America’s Stem Cell Debate

Illuminating Dark Matter

Wash Away Your Troubled Mind

High Energy Particle Physics

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<table>
<thead>
<tr>
<th>Table of Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letter from the editors ......................................................... 1</td>
</tr>
<tr>
<td>Cytochrome P450cam: Impacts of its Elucidation on Structure and Function ................................................. 2</td>
</tr>
<tr>
<td>Craig Fryman</td>
</tr>
<tr>
<td>America’s Stem Cell Debate ........................................................... 4</td>
</tr>
<tr>
<td>Odelya Hartung</td>
</tr>
<tr>
<td>The Effects of Conway Mutation on Character Variety .......................................................... 6</td>
</tr>
<tr>
<td>Nikhil Agarwal</td>
</tr>
<tr>
<td>A Reminder in Our Search for Understanding ......................................................... 7</td>
</tr>
<tr>
<td>Jonathan R. Wachtel</td>
</tr>
<tr>
<td>How a Brandeis Professor is Tricking Flies into Being Bisexual .......................................................... 8</td>
</tr>
<tr>
<td>Mike Keyserman</td>
</tr>
<tr>
<td>Shedding light on dark matter ......................................................... 10</td>
</tr>
<tr>
<td>Kathryn Marable</td>
</tr>
<tr>
<td>Body Worlds 2: Controversial Exhibition in the Museum of Science, Boston ......................................................... 10</td>
</tr>
<tr>
<td>Aybike Onur</td>
</tr>
<tr>
<td>High Energy Particle Physics at Brandeis ......................................................... 12</td>
</tr>
<tr>
<td>Polina Navrotskaya</td>
</tr>
<tr>
<td>Wash Away Your Troubled Mind, Really ......................................................... 14</td>
</tr>
<tr>
<td>Josh Daskin</td>
</tr>
<tr>
<td>Sunspots Can’t Explain Earth’s Climate Changes ......................................................... 15</td>
</tr>
<tr>
<td>Christine Surka</td>
</tr>
<tr>
<td>Just for fun:</td>
</tr>
<tr>
<td>“Pluto” by Joe Liu ........................................................................ 16</td>
</tr>
<tr>
<td>Poetry Corner ........................................................................ 16</td>
</tr>
<tr>
<td>Puzzles .................................................................................. 17</td>
</tr>
</tbody>
</table>

Questions, comments, suggestions?

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Cover: Human stem cell colonies from “non-presidential” stem cell lines derived at Harvard University. Courtesy of Ann Kiessling. Funding for this research provided by private contributions to the Bedford Stem Cell Research Foundation.
Dear Scope Readers,

The world is changing fast, new technologies are being developed daily and new research is opening the doors to even greater development. Yet our policies and regulations are not keeping up. As individuals, it is our responsibility to be informed about the current issues and developments—we cannot take a passive role. Therefore, in this issue the Brandeis Scope has emphasized the current research being debated that will ultimately have an impact in shaping the future of science. The articles focus on minute and specific details. We believe that, after being informed of the particular details, one should step back to see the whole picture. It is only then that we can take in the issues from all perspectives to make competent decisions.

One of the issues that has been debated since it has emerged is that of stem cell research. No matter how developed the science is, or how well-educated scientists are, government regulations determine the progress of stem cell research. It is in our best interest to be informed about every aspect of this important matter. Published in this issue is an article on America’s Stem Cell debate that not only highlights the biology of stem cell research, but evaluates the issue from an admittedly controversial political view. Whether you agree or not, this article is meant to provoke and move its readers to action.

Another much debated controversy is the LHC (Large Hadron Collider) that will switch on next year in Geneva, Switzerland. The LHC will be the biggest particle accelerator in the world. Physicists have been long awaiting its arrival to observe the Higgs boson, perhaps witnessing the origins of mass in the small black holes created by this apparatus. This will open a new era for particle physics that it is difficult to foresee now. People are afraid of the unknown, and they fear that one of the black holes might be big enough to swallow the earth. There is also concern that many physicists will migrate to Europe in order to collaborate on these projects. How this will affect the physics research in the US is unknown.

