar energy in the form of hydrogen so that it can be available any time, day or night, regardless of whether the sun is shining or not, which makes it truly a source of clean fuel," said Prof Sun.

"As of now, we are achieving a very high efficiency of about three times more than if we had used platinum, but at a much lower cost, allowing for cheap hydrogen production. In addition, we can concurrently produce clean water for close-to-zero energy cost, which may change our current water reclamation system over the world for future liveable cities."

Hydrogen is a clean fuel which can be used for automotive fuel-cells or in power plants to generate electricity.

Producing hydrogen and clean water

This discovery, which was published recently in the academic journal, Water Research, showed that a small amount of nanomaterial (0.5 grams of titanium dioxide nanofibres treated with copper oxide), can generate 1.53 millilitre of hydrogen in an hour when immersed in one litre of wastewater. This amount of hydrogen produced is three times more than when Platinum is used in the same situation.

Depending on the type of wastewater, the amount of hydrogen generated can be as much as 200 millilitres in an hour. Also to increase hydrogen production, more nanomaterial can be used in larger amounts of wastewater.

Producing low-cost flexible forward osmosis membranes

Not only can titanium dioxide particles help split water, it can also make water filter membranes hydrophilic - allowing water to flow through it easily, while rejecting foreign contaminants, including those of salt, making it perfect for desalinating water using forward osmosis. Thus a new super high flux (flow rate) forward osmosis membrane is developed. This discovery was published recently in last month's journal of Energy and Environmental Science. This is the first such report of TiO₂ nanofibres and particles used in forward osmosis membrane system for clean water production and energy generation.

Producing new antibacterial bandages

With its anti-microbial properties and low cost, the membrane can also be used to make breathable anti-bacterial bandages, which would not only prevent infections and tackle infection at open wounds, but also promote healing by allowing oxygen to permeate through the plaster. The membrane's material properties are also similar to polymers used to make plastic bandages currently sold on the market.

Producing low-cost flexible solar cells

Prof Sun's research projects have shown out that when treated with other materials or made into another form such as crystals, titanium dioxide can have other uses, such as in solar cells. By making a black titanium dioxide polycrystalline sheet, Prof Sun's team was able to make a flexible solar-cell which can generate electricity from the sun's rays.

Producing longer lasting lithium ion batteries

Concurrently, Prof Sun has another team working on developing the black titanium dioxide nanomaterial to be used in Lithium ion batteries commonly used in electronic devices.

Preliminary results from thin coin-like lithium ion batteries, have shown that when titanium dioxide sphere-like nanoparticles modified with carbon are used as the anode (negative pole), it can double the capacity of the battery. This gives such batteries a much longer lifespan before it is fully drained. The results were featured prominently in a highly respected Journal of Materials Chemistry on its cover page last year.

Next step – commercialisation

Prof Sun and his team of 20, which includes 6 undergraduates, 10 PhD students and 4 researchers, are now working to further develop the material while concurrently spinning off a start-up company to commercialise the product. They are also looking to collaborate with commercial partners to speed up the commercialisation process.

http://www.eurekalert.org/pub_releases/2013-03/acs-ehe032013.php

Explaining how extra virgin olive oil protects against Alzheimer's disease

How consumption of extra virgin olive oil helps reduce the risk of Alzheimer's disease may lie in a component of olive oil

The mystery of exactly how consumption of extra virgin olive oil helps reduce the risk of Alzheimer's disease (AD) may lie in one component of olive oil that helps shuttle the abnormal AD proteins out of the brain, scientists are reporting in a new study. It appears in the journal ACS Chemical Neuroscience.

Amal Kaddoumi and colleagues note that AD affects about 30 million people worldwide, but the prevalence is lower in Mediterranean countries. Scientists once attributed it to the high concentration of healthful monounsaturated fats in olive oil - consumed in large amounts in the Mediterranean diet. Newer research suggested that the actual protective agent might be a substance called oleocanthal, which has effects that protect nerve cells from the kind of damage that occurs in AD. Kaddoumi's team sought evidence on whether oleocanthal helps decrease the accumulation of beta-amyloid (A β) in the brain, believed to be the culprit in AD. They describe tracking the effects of oleocanthal in the brains and cultured brain cells of laboratory mice used as stand-ins for humans in such research. In both instances, oleocanthal showed a consistent pattern in which it boosted production of two proteins and key enzymes believed to be critical in removing A β from the brain.

"Extra-virgin olive oil-derived oleocanthal associated with the consumption of Mediterranean diet has the potential to reduce the risk of AD or related neurodegenerative dementias," the report concludes.

The authors acknowledge funding from the National Institute of General Medical Sciences of the National Institutes of Health.

<http://phys.org/news/2013-03-enceladus-jets-sea.html>

Enceladus' jets reach all the way to its sea

Enceladus' jets very likely reach all the way down to the sea - a salty subsurface sea thought to lie beneath nearly 10 kilometers of ice

Thanks to the Cassini mission we've known about the jets of icy brine spraying from the south pole of Saturn's moon Enceladus for about 8 years now, but this week it was revealed at the 44th Lunar and Planetary Science Conference outside Houston, Texas that Enceladus' jets very likely reach all the way down to the sea - a salty subsurface sea of liquid water that's thought to lie beneath nearly 10 kilometers of ice.

Enceladus' jets were first observed by the Cassini spacecraft in 2005. The jets constantly spray fine particles of ice into space which enter orbit around Saturn, creating the hazy, diffuse E ring in which Enceladus resides. Emanating from deep fissures nicknamed "tiger stripes" that gouge the 512-km (318-mile) -wide moon's south pole the icy jets - and the stripes - have been repeatedly investigated by Cassini, which has discovered that not only do the ice particles contain salts and organic compounds but also that the stripes are surprisingly warm, measuring at 180 Kelvin (minus 135 degrees Fahrenheit) - over twice as warm as most other regions of the moon.

Where the jets are getting their supply of liquid water has been a question scientists have puzzled over for years. Is friction caused by tidal stresses heating the insides of the stripes, which melts the ice and shoots it upwards? Or do the fissures actually extend all the way down through Enceladus' crust to a subsurface ocean of liquid water, and through tidal pressure pull vapor and ice up to the surface?

Researchers are now confident that the latter is the case.

In a presentation at the Lunar and Planetary Science Conference titled "How the Jets, Heat and Tidal Stresses across the South Polar Terrain of Enceladus Are Related" (see the PDF here) Cassini scientists note that the amount of heating due to tidal stress seen along Enceladus' tiger stripes isn't nearly enough to cause the full spectrum of heating observed, and the "hot spots" that have been seen don't correlate with the type of heating caused by shear friction.

Instead, the researchers believe that heat energy is being carried upwards along with the pressurized water vapor from the subsurface sea, warming the areas around individual vents as well as serving to keep their channels open. With 98 individual jets observed so far on Enceladus' south polar terrain and surface heating corresponding to each one, this scenario, for lack of a better term... seems legit.

What this means is that not only does a moon of Saturn have a considerable subsurface ocean of liquid water with a heat source and Earthlike salinity (and also a bit of fizz) but also that it's spraying that ocean, that potentially habitable environment, out into local space where it can be studied relatively easily - making Enceladus a very intriguing target for future exploration. "To touch the jets of Enceladus is to touch the most accessible salty, organic-rich, extraterrestrial body of water and, hence, habitable zone, in our solar system."

<http://bit.ly/YqppZV>

Oceans May Be Common on Rocky Alien Planets

Every rocky planet likely develops a liquid-water ocean shortly after forming, suggesting that potentially habitable alien worlds may be common throughout the universe, a prominent scientist says.

Mar 20, 2013 09:00 AM ET // by Mike Wall, Space.com

The building blocks of rocky planets contain more than enough water to seed oceans, and computer models and Earth's own history suggest such seas should slosh around soon after these worlds' surfaces have cooled down and solidified, said Lindy Elkins-Tanton of the Carnegie Institution for Science in Washington, D.C.

"Habitability is going to be much more common than we had previously thought," Elkins-Tanton said today (March 18) during a talk at the 44th Lunar and Planetary Science Conference in The Woodlands, Texas.

Making an early ocean

Analysis of ancient Earth rocks shows that our own planet hosted an ocean of liquid water at least 4.4 billion years ago, Elkins-Tanton said -- just 160 million years or so after our solar system's birth.

This water came primarily from the planetesimals that glommed together to form Earth long ago rather than from comet impacts, as some researchers had previously believed, she added.

While comet-delivered water probably made a contribution later on, "it's not required," Elkins-Tanton said, citing studies that model planetary building blocks and how they come together. "You can make a water ocean without it."

For example, even if the pieces that built Earth contained just 0.01 percent water by weight -- an extremely conservative estimate -- our planet still would have harbored an early global ocean hundreds of meters deep, she said.

Such primitive oceans form in a multistep process, Elkins-Tanton explained. Water first boils out of the molten rock covering a newborn terrestrial planet heated up by accretionary impacts, creating a steamy atmosphere. This atmosphere then collapses as the planet cools, returning the water to the surface and generating an ocean. "The ramifications of this are that, in any exoplanet system anywhere in our universe, if it's made of rocky materials with similar water contents to ours, every rocky planet would be expected to start with a water ocean," Elkins-Tanton said. Further, models developed by Elkins-Tanton and others "all indicate that this cooling and collapse process happens on the order of 10 million years or less," she added. That's an exciting prospect for astrobiologists, as life on Earth is found nearly anywhere liquid water exists.

Holding on to the water

Of course, forming an ocean and holding onto it are two different matters. After all, Earth's solar system hosts rocky planets -- Mercury, Venus and Mars -- whose surface oceans have long since disappeared, if they ever existed at all. Indeed, how some rocky worlds manage to retain their water is an area ripe for future research, Elkins-Tanton said, specifically citing the case of Venus, Earth's hellishly hot "sister planet" that veered down a very different road after its formation.

It may be tempting to ascribe the apparent desiccation of rocky worlds like Venus to the giant impacts that pummeled them in our solar system's early days. But Earth held onto much of its water despite a massive collision with a Mars-size body (which is thought to have led to the formation of the moon), and data from NASA's Messenger spacecraft show that Mercury still harbors many volatile compounds, Elkins-Tanton said. "Now if there would be a poster child for the body that should be depleted by giant impacts, that would be Mercury," Elkins-Tanton said. "Giant impacts do not dry bodies."

<http://phys.org/news/2013-03-japan-rich-rare-earth-deposits.html>

Japan finds rich rare earth deposits on seabed

Japanese researchers said Thursday they have found a rich deposit of rare earths on the Pacific seabed, with reports suggesting it could be up to 30 times more concentrated than Chinese reserves.

Mud samples taken from 5,800 metres (19,000 feet) below the waves contained highly concentrated amounts of the precious minerals, which are vital for high-tech manufacturing and used in products including wind turbines and iPods. The proving of resources is significant for Japan, which currently relies largely on China, the source of around 90 percent of the world's supply of rare earths.

Manufacturers have complained in the past that Beijing restricts exports of the materials at times of tension. "Rare earths are necessary for cutting-edge technologies. Japan faces an urgent task to secure stable supplies," said a statement by researchers from the Japan Agency for Marine-Earth Science and Technology and the University of Tokyo.

The samples, taken from the seabed near Minamitori island some 2,000 kilometres (1,250 miles) southeast of Tokyo, were 10 times more concentrated than that of mud collected from the seabed near Hawaii, the researchers said.

The concentration was 20 to 30 times higher than that from Chinese mines, Japanese media said. Scientists believe the seabed contains about 6.8 million tonnes of the materials, the equivalent of 220 to 230 years worth of rare earths used in Japan.

But despite the desire to move away from dependence on China, the cost of extracting supplies from such a depth and in such hostile conditions may prove problematic, commentators said. In its afternoon edition, the mass-selling Yomiuri Shimbun said there had been no successful commercial mining below 5,000 metres. The researchers said they plan to continue their survey, which began in January, to further study rare earth resources and find out how extensive the deposits are.

<http://phys.org/news/2013-03-planck-reveals-universe.html>

Planck's most detailed map ever reveals an almost perfect Universe

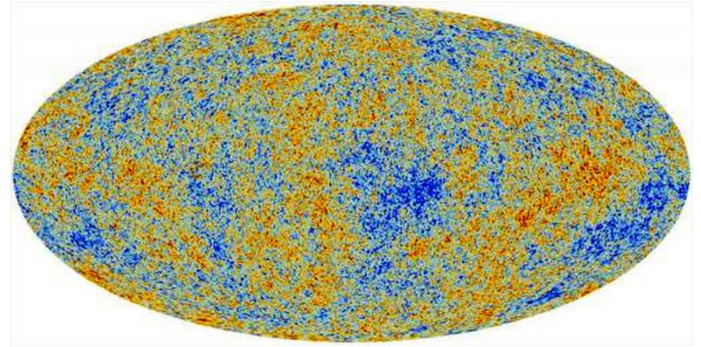
Acquired by ESA's Planck space telescope, the most detailed map ever created of the cosmic microwave background – the relic radiation from the Big Bang – was released today revealing the existence of features that challenge the foundations of our current understanding of the Universe.

Phys.org - The image is based on the initial 15.5 months of data from Planck and is the mission's first all-sky picture of the oldest light in our Universe, imprinted on the sky when it was just 380 000 years old.

At that time, the young Universe was filled with a hot dense soup of interacting protons, electrons and photons at about 2700°C. When the protons and electrons joined to form hydrogen atoms, the light was set free. As the Universe has expanded, this light today has been stretched out to microwave wavelengths, equivalent to a temperature of just 2.7 degrees above absolute zero.

This 'cosmic microwave background' – CMB – shows tiny temperature fluctuations that correspond to regions of slightly different densities at very early times, representing the seeds of all future structure: the stars and galaxies of today.

According to the standard model of cosmology, the fluctuations arose immediately after the Big Bang and were stretched to cosmologically large scales during a brief period of accelerated expansion known as inflation. Planck was designed to map these fluctuations across the whole sky with greater resolution and sensitivity than ever before. By analysing the nature and distribution of the seeds in Planck's CMB image, we can determine the composition and evolution of the Universe from its birth to the present day.

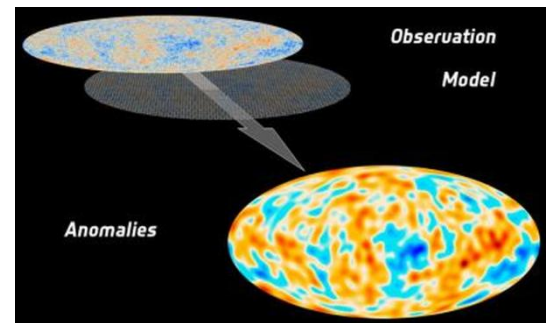


The anisotropies of the Cosmic microwave background (CMB) as observed by Planck. The CMB is a snapshot of the oldest light in our Universe, imprinted on the sky when the Universe was just 380 000 years old. It shows tiny temperature fluctuations that correspond to regions of slightly different densities, representing the seeds of all future structure: the stars and galaxies of today. Credit: ESA

Overall, the information extracted from Planck's new map provides an excellent confirmation of the standard model of cosmology at an unprecedented accuracy, setting a new benchmark in our manifest of the contents of the Universe.

But because precision of Planck's map is so high, it also made it possible to reveal some peculiar unexplained features that may well require new physics to be understood.

"The extraordinary quality of Planck's portrait of the infant Universe allows us to peel back its layers to the very foundations, revealing that our blueprint of the cosmos is far from complete. Such discoveries were made possible by the unique technologies developed for that purpose by European industry," says Jean-Jacques Dordain, ESA's Director General.

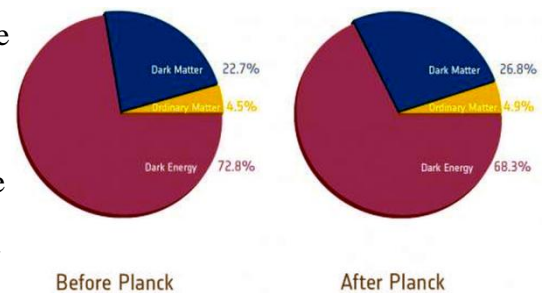


When compared to the best fit of observations to the standard model of cosmology, Planck's high-precision capabilities reveal that the fluctuations in the cosmic microwave background at large scales are not as strong as expected. The graphic shows a map derived from the difference between the two, which is representative of what the anomalies could look like. Credit: ESA

"Since the release of Planck's first all-sky image in 2010, we have been carefully extracting and analysing all of the foreground emissions that lie between us and the Universe's first light, revealing the cosmic microwave background in the greatest detail yet," adds George Efstathiou of the University of Cambridge, UK.

One of the most surprising findings is that the fluctuations in the CMB temperatures at large angular scales do not match those predicted by the standard model – their signals are not as strong as expected from the smaller scale structure revealed by Planck.

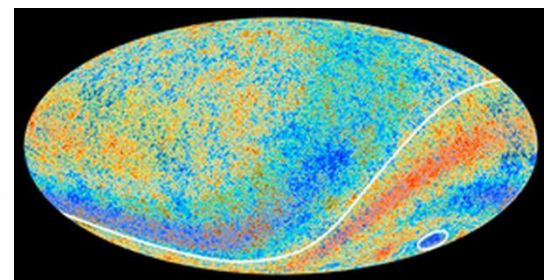
Another is an asymmetry in the average temperatures on opposite hemispheres of the sky. This runs counter to the prediction made by the standard model that the Universe should be broadly similar in any direction we look. Furthermore, a cold spot extends over a patch of sky that is much larger than expected.