There is a big puzzle standing in front of us. We scientists search for specific pieces of information in order to contribute to the completion of this giant enigma. It is easy to get lost in the infinitesimal pieces of the puzzle. However, we must always remember to step back, look at the bigger picture and think why we are here. In this issue, we tried to remind our readers and ourselves to keep things in perspective. Every decision we make is like adding a small piece to the larger puzzle; we shouldn’t forget to see the bigger picture. As the legendary Eagles sang, “You can see the stars but still not see the light.”

Enjoy!

Odelya Hartung  Selin Neseliler
Biology ’08  Neuroscience ’08
The fields of biochemistry and molecular biology are expanding into arenas of science that could not be explored forty to fifty years ago. In an area in which the development of new technology has become increasingly fast we are now more equipped to observe and analyze proteins in all their various conformations. The proteins present in nature vary diversely with respect to their structure and function. The proteins that make up enzymes can be extraordinarily dynamic molecules. Because some enzymes can undergo conformation changes in mere nanoseconds, it is particularly difficult to observe them. The elucidation of their structures as well as the mechanisms by which they undergo these continuous changes has many significant scientific and medical applications.

A particular superfamily of proteins, known as cytochromes P450, is currently undergoing extensive research at Brandeis University. Cytochromes P450, so named for their characteristic maximum absorbance of light at wavelengths near 450 nm, comprise a superfamily of enzymes that play a crucial role in many biological processes such as drug metabolism and the synthesis of many steroid hormones [1]. Professor Thomas C. Pochapsky of Brandeis University heads a research team that is honing in on one specific enzyme named cytochrome P450\textsubscript{cam}.

Cytochrome P450\textsubscript{cam} was first isolated from the bacterium \textit{Pseudomonas putida}, free-living organisms often found in soil or water. These bacteria are characterized by great metabolic diversity and are able to utilize a wide range of carbon sources, including camphor. P450\textsubscript{cam} will initiate the first step in the degradation process of camphor by splitting a molecule of dioxygen and hydroxylating camphor. Substrate binding to P450\textsubscript{cam} may involve large conformational changes to the enzyme; however, the P450\textsubscript{cam} monooxygenase system is complex and not yet fully understood [3]. Professor Pochapsky and his team are currently attempting to determine the various conformations of this dynamic enzyme using Nuclear Magnetic Resonance (NMR) spectroscopy. The use of NMR spectroscopy has significantly aided in the determination of the various conformations and components of P450\textsubscript{cam}.

When the first structure of P450\textsubscript{cam} was determined an immediate question raised was how camphor gains access to the active site of P450\textsubscript{cam} “since there is no obvious opening” [2]. Poulos and Johnson point out that the substrate-free and bound structures showed no obvious differences except that the B’, F, and G helices exhibited significantly higher thermal motion [2]. This indicates that perhaps helices B’, F, and G move in order to allow camphor to enter the active site of the enzyme, thereby allowing its subsequent hydroxylation.

This significant realization was brought to light in 1998 by experiments carried out by

![Figure 1: P450\textsubscript{cam} hydroxylates camphor [2].](image)

DiGleria, Hill, Wong, and Fulop. The aforementioned flexibility of particular helices of P450\textsubscript{cam} was demonstrated by binding an electroactive sulfhydryl reagent (a substrate mimic) to the active site of the enzyme. This mimic substrate caused the unfolding of the helices of P450\textsubscript{cam} exposing the active site. What was observed was an unobstructed “tunnel” from the surface of the enzyme straight down to the active site. This clearly indicated the presence of the open channel that DiGleria, Hill, Wong, Fulop and their colleagues were looking for. Poulos and Johnson note here
that although this may not mimic what actually happens when the substrate (i.e. camphor) binds, it does show that a possible conformation exists that would permit the exposure of the active site [2].

The determination of the structures of the various conformations that P450\textsubscript{cam} undergoes in its 5-exo-hydroxylation of camphor is essential to a more complete understanding of the entire cytochrome P450 superfamily [4]. A useful technique to use is x-ray crystallography. However, it can only determine the most stable conformations of P450\textsubscript{cam} because less stable forms of the enzyme do not crystallize. High resolution NMR spectroscopy is the only technique that can provide detailed information on the three dimensional structure of proteins in solution; it allows identification of less stable conformations of the protein. For example, the involvement of putidaredoxin and putidaredoxin reductase - key components of P450\textsubscript{cam} - in the transfer of electrons from NADH was not fully understood until Pochapsky \textit{et al.} developed a model based on NMR data, mutagenesis, and computational studies [2].