Cosmic recipe pie chart

The asymmetry and the cold spot had already been hinted at with Planck's predecessor, NASA's WMAP mission, but were largely ignored because of lingering doubts about their cosmic origin.

"The fact that Planck has made such a significant detection of these anomalies erases any doubts about their reality; it can no longer be said that they are artefacts of the measurements. They are real and we have to look for a credible explanation," says Paolo Natoli of the University of Ferrara, Italy.



Planck's anomalous sky

"Imagine investigating the foundations of a house and finding that parts of them are weak. You might not know whether the weaknesses will eventually topple the house, but you'd probably start looking for ways to reinforce it pretty quickly all the same," adds François Bouchet of the Institut d'Astrophysique de Paris.

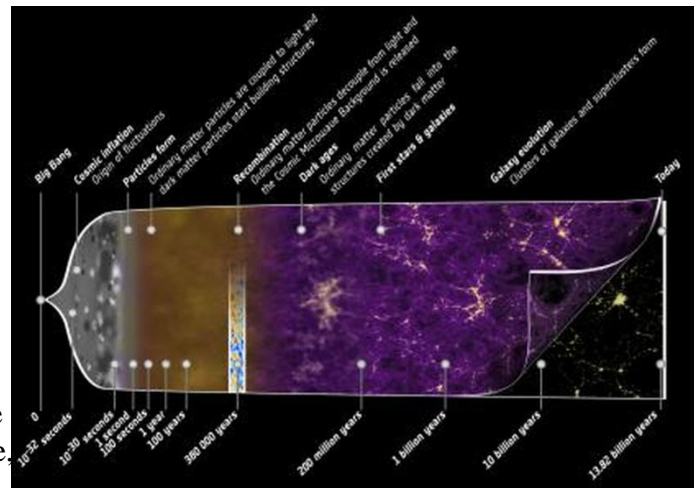
One way to explain the anomalies is to propose that the Universe is in fact not the same in all directions on a larger scale than we can observe. In this scenario, the light rays from the CMB may have taken a more complicated route through the Universe than previously understood, resulting in some of the unusual patterns observed today.

"Our ultimate goal would be to construct a new model that predicts the anomalies and links them together. But these are early days; so far, we don't know whether this is possible and what type of new physics might be needed. And that's exciting," says Professor Efstathiou.

New cosmic recipe

Beyond the anomalies, however, the Planck data conform spectacularly well to the expectations of a rather simple model of the Universe, allowing scientists to extract the most refined values yet for its ingredients.

Normal matter that makes up stars and galaxies contributes just 4.9% of the mass/energy density of the Universe. Dark matter, which has thus far only been detected indirectly by its gravitational influence, makes up 26.8%, nearly a fifth more than the previous estimate. Conversely, dark energy, a mysterious force thought to be responsible for accelerating the expansion of the Universe, accounts for less than previously thought.



Planck's history of the universe

Finally, the Planck data also set a new value for the rate at which the Universe is expanding today, known as the Hubble constant. At 67.15 kilometres per second per megaparsec, this is significantly less than the current standard value in astronomy. The data imply that the age of the Universe is 13.82 billion years.

"With the most accurate and detailed maps of the microwave sky ever made, Planck is painting a new picture of the Universe that is pushing us to the limits of understanding current cosmological theories," says Jan Tauber, ESA's Planck Project Scientist.

"We see an almost perfect fit to the standard model of cosmology, but with intriguing features that force us to rethink some of our basic assumptions.

"This is the beginning of a new journey and we expect that our continued analysis of Planck data will help shed light on this conundrum." *Provided by European Space Agency*

http://www.eurekalert.org/pub_releases/2013-03/si-tno032013.php

The neuroscience of finding your lost keys

Salk scientists discover how the brain keeps track of similar but distinct memories

LA JOLLA, CA - Ever find yourself racking your brain on a Monday morning to remember where you put your car keys?

When you do find those keys, you can thank the hippocampus, a brain region responsible for storing and retrieving memories of different environments—such as that room where your keys were hiding in an unusual spot.

Now, scientists at the Salk Institute for Biological Studies have helped explain how the brain keeps track of the incredibly rich and complex environments people navigate on a daily basis. They discovered how the dentate gyrus, a subregion of the hippocampus, helps keep memories of similar events and environments separate, a finding they reported March 20 in *eLife*. The findings, which clarify how the brain stores and distinguishes between memories, may also help identify how neurodegenerative diseases, such as Alzheimer's disease, rob people of these abilities.

"Every day, we have to remember subtle differences between how things are today, versus how they were yesterday - from where we parked our car to where we left our cellphone," says Fred H. Gage, senior author on the paper and the Vi and John Adler Chair for Research on Age-Related Neurodegenerative Disease at Salk.

"We found how the brain makes these distinctions, by storing separate 'recordings' of each environment in the dentate gyrus."

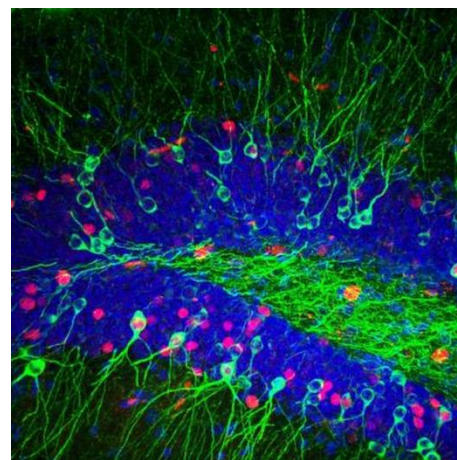
The process of taking complex memories and converting them into representations that are less easily confused is known as pattern separation. Computational models of brain function suggest that the dentate gyrus helps us

perform pattern separation of memories by activating different groups of neurons when an animal is in different environments.

However, previous laboratory studies found that in fact the same populations of neurons in the dentate gyrus are active in different environments, and that the way the cells distinguished new surroundings was by changing the rate at which they sent electrical impulses. This discrepancy between theoretical predictions and laboratory findings has perplexed neuroscientists and obscured our understanding of memory formation and retrieval.

To explore this mystery more deeply, the Salk scientists compared the functioning of the mouse dentate gyrus and another region of the hippocampus, known as CA1, using laboratory techniques for tracking the activity of neurons at multiple time points.

First, the researchers took mice from their original chamber and placed them in a novel chamber to learn about a new environment (episode 1). Meanwhile, they recorded which hippocampal neurons were active as the animals responded to their new surroundings. Subsequently, the mice were either returned to that same novel chamber to measure memory recall or to a slightly modified chamber to measure discrimination (episode 2). The active neurons in episode 2 were also labeled in order to determine if the neurons activated in episode 1 were used in the same way for recall and for discrimination of small differences between environments.



Salk researchers discovered how the brain keeps track of similar but distinct memories. This microscope image shows neural activity in the dentate gyrus, a subsection of the hippocampus where distinct groups of cells were active during the learning episodes (green) and memory retrieval (red). Courtesy of Wei Deng, Salk Institute for Biological Studies

When the researchers compared the neural activity during the two episodes, they found that the dentate gyrus and CA1 sub-regions functioned differently. In CA1, the same neurons that were active during the initial learning episode were also active when the mice retrieved the memories. In the dentate gyrus, however, distinct groups of cells were active during the learning episodes and retrieval. Also, exposing the mice to two subtly different environments activated two distinct groups of cells in the dentate gyrus.

"This finding supported the predictions of theoretical models that different groups of cells are activated during exposure to similar, but distinct, environments," says Wei Deng, a Salk postdoctoral research and first author on the paper. "This contrasts with the findings of previous laboratory studies, possibly because they looked at different sub-populations of neurons in the dentate gyrus."

The Salk researchers' findings suggest that recalling a memory—such as the location of missing keys—does not always involve reactivation of the same neurons that were active during encoding. More importantly, the results indicate that the dentate gyrus performs pattern separation by using distinct populations of cells to represent similar but non-identical memories. The findings help clarify the mechanisms that underpin memory formation and shed light on systems that are disrupted by injuries and diseases of the nervous system.

Mark Mayford, of Scripps Institute Research Institute, also contributed to the research. The study was supported by the James S. McDonnell Foundation, the Lookout Fund, the Kavli Institute for Brain and Mind, and the National Institutes of Health (Grants: MH-090258, NS-050217, AG-020938).

http://www.eurekalert.org/pub_releases/2013-03/mc-aod031913.php

Acting out dreams linked to development of dementia, Mayo Clinic study finds

The strongest predictor of whether a man is developing dementia with Lewy bodies - the second most common form of dementia in the elderly - is whether he acts out his dreams while sleeping, Mayo Clinic researchers have discovered.

SAN DIEGO - Patients are five times more likely to have dementia with Lewy bodies if they experience a condition known as rapid eye movement (REM) sleep behavior disorder than if they have one of the risk factors now used to make a diagnosis, such as fluctuating cognition or hallucinations, the study found.

The findings were being presented at the annual meeting of the American Academy of Neurology in San Diego. REM sleep behavior disorder is caused by loss of the normal muscle paralysis that occurs during REM sleep. It can appear three decades or more before a diagnosis of dementia with Lewy bodies is made in males, the researchers say. The link between dementia with Lewy bodies and the sleep disorder is not as strong in women, they add.

"While it is, of course, true that not everyone who has this sleep disorder develops dementia with Lewy bodies, as many as 75 to 80 percent of men with dementia with Lewy bodies in our Mayo database did experience REM sleep behavior disorder. So it is a very powerful marker for the disease," says lead investigator Melissa Murray, Ph.D., a neuroscientist at Mayo Clinic in Florida.

The study's findings could improve diagnosis of this dementia, which can lead to beneficial treatment, Dr. Murray says.

"Screening for the sleep disorder in a patient with dementia could help clinicians diagnose either dementia with Lewy bodies or Alzheimer's disease," she says. "It can sometimes be very difficult to tell the difference between these two dementias, especially in the early stages, but we have found that only 2 to 3 percent of patients with Alzheimer's disease have a history of this sleep disorder."

Once the diagnosis of dementia with Lewy bodies is made, patients can use drugs that can treat cognitive issues, Dr. Murray says. No cure is currently available.

Researchers at Mayo Clinic in Minnesota and Florida, led by Dr. Murray, examined magnetic resonance imaging, or MRI, scans of the brains of 75 patients diagnosed with probable dementia with Lewy bodies. A low-to-high likelihood of dementia was made upon an autopsy examination of the brain.

The researchers checked the patients' histories to see if the sleep disorder had been diagnosed while under Mayo care. Using this data and the brain scans, they matched a definitive diagnosis of the sleep disorder with a definite diagnosis of dementia with Lewy bodies five times more often than they could match risk factors, such as loss of brain volume, now used to aid in the diagnosis. The researchers also showed that low-probability dementia with Lewy bodies patients who did not have the sleep disorder had findings characteristic of Alzheimer's disease.

"When there is greater certainty in the diagnosis, we can treat patients accordingly. Dementia with Lewy bodies patients who lack Alzheimer's-like atrophy on an MRI scan are more likely to respond to therapy - certain classes of drugs - than those who have some Alzheimer's pathology," Dr. Murray says.

The study's other key researchers at Mayo include neuroradiologist Kejal Kantarci, M.D., neuropsychologist Tanis J. Ferman, Ph.D., neurologist Bradley F. Boeve, M.D., and neuropathologist Dennis W. Dickson, M.D.

The study was supported by the National Institutes of Health/National Institute on Aging [P50-AG016574, R01-AG040042, R01-AG011378, U01-AG006786], the Harry T. Mangurian, Jr., Foundation, and the Robert H. and Clarice Smith and Abigail Van Buren Alzheimer's Disease Research Program of the Mayo Foundation.

http://www.eurekalert.org/pub_releases/2013-03/teia-mtt031913.php

Megavolcanoes tied to pre-dinosaur mass extinction

An apparent sudden climate shift could have analog today

Scientists examining evidence across the world from New Jersey to North Africa say they have linked the abrupt disappearance of half of earth's species 200 million years ago to a precisely dated set of gigantic volcanic eruptions. The eruptions may have caused climate changes so sudden that many creatures were unable to adapt - possibly on a pace similar to that of human-influenced climate warming today. The extinction opened the way for dinosaurs to evolve and dominate the planet for the next 135 million years, before they, too, were wiped out in a later planetary cataclysm

In recent years, many scientists have suggested that the so-called End-Triassic Extinction and at least four other known past die-offs were caused at least in part by mega-volcanism and resulting climate change. However, they were unable to tie deposits left by eruptions to biological crashes closely in time. This study provides the tightest link yet, with a newly precise date for the ETE--201,564,000 years ago, exactly the same time as a massive outpouring of lava. "This may not quench all the questions about the exact mechanism of the extinction itself. However, the coincidence in time with the volcanism is pretty much ironclad," said coauthor Paul Olsen, a geologist at Columbia University's Lamont-Doherty Earth Observatory who has been investigating the boundary since the 1970s.

The new study unites several pre-existing lines of evidence by aligning them with new techniques for dating rocks. Lead author Terrence Blackburn (then at Massachusetts Institute of Technology; now at the Carnegie Institution) used the decay of uranium isotopes to pull exact dates from basalt, a rock left by eruptions. The basalts analyzed in the study all came from the Central Atlantic Magmatic Province (CAMP), a series of huge eruptions known to have started around 200 million years ago, when nearly all land was massed into one huge continent. The eruptions spewed some 2.5 million cubic miles of lava in four sudden spurts over a 600,000-year span, and initiated a rift that evolved into the Atlantic Ocean; remnants of CAMP lavas are found now in North and South America, and North Africa. The scientists analyzed samples from what are now Nova Scotia, Morocco and the New York City suburbs. (Olsen hammered one from a road cut in the Hudson River Palisades, about 1,900 feet from the New Jersey side of the George Washington Bridge.)

Previous studies have suggested a link between the CAMP eruptions and the extinction, but other researchers' dating of the basalts had a margin of error of 1 to 3 million years. The new margin of error is only a few thousand years - in geology, an eye blink. Blackburn and his colleagues showed that the eruption in Morocco was the earliest, with ones in Nova Scotia and New Jersey coming about 3,000 and 13,000 years later,

respectively. Sediments below that time contain pollen, spores and other fossils characteristic of the Triassic era; in those above, the fossils disappear. Among the creatures that vanished were eel-like fish called conodonts, early crocodylians, tree lizards and many broad-leaved plants. The dating is further strengthened by a layer of sediment just preceding the extinction containing mineral grains providing evidence of one of earth's many periodic reversals of magnetic polarity. This particular reversal, labeled E23r, is consistently located just below the boundary, making it a convenient marker, said coauthor Dennis Kent, a paleomagnetism expert who is also at Lamont-Doherty. With the same layers found everywhere the researchers have looked so far, the eruptions "had to be a hell of an event," said Kent.

The third piece of chronological evidence is the sedimentary layers themselves. Sedimentary rocks cannot be dated directly - one reason why the timing of the extinction has been hard to nail. Olsen and some others have long contended that the earth's precession - a cyclic change in the orientation of the axis toward the sun and resulting temperature changes - consistently created layers reflecting the alternate filling and drying of large lake basins on a fairly steady 20,000-year schedule. This idea is well accepted for more recent time, but many scientists have had doubts about whether it could be applied much farther back. By correlating the precisely dated basalts with surrounding sedimentary layers, the new study shows that precession operated pretty much the same way then, allowing dates with a give or take of 20,000 years to be assigned to most sediments holding fossils, said Olsen.

Olsen has painstakingly cataloged the layers around the time of the End Triassic, and the initial phase of the extinction occurs in just one layer - meaning the event took 20,000 years at most. But, he said, "it could have taken much less. This is the level of resolution we have now, but it's the 'less' part that is the more important, and that's what we are working on now."

Many scientists assume that giant eruptions would have sent sulfurous particles into the air that darkened the skies, creating a multi-year winter that would have frozen out many creatures. A previous study by Kent and Rutgers University geochemist Morgan Schaller has also shown that each pulse of volcanism doubled the air's concentration of carbon dioxide - a major component of volcanic gases. Following the cold pulses, the warming effects of this greenhouse gas would have lasted for millennia, wiping out creatures that could not take too much heat. (It was already quite hot to begin with at that time; even pre-eruption CO₂ levels were higher than those of today.) Fossils show that heat-sensitive plants especially suffered; there is also evidence that the increased CO₂ caused chemical reactions that made the oceans more acidic, causing populations of shell-building creatures to collapse. As if this were not enough, there is also some evidence that a large meteorite hit the earth at the time of the extinction--but that factor seems far less certain. A much stronger case has been made for the extinction of the dinosaurs by a meteorite some 65 million years ago - an event that opened the way for the evolution and dominance of mammals, including human beings. Volcanism may have been involved in that extinction as well, with the meteorite delivering the final blow.)

The End Triassic was the fourth known global die-off; the extinction of the dinosaurs was the fifth. Today, some scientists have proposed that we are on the cusp of a sixth, manmade, extinction. Explosive human population growth, industrial activity and exploitation of natural resources are rapidly pushing many species off the map. Burning of fossil fuels in particular has had an effect, raising the air's CO₂ level more than 40 percent in just 200 years - a pace possibly as fast, or faster, than that of the End Triassic. Resulting temperatures increases now appear to be altering ecosystems; and CO₂ entering seawater is causing what could be the fastest ongoing acidification of the oceans for at least the last 300 million years, according to a 2012 study. "In some ways, the End Triassic Extinction is analogous to today," said Blackburn. "It may have operated on a similar time scale. Much insight on the possible future impact of doubling atmospheric CO₂ on global temperatures, ocean acidity and life on earth may be gained by studying the geologic record."