The P450 superfamily of enzymes exhibits a multiplicity of forms and functionalities [1]. Homologs of various bacterial P450 enzymes found in humans play major roles in drug metabolism, something pharmaceutical industries have taken quite an interest in. Research areas such as toxicology and more specifically metabolic activation of procarcinogens and detoxification of xenobiotics (antibiotics) have much to gain. Cytochromes of the P450 superfamily are involved in the metabolism and biosynthesis of steroids, fatty acids, vitamin D, herbicides, insecticides and in the degradation of terpenes and alkanes. Among the oldest of proteins, they clearly play an integral role in the biological world.

Camphor is a white, crystalline substance that comes from the Asian evergreen tree \textit{Cinnamomum camphora}, or camphor laurel. Camphor is used for its pungent odor, as an embalmer, and for medicinal purposes.

\textit{from} http://www.botanical.com
\textit{Accessed October 17, 2006.}

References:
AMERICA’S STEM CELL DEBATE

Cardiologists hope to see them turn into beating heart cells that can repair tissue damaged from heart attacks. Neurologists hope to see them turn into neurons that can revive damaged nerves, or replace brain cells destroyed by neurodegenerative diseases such as Alzheimer’s and Parkinson’s. Endocrinologists hope to see them transformed into pancreatic cells that can treat diabetes. The hopes for embryonic stem cell treatments are as varied as the cells themselves have the potential to become. Unfortunately, under the current President, American hopes will have to wait. In the meantime, the Stem Cell Debate continues.

This past summer, on July 19th, President Bush executed the first and only veto of his administration [1]. Formally called “The Stem Cell Research Enhancement Act of 2005,” the bill outlines the allowable uses of donated embryos leftover from In Vitro Fertilization procedures (see explanatory box on “IVF and Stem Cell Applications”) [2]. According to the bill, patients having undergone fertility treatment could give written consent to donate the embryos that were not used during treatment. The main condition outlined by the bill is that donated embryos would not have been implanted, and would have otherwise been discarded [2]. The bill was passed earlier that day by the Republican-dominated Congress, and would have effectively overturned restrictions on stem cell research that President Bush imposed five years ago [1].

Restrictions passed in 2001 mandated that no new stem cell lines could be created or used for federally funded research. At that time, it was thought that there were over 70 experimentally useful lines of embryonic stem cells, but that number is now thought to be less than twenty [3]. This is because the viability and utility of the lines deteriorates with time due to spontaneous genetic mutation. In addition, many scientists feel that these lines are not satisfactory for current research because they were grown with mouse feeder cells, and other animal products that may have contaminated them with viruses [3].

It doesn’t take a PhD to see that new sources of embryonic stem cells are crucial to the progress of this field, but many conservatives still believe that Stem Cell Research is simply unnecessary. The argument given by such politicians is that adult stem cells (such as those found in bone marrow) are an equal or better source of therapeutically useful cells as embryonic stem cells. However, even researchers working with adult stem cells call that argument unreasonable. They agree that the potential for embryonic stem cells far exceeds that of adult stem cells [3]. (More on the therapeutic potential for embryonic stem cells will be presented in the next issue of The Brandeis Scope.)

So the question remains, what will become of stem cell research in the United States? On this topic everyone agrees: If something isn’t done soon, American researchers will migrate to Europe and Asia, where regulations are not as stringent. As for now, it is predicted that the stem cell issue will have major electoral repercussions for the General Elections in November 2006 and 2008. This is one issue that concerns everybody: our health is at stake. This is particularly true for young adults, as it will likely be this generation that will reap the benefits of stem cell research. Young adults should make a careful point of educating themselves about this issue; their vote in November could save their lives in thirty years.

Democratic candidates for Massachusetts Governor Chris Gabrieli and Deval Patrick have both stated firm support for Stem Cell Research [4]. Even Republican candidate Kerry Healy declared her support for Stem Cell Research—a sure sign that this is no longer a one party issue in Massachusetts [5]. In a national poll conducted by the Pew Research Center, a nonpartisan organization that has been tracking the issue, results showed that about two-thirds of all Democrats and Independents favor embryonic stem cell research, while nearly half of all Republicans do [1]. Even citizens that oppose abortion are finding it increasingly difficult to equate human life with a clump of cells barely visible to the naked eye. Nevertheless, uncertainty still prevails among US House and Senate Republicans.

Considered by many to be the epicenter of biotechnology research, Boston has much to lose if the national climate regarding
stem cell research doesn’t change soon. According to Dr. Ann Kiessling, founder of the Bedford Stem Cell Research Foundation, Massachusetts is currently ahead in this field, but this may only be temporary. Dr. Kiessling explains, “The problem is staying ahead because the scientists with the expertise cannot get funding for basic studies [6].” Kiessling believes that relying on the Federal Government for funding is foolish and that private funds should be raised instead [6]. In her experience she has found that institutions have a tendency to wait for federal funding rather than obtain the funds from private donors [6].

Dr. Kiessling emphasizes that Boston-area universities such as Brandeis should not take a passive role. The future scientists and physicians of America are being educated here and their involvement in this matter should not be undermined. Kiessling states, “Students can expect/demand curricula that include stem cell science at all levels, and remind the public that government funds (either state or federal) are too slow in coming to maintain our current lead.” So, what is the take-home message? Something has to be done. Kiessling writes, “[I]n the short term, a lot of folks (private donors, senators and representatives) are going to have to back the efforts (to recruit Stem Cell Funding), or we are going to read about important breakthroughs being developed in other parts of the world [6].”

References:

IVF and Stem Cell Applications

(a) Embryos are graded according to their growth potential.
(b) At 5 days old, the best two or three embryos are isolated and transferred into the patient using a catheter. If one of the embryos implants, the mother may become pregnant and give birth to a full-term infant. The remaining embryos are frozen; the patient (and spouse) may try to implant them in the future, but in many cases the embryos are discarded.
(c) If unused embryos were donated to research rather than destroyed, they could be used for stem cell therapies.
(d) Inner cell mass (ICM) cells are removed from the blastocyst and allowed to proliferate.
(e) These cells are capable of producing any kind of somatic cell in the body. Nerve cells, pancreatic cells, and skin cells are three examples.
The Effects of Conway Mutation on Character Variety

Nikhil Agarwal

Knot Theory is a relatively new branch of mathematics that studies knots that can be tied using strings. For convenience, mathematicians often work with diagrams of knots instead of strings. However, each knot has infinitely many diagrammatic representations. Given any two knot diagrams, it cannot always be determined if the two knots are different. Thus, a common question knot theorists will often ask is whether two given knots are different. It is difficult to distinguish knot pairs that are related to each other by a Conway mutation (Fig 1). This summer, under the guidance of Professor Ruberman, I studied a commonly used method of differentiating mutant knots.

A useful analogy used in understanding how this method works is as follows: if you were given two objects that looked possibly identical and were asked to determine whether they are different, you may try to measure their weights or their lengths or other physical characteristics to see if you can find a difference. If your measurements do not agree, you can conclude that the objects you are studying are different. However, if you cannot find any differences, you still can’t be certain that they are the same because for all you know, their chemical properties may be different.

Similarly, because each knot has a unique algebraic structure associated with it, a good method to differentiate mutant knots is to compare two knots with respect to their algebraic properties. These algebraic structures can be represented in simpler algebraic structures known as target groups. The key to success when distinguishing knots is to compare the knots with the correct candidate target group. If two knots yield different representations, one may conclude that the knots are mathematically different.

Since there are infinitely many pairs of mutants, each with possibly a different choice of comparison that “works”, the question needs to be generalised. Thus, it is worthwhile to study mutations without specific reference to the knots they are acting on.

In my research, I separated the mutations into two types: positive and negative [1]. Orientation preserving mutations are referred to as positive and those that aren’t orientation preserving are negative (Fig. 2). During the course of the summer, I discovered an algebraic property and proved that target groups with that property did not allow positive mutants to be told apart. This result holds true for all positive mutants and all algebraic structures with the discovered property. A certain set of algebraic structures were also identified that are likely to have this property. Using computer programming, this result was verified for a few members of this set [2]. For negative mutations, another algebraic property was found which changed the expected course of the research. This property of negative mutations differentiated their behaviour from that of positive mutants with respect to the methods used to compare the two knots. It turns out that a different, possibly more complicated, algebraic property will be needed to produce similar results in negative mutations.