Paul Renne, a researcher at the Berkeley Geochronology Center in California, who studies the End Triassic but was not involved in the Science paper, said the study was "part of a growing pattern in which we see that the major ecosystem crises were triggered" by volcanism. He said the new data "make the case stronger than it was. ... The pendulum continues to swing in favor of that idea." Of the actual mechanism that killed creatures, he said climate change was the most popular suspect. But, he added, "We still don't have any way yet of knowing exactly how much CO₂ was put into the atmosphere at that time, and what it did. If we did, we would then be able to say to people, 'Look folks, this is what we're facing now, and here's what we have to do about it. But we don't know that yet.'"

The other authors of the study are Samuel Bowring and Noah McLean (MIT); John Puffer (Rutgers); Greg McHone (Grand Manan, New Brunswick, Canada); E. Troy Rasbury (Stony Brook University); and Mohammed Et-Touhami (Université Mohammed Premier, Oujda, Morocco).

http://www.eurekalert.org/pub_releases/2013-03/jhu-lc032113.php

Low-cost 'cooling cure' would avert brain damage in oxygen-starved babies

Students have devised a low-tech \$40 unit to provide protective cooling in the absence of modern hospital equipment

When babies are deprived of oxygen before birth, brain damage and disorders such as cerebral palsy can occur. Extended cooling can prevent brain injuries, but this treatment is not always available in developing nations where advanced medical care is scarce. To address this need, Johns Hopkins undergraduates have devised a low-tech \$40 unit to provide protective cooling in the absence of modern hospital equipment that can cost \$12,000.

The device, called the Cooling Cure, aims to lower a newborn's temperature by about 6 degrees F for three days, a treatment that has been shown to protect the child from brain damage if administered shortly after a loss of oxygen has occurred. Common causes of this deficiency are knotting of the umbilical cord or a problem with the mother's placenta during a difficult birth. In developing regions, untrained delivery, anemia and malnutrition during pregnancy can also contribute to oxygen deprivation.

In a recent issue of the journal *Medical Devices: Evidence and Research*, the biomedical engineering student inventors and their medical advisors reported successful animal testing of the Cooling Cure prototype. The device is made of a clay pot, a plastic-lined burlap basket, sand, instant ice-pack powder, temperature sensors, a microprocessor and two AAA batteries. To activate it, just add water.

The device could help curtail a serious health problem called hypoxic ischemic encephalopathy, which is triggered by oxygen deficiency in the brain. Globally, more than half of the newborns with a severe form of this condition die, and many of the survivors are diagnosed with cerebral palsy or other brain disorders. The problem is particularly acute in impoverished regions where pregnant women do not have easy access to medical specialists or high-tech hospital equipment. The inventors say Cooling Cure could address this issue.

"The students came up with a neat device that's easy for non-medical people to use. It's inexpensive and user-friendly," said Michael V. Johnston, a Johns Hopkins School of Medicine pediatric neurology professor who advised the undergraduate team. Johnston also is chief medical officer and executive vice president of the Kennedy Krieger Institute, an internationally recognized center in Baltimore that helps children and adolescents with disorders of the brain, spinal cord and musculoskeletal systems.

For the past 25 years, Johnston has been studying ways to protect a newborn's brain, including the use of costly hospital cooling units that keep brain cells from dying after an oxygen deficiency. Several years ago, while visiting Egypt, he learned that local doctors were using window fans or chilled water bottles in an inadequate effort to treat oxygen-deprived babies. When he returned to Baltimore, Johnston and Ryan Lee, a pediatric neurologist and postdoctoral fellow at Kennedy Krieger, discussed the problem with Robert Allen, a Johns Hopkins associate research professor in a biomedical engineering program that requires undergraduates to design and build devices to solve pressing medical problems. Allen suggested that Johnston and Lee present the baby-cooling dilemma to biomedical engineering students in the school's Center for Bioengineering Innovation and Design.

The challenge was accepted in 2011 by a team of Whiting School of Engineering undergraduates. With an eye toward simplicity and low cost, the students designed a cooler made of a clay pot and a plastic-lined basket, separated by a layer of sand and urea-based powder. This powder is the type used in instant cold-packs that help reduce swelling. To activate the baby-cooling unit, water is added to the mixture of sand and powder, causing a chemical reaction that draws heat away from the upper basket, which cradles the child. (The chemical would not come into direct contact with the newborn.)

The unit's batteries power a microprocessor and sensors that track the child's internal and skin temperatures. Small lights flash red if the baby's temperature is too hot, green if the temperature is correct and blue if the child is too cold. By viewing the lights, the baby's nurse or a family member could add water to the sand to increase cooling. If the child is too cool, the caregiver could lift the child away from the chilling surface until the proper temperature is restored.

Last May, at a student invention showcase organized by the university's Department of Biomedical Engineering, the Cooling Cure team presented its prototype, designed for a full-term newborn weighing up to 9 pounds and measuring up to 18 inches in length. The team won the Linda Trinh Memorial Award, which recognized Cooling Cure as an innovative global health project. In August, two of the student inventors were chosen to visit medical centers in India for a two-week trip sponsored by a group called Medical and Educational Perspectives. The group has also offered modest financial support to advance the Cooling Cure design project.

In recent months, three of the Cooling Cure's student inventors -- John J. Kim, Nathan Buchbinder and Simon Ammanual -- have opted to move the project forward through animal testing and improvement of the prototype. "We've tried to continue this because we've gotten such good feedback from people," said Kim, of Santa Barbara, Calif., a leader of the student team who completed his undergraduate studies in December. "This is a nonprofit project. The main thing we want to do is to make sure that people in developing countries can benefit from this device."

Fellow team member Buchbinder, a sophomore from Marlboro, N.J., added, "It's not every day that you get to work on a medical device that could save lives and prevent disabilities in kids."

Working with the Johns Hopkins Technology Transfer staff, the students and their faculty advisors have obtained a provisional patent covering the low-cost baby-cooling unit. In the near future, the student inventors hope to link up with an international medical aid group and begin human clinical trials in a developing region. *John Kim was lead author of the Medical Devices: Evidence and Research study. The co-authors -- all Johns Hopkins student inventors and faculty advisors -- were Buchbinder, Ammanual, Robert Kim, Erika Moore, Neil O'Donnell, Jennifer K. Lee, Ewa Kulikowicz, Soumyadipta Acharya, Robert H. Allen, Ryan W. Lee and Michael V. Johnston. The article can be viewed at http://www.dovepress.com/articles.php?article_id=11849*

http://www.eurekalert.org/pub_releases/2013-03/whoi-srq032113.php

Scientists reveal quirky feature of Lyme disease bacteria

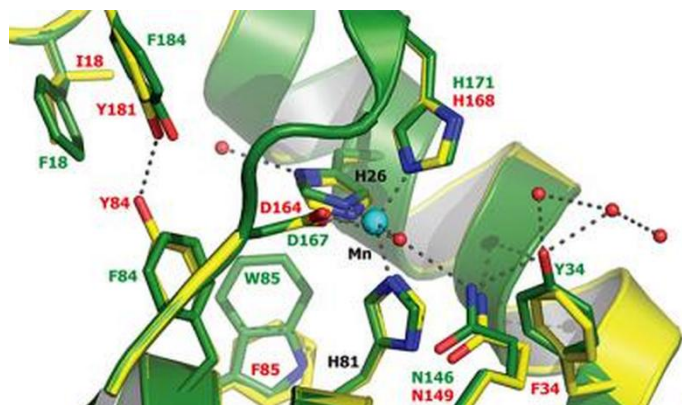
Unlike most organisms, they don't need iron, but they crave manganese

Scientists have confirmed that the pathogen that causes Lyme Disease - unlike any other known organism - can exist without iron, a metal that all other life needs to make proteins and enzymes. Instead of iron, the bacteria substitute manganese to make an essential enzyme, thus eluding immune system defenses that protect the body by starving pathogens of iron.

To cause disease, *Borrelia burgdorferi* requires unusually high levels of manganese, scientists at Johns Hopkins University (JHU), Woods Hole Oceanographic Institution (WHOI), and the University of Texas reported. Their study, published March 22, 2013, in the *Journal of Biological Chemistry*, may explain some mysteries about why Lyme Disease is slow-growing and hard to detect and treat. The findings also open the door to search for new therapies to thwart the bacterium by targeting manganese.

"When we become infected with pathogens, from tuberculosis to yeast infections, the body has natural immunological responses," said Valeria Culotta, a molecular biologist at the JHU Bloomberg School of Public Health. The liver produces hepcidin, a hormone that inhibits iron from being absorbed in the gut and also prevents it from getting into the bloodstream. "We become anemic, which is one reason we feel terrible, but it effectively starves pathogens of iron they need to grow and survive," she said.

Borrelia, with no need for iron, has evolved to evade that defense mechanism. In 2000, groundbreaking research on *Borrelia*'s genome by James Posey and Frank Gherardini at the University of Georgia showed that the bacterium has no genes that code to make iron-containing proteins and typically do not accumulate any detectable iron.



Saito collaborated with biomedical researchers at Johns Hopkins University, applying his proteomic techniques to explore proteins in a terrestrial organism, the bacteria that cause Lyme Disease. Unlike all other known organisms, Borrelia burgdorferi need manganese (blue dot), rather than iron, to serve as linchpins bonded into key enzymes. The scientists found that to cause disease, Borrelia require unusually high levels of manganese. The findings open new avenues to search for ways to attack the bacteria.

Illustration by P. John Hart, University of Texas

Culotta's lab at JHU investigates what she called "metal-trafficking" in organisms - the biochemical mechanisms that cells and pathogens such as *Borrelia* use to acquire and manipulate metal ions for their biological purposes. "If *Borrelia* doesn't use iron, what does it use?" Culotta asked.

To find out, Culotta's lab joined forces with Mak Saito, a marine chemist at WHOI, who had developed techniques to explore how marine life uses metals. Saito was particularly intrigued because of the high incidence of Lyme Disease on Cape Cod, where WHOI is located, and because he specializes in metalloproteins, which contain iron, zinc, cobalt, and other elements often seen in vitamin supplements. The metals serve as linchpins, binding to enzymes. They help determine the enzymes' distinctive three-dimensional shapes and the specific chemical reactions they catalyze.

It's difficult to identify what metals are within proteins because typical analyses break apart proteins, often separating metal from protein. Saito used a liquid chromatography mass spectrometer to distinguish and measure separate individual *Borrelia* proteins according to their chemical properties and infinitesimal differences in their masses. Then he used an inductively coupled plasma mass spectrometer to detect and measure metals down to parts per trillion. Together, the combined analyses not only measured the amounts of metals and proteins, they showed that the metals are components of the proteins. "The tools he has are fantastic," Culotta said. "Not too many people have this set of tools to detect metalloproteins."

The experiments revealed that instead of iron, *Borrelia* uses that element's next-door neighbor on the periodic chart, manganese, in certain *Borrelia* enzymes. These include an amino peptidase and an important antioxidant enzyme called superoxide dismutase.

Superoxide dismutase protects the pathogens against a second defense mechanism that the body throws against them. The body bombards pathogens with superoxide radicals, highly reactive molecules that cause damage within the pathogens. Superoxide dismutase is like an antioxidant that neutralizes the superoxides so that the pathogens can continue to grow.

The discoveries open new possibilities for therapies, Culotta said. "The only therapy for Lyme Disease right now are antibiotics like penicillin, which are effective if the disease is detected early enough. It works by attacking the bacteria's cell walls. But certain forms of *Borrelia*, such as the L-form, can be resistant because they are deficient in cell walls."

"So we'd like to find targets inside pathogenic cell that could thwart their growth," she continued. "The best targets are enzymes that the pathogens have, but people do not, so they would kill the pathogens but not harm people." *Borrelia*'s distinctive manganese-containing enzymes such as superoxide dismutase may have such attributes.

In search of new avenues of attack, the groups are planning to expand their collaborative efforts by mapping out all the metal-binding proteins that *Borrelia* uses and investigating biochemical mechanisms that the bacteria use to acquire manganese and directs it into essential enzymes. Knowing details of how that happens offers ways to disrupt the process and deter Lyme Disease.

The authors of the new study are J. Daphne Aguirre, Hillary Clark, Christine Vazquez, Shaina Palmere, and Culotta (JHU Bloomberg School of Public Health); Saito and Matthew McIlvin (WHOI); Denise Grab (JHS School of Medicine); Janakiram Seshu (University of Texas); and P. John Hart (University of Texas Health Science Center).

This research was funded by the National Institutes of Health, the National Science Foundation, and the Gordon and Betty Moore Foundation.

http://www.eurekalert.org/pub_releases/2013-03/uoc-pfd032113.php

Prescription for double-dose algebra proves effective

Martin Gartzman sat in his dentist's waiting room last fall when he read a study in Education Next that nearly brought him to tears.

By Chelsea Leu

A decade ago, in his former position as chief math and science officer for Chicago Public Schools, Gartzman spearheaded an attempt to decrease ninth-grade algebra failure rates, an issue he calls "an incredibly vexing problem." His idea was to provide extra time for struggling students by having them take two consecutive periods of algebra. Gartzman had been under the impression that the double-dose algebra program he had instituted had only marginal results, but the study he read indicated otherwise.

"We find positive and substantial longer-run impacts of double-dose algebra on college entrance exam scores, high school graduation rates and college enrollment rates, suggesting that the policy had significant benefits that were not easily observable in the first couple of years of its existence," wrote the article's authors.

As executive director of the University of Chicago's Center for Elementary Mathematics and Science Education, Gartzman oversees a research and development enterprise dedicated to improving math and science education in primary and secondary schools. The center is especially well known for being the institutional home of the authors of *Everyday Mathematics*, a pre-K through sixth-grade curriculum that serves 4.3 million students annually in 220,000 classrooms nationwide.

In high schools, ninth-grade algebra is typically the class with the highest failure rate. This presents a barrier to graduation, because high schools usually require three to four years of math to graduate.

Students have about a 20 percent chance of passing the next math level if they don't first pass algebra, Gartzman said, versus 80 percent for those who do pass. The data are clear: If students fail ninth-grade algebra, the likelihood of passing later years of math, and ultimately of graduating, is slim.

This entrenched problem has attracted widespread attention: A New York Times editorial last July called for the removal of the algebra requirement from high schools altogether. "People have been grasping at straws," Gartzman said.

Keeping freshmen on track

Gartzman's work to decrease algebra failure rates at CPS was motivated by a study of Melissa Roderick, the Hermon Dunlap Smith Professor at UChicago's School of Social Service Administration. The study emphasized the importance of keeping students academically on track in their freshman year to increase the graduation rate. Some administrators and teachers resisted the new policy. Teachers called these sessions "double-period hell" because they gathered, in one class, the most unmotivated students who had the biggest problems with math. Principals and counselors sometimes saw the double periods as punishment for the students, depriving them of courses they may have enjoyed taking and replacing them with courses they disliked.

It seemed to Gartzman that double-period students were learning more math, though he had no supporting data. He gauged students' progress by class grades, not by standardized tests. The CPS educators had no way of fully assessing their double-period idea. All they knew was that failure rates didn't budge.

Gartzman took a new position in 2006 as assistant vice chancellor for high school development at the University of Illinois at Chicago, with what he regarded as unfinished business at CPS. "We had not made the progress with the underprepared students or with the double-period classes that I had hoped would happen." He has continued his work with this issue, spearheading a National Science Foundation-funded project to develop new instructional materials for the double-period classes.

Gartzman later learned that two educational researchers were studying CPS's double-dose algebra program. One of these researchers was Takako Nomi, an affiliated researcher at UChicago's Consortium on Chicago School Research, also an assistant professor of education at St. Louis University.

Nomi and Elaine Allensworth, interim director of UChicago CCSR, tracked students immediately above and below the cutoff score for placement into the double periods. They found that students above the cutoff failed at slightly higher rates than in previous years, but that students in double-period sections scored better on standardized tests.

Encouraging data

"Double-dosing had an immediate impact on student performance in algebra, increasing the proportion of students earning at least a B by 9.4 percentage points, or more than 65 percent," noted the Education Next article. Although ninth-grade algebra passing rates remained mostly unaffected, "The mean GPA across all math courses taken after freshman year increased by 0.14 grade points on a 4.0 scale."

They also found significantly increased graduation rates. The researchers concluded on an encouraging note: "Although the intervention was not particularly effective for the average affected student, the fact that it improved high school graduation and college enrollment rates for even a subset of low-performing and at-risk students is extraordinarily promising when targeted at the appropriate students."

Gartzman recalled that reading the article "was mind-blowing for me. I had no idea that the researchers were continuing to study these kids."

The study had followed a set of students from eighth grade through graduation, while Gartzman's team could only follow them for a year after the program began. The improvements appeared five years after launching double-dose algebra, hiding them from the CPS team, which had focused on short-term student performance. Gartzman stressed the importance of education policy research. "Nomi and Allensworth did some really sophisticated modeling that only researchers could do, that school districts really can't do. It validates school districts all over the country who had been investing in double-period strategies."

Gartzman notes, with a tinge of regret, that he wishes he had these results while still working at CPS. But he's hopeful that this research marks a step toward effective education reform.