The result for positive mutations has the potential to develop into an
algebraic invariant, a property that remains unchanged under a transformation, of the knot mutations. The analysis conducted was along the lines of previous work by Riley [3], Ruberman [4] and Tillman [5]. Tillman’s analysis dealt with algebraic structures of infinite size, which are computationally more difficult to deal with than the finite structures that were examined [5]. Even while dealing with the finite structures, the computations became memory intensive very quickly and available computing power limited the extent of the research. Hopefully, future research will allow target groups to be classified according to their ability to differentiate knot mutants.

References:
5. Tillman, Stephan. On The Kinoshita-Terrance advances in technology, which have led to still further scientific progress. But we are often like people who have gotten lost in their theories concerning reality, and who consequently fail to experience reality directly and who forget what it is that they are truly trying to describe. We name and categorize and try to understand the rules by which the system of the world is governed, and we try to use those rules to aid us in further technological developments.

Yet, in the nearly innumerable branches of our search for knowledge, there seems not one that works like the brain of a true multicellular organism, which governs over the entire body of differentiated cells, assuring that they work together and in sync and that they continue as parts working toward the purpose of the whole. Every once in a while, we have to take a step back and gain perspective on our search and on how it fits into the big picture of things. Our advancements have sometimes obscured from us the grand and magnificent universe that we have once gazed upon with fear and awe. We must not lose sight of the fact that we are still children when it comes to our understanding of the universe. We still have our childlike curiosity and desire to explore; let us not lose our wonder of the ever-mysterious and beautifully complex yet comprehensible universe in our process of exploration.

Figure 2. The Mutation Surface (S)
Mutations along the surface in figure 2 were divided into two categories: positive and negative. In the figure, one of t1 , t2 and t3 is positive (and the other two negative) depending on how the knot is oriented with respect to the surface.

Knot theory has been used to estimate properties of enzymes that unknot the super-coiled DNA strands during replication.


A Remindery in Our Search for Understanding

Jonathan R. Wachtel

As long as humans have walked the earth, we have sought to understand our surroundings, ourselves and our place in our surroundings. Our search has progressed like a branching tree, with increasing differentiation and specialization over time. But, like cells in a true multicellular organism that have matured, differentiated and have consequently lost their ability to witness the full grandeur of the system in which they play only a single, specialized role, humanity’s ability to truly experience the full picture of this vast universe has seemingly gotten lost in the search for understanding.

Scientific progress has led to tremendous advances in technology, which have led to still further scientific progress. But we are often like people who have gotten lost in their theories concerning reality, and who consequently fail to experience reality directly and who forget what it is that they are truly trying to describe. We name and categorize and try to understand the rules by which the system of the world is governed, and we try to use those rules to aid us in further technological developments.

Yet, in the nearly innumerable branches of our search for knowledge, there seems not one that works like the brain of a true multicellular organism, which
When Prof. Jeffery Hall (BIO) is not teaching biology, he can often be found tricking female fruit flies into thinking that they are actually male. For the past 25 years, Hall has been studying a gene called fruitless. Fruitless is a novel sex gene that determines maleness in fruit flies, *Drosophila melanogaster*. This gene alone is responsible for the development of all male characteristics, including mating, courtship and nervous system development. By studying this gene, Hall and other scientists hope to learn more about the biology of sexuality.

Prof. Kulbir Gill of Yale University first discovered in 1963 that mutations in the fruitless gene causes strange behavior in the fruit flies. The fruitless gene is present in both males and females, but when a simple mutation is induced in this gene males will court females. This courtship is typically characterized by vibrating of the fruit fly’s wings which creates a high frequency song that attracts females. These flies, however, would not actually mate. Gill also observed that groups of males would court one another, something that has not been observed in this species. These findings suggest that a simple change in DNA can cause bisexuality in fruit flies.

After 15 years of research lying uncultivated, Hall picked up the study of the mysterious fruitless gene at Brandeis University. He wanted to identify how the fruitless gene caused such atypical sexual behavior among males. Studying the neurological and physiological effects of fruitless, he noticed that mutant males were missing a large muscle, called the muscle of Laurence. Moreover, he demonstrated that the mutant male flies’ sperm was completely normal. These findings caused Hall to turn to DNA for clues to decipher the effects of fruitless genes.