"These are really hard problems. A great 21st-century university ought to try to solve the hardest problems facing our society," Gartzman said. "In the world of K-12 education, this is one of the hardest problems."

<http://bit.ly/11s7lf3>

Genetically Engineered Immune Cells Found to Rapidly Clear Leukemia Tumors

The new therapy for acute lymphoblastic leukemia, a swift-growing cancer that tends to kill more than 60 percent of those afflicted, involves extracting T cells and modifying them to home in on and destroy B cells in healthy and cancerous tissue

By Heidi Ledford and Nature magazine | Thursday, March 21, 2013

Genetically engineered immune cells can drive an aggressive type of leukemia into retreat, a small clinical trial suggests. The results of the trial - done in five patients with acute lymphoblastic leukemia - are published in Science Translational Medicine and represent the latest success for a 'fringe' therapy in which a type of immune

cell called T cells are extracted from a patient, genetically modified, and then reinfused back. In this case, the T cells were engineered to express a receptor for a protein on other immune cells, known as B cells, found in both healthy and cancerous tissue.

When reintroduced into the patients, the tricked T cells quickly homed in on their targets. “All of our patients very rapidly cleared the tumor,” says Michel Sadelain, a researcher at the Memorial Sloan-Kettering Cancer Center in New York and an author of the study. The treatment “worked much faster than we thought”. The technique has already shown promise against chronic leukemia, but there were doubts about whether it could take on the faster-growing acute lymphoblastic leukemia, a tenacious disease that kills more than 60% of those afflicted.

Carl June, an immunologist at the University of Pennsylvania in Philadelphia and a pioneer in engineering T cells to fight cancer, says that he is surprised that the method worked so well against such a swift-growing cancer. The next step, he says, is to move the technique out of the ‘boutique’ academic cancer centers that developed it and into multicenter clinical trials.

“What needs to be done is to convince oncologists and cancer biologists that this new kind of immunotherapy can work,” he says.

Extra hope

Oncologist Renier Brentjens, also at Memorial Sloan-Kettering Cancer Center, remembers the day that he had to tell one of the patients in the trial that the weeks of high-dose chemotherapy the 58-year-old man had endured had not worked after all. “It was painful to have that conversation,” says Brentjens. “He tells me now it was the worst news he has ever heard in his life.”

Another month in the hospital on intensive chemotherapy drugs did nothing to help. By the time the man started the trial, 70% of his bone marrow was tumor.

Brentjens, Sadelain and their colleagues then extracted T cells from the patient and engineered them to express a ‘chimeric antigen receptor’, or CAR, that would target cells expressing a protein called CD19. Because CD19 is found on both healthy and cancerous B cells, the engineered T cells were unable to discriminate between the two. However, patients can live without B cells.

By two weeks after the procedure, the patient was showing signs of improvement. The treatment had driven his cancer into remission — as it did for the other four patients in the trial — so he became eligible for a bone-marrow transplant. A hundred days later, he is doing well, says Brentjens. Four of the five patients were well enough to receive transplants; the remaining patient relapsed and was ineligible.

Pharmaceutical firms have tended to be wary of the CAR technique because it is technically challenging, must be personalized to the patient and faces an untested path to regulatory approval, says Steven Rosenberg, head of the tumor immunology section at the National Cancer Institute in Bethesda, Maryland.

But this seems to be changing. Rosenberg points to a collaboration formed in August last year between June's group and the drug giant Novartis, as well as the launch of several small CAR-focused biotechnology firms. And Sadelain says that he is an investigator on a trial with the Dana-Farber Cancer Institute in Boston, Massachusetts, to test whether the technique can be exported to other treatment centers, among other outcomes. Brentjens, meanwhile, is happy to have his patients in fighting spirits again. “You see these people at their lowest low emotionally as well as physically,” he says. “And now you can tell they're in better shape because they're making fun of your tie again.”

<http://phys.org/news/2013-03-africa-date-brought.html>

Out of Africa date brought forward

A study on human mitochondrial DNA has led to a new estimate of the time at which humans first began to migrate out of Africa, which was much later than previously thought.

Phys.org - The new study by an International group of evolutionary geneticists used mitochondrial DNA from the remains of ancient modern humans to estimate the rate of genetic mutations. Three of the skeletons were from the Czech Republic and dated at 31,000 years old, two were 14,000 years old, from Oberkassel, Germany. Another sample used was the natural mummy Ötzi the Iceman, who lived sometime between 3350 and 3100 BC. The most recent skeleton was that of a man who lived in medieval France 700 years ago, while the oldest was dated at 40,000 years ago, and came from Tianyuan in China.

The results suggest that the genetic divergence between African and non-African humans began between 62 and 95 thousand years ago, which tallies with other studies estimating the time through dating of stone tools and fossils, but they disagree with the results of recent genetic studies that estimated the migration began much earlier, up to 130 thousand years ago or even before.

The previous studies sequenced the entire genome of living humans to count the number of genetic mutations (around 50) in newborn babies compared to the parents to determine the generational mutation rate. This then provided the "molecular clock," which could be extrapolated backwards to date important events in human evolution.

The new study sequenced mitochondrial DNA from fossils of ancient modern humans rather than living humans. The fossils were dated using radiocarbon dating methods. Since the samples were from humans who lived up to 40,000 years ago, mutations that have occurred in the genome since they died would be missing, and the samples provided a range of calibration points for their estimation of the start of the migration.

The disagreement in dating the migration between the new study and previous genetic research could be due to underestimating the number of new mutations in a generation of living humans because of the difficulty of discriminating between true mutations and mistaken ones and because of a desire to avoid false positives.

Under-counting would lead to an older estimate for the migration from Africa and other important events.

The new date, which agrees with the archaeological evidence, shows that modern humans were in Europe and Asia before and after the most recent glaciation, and they were therefore able to survive and adapt to a dramatically changing climate.

The paper was published in the journal Current Biology on 21st March.

More information: A Revised Timescale for Human Evolution Based on Ancient Mitochondrial Genomes, Current Biology, 21 March 2013, DOI: 10.1016/j.cub.2013.02.044 www.cell.com/current-biology/retrieve/pii/S0960982213002157

http://www.eurekalert.org/pub_releases/2013-03/wt-pdh032213.php

Parkinson's' drug helps older people to make decisions

Parkinson's Disease drug can reverse age-related impairments in decision making in older people

A drug widely used to treat Parkinson's Disease can help to reverse age-related impairments in decision making in some older people, a study from researchers at the Wellcome Trust Centre for Neuroimaging has shown.

The study, published today in the journal Nature Neuroscience, also describes changes in the patterns of brain activity of adults in their seventies that help to explain why they are worse at making decisions than younger people.

Poorer decision-making is a natural part of the ageing process that stems from a decline in our brains' ability to learn from our experiences. Part of the decision-making process involves learning to predict the likelihood of getting a reward from the choices that we make.

An area of the brain called the nucleus accumbens is responsible for interpreting the difference between the reward that we're expecting to get from a decision and the reward that is actually received. These so called 'prediction errors', reported by a brain chemical called dopamine, help us to learn from our actions and modify our behaviour to make better choices the next time.

Dr Rumana Chowdhury, who led the study at the Wellcome Trust Centre for Neuroimaging at UCL, said: "We know that dopamine decline is part of the normal aging process so we wanted to see whether it had any effect on reward-based decision making. We found that when we treated older people who were particularly bad at making decisions with a drug that increases dopamine in the brain, their ability to learn from rewards improved to a level comparable to somebody in their twenties and enabled them to make better decisions."

The team used a combination of behavioural testing and brain imaging techniques, to investigate the decision-making process in 32 healthy volunteers aged in their early seventies compared with 22 volunteers in their mid-twenties. Older participants were tested on and off L-DOPA, a drug that increases levels of dopamine in the brain. L-DOPA, more commonly known as Levodopa, is widely used in the clinic to treat Parkinson's.

The participants were asked to complete a behavioural learning task called the two-arm bandit, which mimics the decisions that gamblers make while playing slot machines. Players were shown two images and had to choose the one that they thought would give them the biggest reward. Their performance before and after drug treatment was assessed by the amount of money they won in the task.

"The older volunteers who were less able to predict the likelihood of a reward from their decisions, and so performed worst in the task, showed a significant improvement following drug treatment," Dr Chowdhury explains.

The team then looked at brain activity in the participants as they played the game using functional Magnetic Resonance Imaging (fMRI), and measured connections between areas of the brain that are involved in reward prediction using a technique called Diffusor Tensor Imaging (DTI).

The findings reveal that the older adults who performed best in the gambling game before drug treatment had greater integrity of their dopamine pathways. Older adults who performed poorly before drug treatment were

not able to adequately signal reward expectation in the brain – this was corrected by L-DOPA and their performance improved on the drug.

Dr John Williams, Head of Neuroscience and Mental Health at the Wellcome Trust, said: "This careful investigation into the subtle cognitive changes that take place as we age offers important insights into what may happen at both a functional and anatomical level in older people who have problems with making decisions. That the team were able to reverse these changes by manipulating dopamine levels offers the hope of therapeutic approaches that could allow older people to function more effectively in the wider community."

<http://bit.ly/15K9ob0>

Banks gone bad: Our evolved morality has failed us

We seem to be unable to punish bankers for their scandalous behaviour. That's because our moral instincts can't cope, says a professor of biological sciences and anthropology

25 March 2013 by Christopher Boehm

Why is it so hard to punish bankers for their scandalous behaviour? Have our evolved moral instincts failed us? ROB a bank and you risk a long stretch in jail. Run a bank whose dubious behaviour leads to global economic collapse and you risk nothing of the sort, more likely a handsome pay-off.

Illegal and dangerous mistakes associated with the financial industry have caused serious harm to US and world economies. That is beyond doubt. And the scandals keep coming – rate rigging, money laundering, mis-selling and sanctions busting. The wider backlash against the industry shows no sign of easing.

So given the scale of damage and public anger, fuelled by the industry's bonus culture, it is curious that those responsible have largely avoided punishment in the traditional judicial sense, despite the clamour for it.

That we so want those involved to get their just deserts has its roots in ancient human forms of social control, which led to our modern sense of morality.

In their rudimentary, hunter-gatherer forms, crime and punishment surely go back for tens of millennia. The case has been made that by 45,000 years ago, or possibly earlier, people were practising moralistic social control much as we do.

Without exception, foraging groups that still exist today and best reflect this ancient way of life exert aggressive surveillance over their peers for the good of the group. Economic miscreants are mainly bullies who use threats or force to benefit themselves, along with thieves and cheats.

All are free-riders who take without giving, and all are punished by the group. This can range from mere criticism or ostracism to active shaming, ejection or even capital punishment. This moral behaviour was reinforced over the millennia that such egalitarian bands dominated human life.

Then around 12,000 years ago, larger, still-egalitarian sedentary tribes arrived with greater needs for centralised control. Eventually clusters of tribes formed authoritative chiefdoms. Next came early civilisations, with centrally prescribed and powerfully enforced moral orders. One thing tied these and modern, state-based moral systems to what came before and that was the human capacity for moral indignation. It remains strong today. So there is an inevitable outcry when bankers seem to "get away with it", offending this instinctive moral corrective sense.

And ultimately, such public opinion should strongly influence how we police fiscal deviants – but there are complicating factors that suggest this instinct is being undermined when it comes to taming the most harmful behaviour in the banking world.

Firstly, if popular morality has from ancient times been about protecting individual interests from damage through social predation, we must ask some questions. What happens when lawbreaking becomes embedded in large, hard-to-understand economic systems, and when the immediate damaging consequences seem to be diffuse and institutional, rather than direct and personal?

There is an obvious disconnect between what takes place in a small band, in which moral outrage leads to hurtful punishments that fit with hurtful crimes, and a very large system of international finance in which the negative consequences are so much less direct and the power to deter gets lost in the process.

To this we must add the fact that the US democratic system of popular representation, and to a degree that of other nations, is compromised by lobbying that too often amounts to institutionalised bribery. Reform is unlikely because the heavily lobbied politicians we elect are in charge of both our electoral system and, to an extent, our system of justice.

The result is that lobbies often trump what we fondly refer to as the people's will, as long as really serious, electorally significant moral indignation in the populace can be avoided. Banking institutions loom large on the lobbying stage. A 2009 report from the International Monetary Fund concluded that lenders who lobbied most were those engaged in riskier practices.

Add in our long-standing tradition of coddling white-collar offenders whose acts seem to impact only on corporations, and the sheer complexity of judging the economic consequences of errant behaviour, and maybe we can better understand why moral outrage doesn't translate into action.

Ultimately we are still left with what to do about this, how to regulate a free-market economy to deter behaviour that causes major fiscal problems. Morality aside, economists learned from the Soviet Union that excessive regulation leads to gross economic inefficiency, and most people in capitalist economies believe in having sensibly but minimally regulated economies that largely organise themselves.

Modern democracies are quite similar to egalitarian hunting bands in that moralistic public opinion helps to protect populaces against social predation, and dictates much of social policy. In a sense, the Founding Fathers were brilliant in creating a larger-scale system, one that basically guarantees personal autonomy yet permits enough centralised control to run a much bigger ship.

However, the sheer scale of society, combined with the internationalisation of business, has produced cognitive challenges that must, in an age of increasing manipulation by lobbyists, be met by ordinary voters. Fortunately, voters don't always follow the political advertising money.

Simplistic solutions, such as criminalising any financial rule-breaking that leads to serious social harm, would provoke much debate. What is beyond debate is that in the case of major corporate crimes an ancient approach to making justice serve the greater good is creaking and groaning, and that new answers must be sought.

Christopher Boehm is author of Moral Origins (Basic Books) and professor of biological sciences and anthropology at the University of Southern California

<http://nyti.ms/ZjSfV2>

Infants Are Fed Solid Food Too Soon, C.D.C. Finds

Many mothers appear to be introducing solid food well before their babies' bodies can handle it

By DOUGLAS QUENQUA

Despite growing warnings from pediatricians about feeding newborns anything other than breast milk or formula, many mothers appear to be introducing solid food well before their babies' bodies can handle it, says a study published Monday in the journal Pediatrics.

In a national survey of 1,334 mothers, conducted by the Centers for Disease Control and Prevention, 40 percent said they gave their baby solid food before they were 4 months old, with 9 percent starting as early as 4 weeks. Doctors now recommend waiting until a baby is at least 6 months old.

For at least 20 years, the American Academy of Pediatrics had advised against feeding babies solid food before they turned at least 4 months old. Last year, encouraged by growing evidence of the health benefits of breast milk, the group raised that age, saying babies should be fed nothing but breast milk for six months. When breast milk is not an option, formula is an acceptable alternative, the group says.

But the survey suggests that mothers are not aware of the recommendations or find them difficult to follow. Popular reasons for giving solid food to babies before 4 months included "my baby is old enough," "my baby seemed hungry," "I wanted my baby to sleep longer at night" and — most alarming to researchers — "a doctor or health care professional said my baby should begin eating solid food."

"Clearly we need better dissemination of the recommendations on solid food introduction," said Kelley Scanlon, an epidemiologist with the C.D.C. and an author of the study. "Health care providers need to provide clear and accurate guidance, and then provide support to help parents carry out those recommended practices."

The study suggested that economics were a factor in the decision to introduce solid food, with poorer women who saw formula as too expensive more likely to feed solids too soon. Women who were feeding their children exclusively formula or a mix of formula and breast milk were not only more likely to introduce solid food early, but to say their doctors gave them the go-ahead.

"It makes me want to know more about the other advice that those parents were getting on infant feeding," Dr. Scanlon said.

Further, the women in the survey who turned to solid food early were more likely to be young, less educated and unmarried. They also had lower levels of income or education, and were more likely to participate in the Special Supplemental Nutrition Program for Women, Infants and Children.

While many pediatricians are sympathetic to the difficulties parents face feeding their child nothing but breast milk or formula for six months, they say little good can come from feeding solid food to a child before he or she is physically ready.

"When a baby is ready to start eating food, he will put his hands in his mouth, and you will see him actually making chewing motions," said Dr. T J Gold, a pediatrician with Tribeca Pediatrics in Brooklyn. "At 2, 3 months, they can't even hold their heads up well, and they can't sit," making it difficult, if not dangerous, to put solid food in their mouths.

They also have yet to develop the proper gut bacteria that allow them to process solid food safely, potentially leading to gastroenteritis and diarrhea, Dr. Gold said. The early introduction of solid foods has also been linked to increased risk of obesity, diabetes, eczema and celiac disease.

One reason parents turn to solid food early is the persistence of myths about solid food helping babies sleep through the night or put on weight.

“That big fat bottle at the end of the night isn’t why your baby is sleeping — it’s a skill you acquire,” Dr. Gold said. “And if you think giving your child more calories is going to help him gain weight, but it gives him more diarrhea, then he’s not actually absorbing as much.”

But even parents who are aware of the guidelines can have trouble following them, particularly if they are struggling to buy enough formula to feed a rapidly growing child. “The formula gets really expensive, especially in the 4-to-6-month window,” Dr. Gold said. “And if you have more than one child and you’re already preparing food for the whole family, it’s much easier to just start sweeping things off your plate.”

Pediatricians can help parents delay solid food by helping them better understand their baby’s signals, Dr. Scanlon said. “When the baby is fussy, they need to help them understand that doesn’t necessarily mean they’re hungry and need solid foods,” she said.

Parents should also know the signs that their child is ready for solid food, like sitting up, being able to take food off a fork and not closing the mouth when food is offered, Dr. Scanlon said.