“I went on to isolate the genetic material, the DNA, of the fruitless gene in collaboration with a close friend of mine. We discovered that fruitless did not lie on the sex chromosome but it was a novel sex gene that regulated neurological development,” Hall said.

Fruitless was identified as the regulator of all masculine behaviors, but females, who also have the gene, do not express the same characteristics the gene typically produces in males. At the molecular level, female flies cannot convert the genetic material into functional proteins that will regulate neurological development as male flies can.

A number of new fruitless mutants were isolated by inducing different mutations in the DNA. Some mutant males will mate for hours, rather than the customary 15 minutes, and will not detach from the female flies. Other mutants will mate, but not ejaculate. By studying these various induced fruitless mutants, Hall could better understand the mechanism of the gene and the spectrum of events it triggers in fruit flies. Hall was able to determine that the proteins encoded...
by the fruitless gene seem to affect all aspects of male sexual behavior, courtship, physiological structure, and neuron function.

“Critics have called me a chauvinist because they claim that I only study male fruit flies,” Hall said. “What they fail to realize is that fruitless hones in on maleness. Quite interestingly, in the lab we were able to trick females into thinking they were males and fruitless was expressed. This resulted in the tricked females mating with other females.”

The study of the fruitless gene has now become a cottage industry, as many labs around the world have been dedicated to the study of this gene. A new laboratory in Austria recently confirmed Hall’s results that female flies could be tricked into believing they are male by expressing the fruitless gene.

“I never intended to achieve these kinds of results. We still don’t know what fruitless specifically regulates and it is going to be very entertaining to figure this out,” Hall said.

It has been documented that some genes in mouse and humans control sexuality in a similar manner to fruitless. Because of this similarity, scientists have tried to see if human or mouse genes can be transplanted into fruit flies. They are investigating to see if they have similar effects as fruitless. Hall, however, thinks a human equivalent does exist, yet it will be difficult to identify a particular one that works in the same way as fruitless.

According to Hall, behavior genetics has many ethical issues. Behavioral genetics uses mutants and molecular gene manipulations to study the nervous system and how it regulates specific behaviors. Working on behavior genetics is morally dubious. The goal is not to ask if a behavior is genetic, but which genes and how does the gene go about regulation. One cannot develop a nervous system without gene action.

“The work we do is dangerous because a human [equivalent] may exist and one will want to manipulate the fruitless gene for eugenics purposes,” says Professor Hall. “But.. there is no single gene to manipulate.”

Carmen Miranda isn’t the only one concerned about this new research. “The work we do is dangerous because a human [equivalent] may exist and one will want to manipulate the fruitless gene for eugenics purposes,” says Professor Hall. “But.. there is no single gene to manipulate.”


“The work we do is dangerous because a human [equivalent] may exist and one will want to manipulate the fruitless gene for eugenics purposes. But there isn’t any gene to manipulate in humans! It is moot because there is no single gene to manipulate.” Hall said.

Hall works with Hayden Lincicome ’06 and since 1990 has worked with senior research associate Adriana Villella, an expert on fruit fly courtship.

“It has been a remarkable experience working for the one-of-a-kind Professor Hall because he is committed to understanding biology and not just publishing papers,” Lincicome said. “Progress in our work on the fruitless gene is slow, but everyday we learn more and more; and who knows where that will take us.”

References:
Personal Communication with Jeffery Hall.

A gene that helps fruit flies develop alcohol tolerance has recently been found, and named “hangover.”

Astronomers announced in August that recent observations from a pair of colliding galaxies known as the bullet cluster prove the existence of dark matter [1].

For a while, scientists have known that many galaxies and galaxy clusters behave as if they had much more mass than they appear to. To explain this discrepancy, they hypothesized that the missing mass was dark matter, a mysterious substance that can only be observed by its gravitational effects yet is roughly five times more common than normal matter [1].

But the strange behavior might also be explained by a modified theory of gravity where gravity was stronger on larger scales. Proponents argued that it was more likely that our theories of gravity were lacking than the possibility that a substance that makes up four-fifths of the universe has remained undetected throughout human history [2].

In the bullet cluster, however, gravity is not only stronger than predicted by standard theory, it is pulling towards places where there is no normal matter [2]. Dark matter theory explains this perfectly: this is a rare case where dark matter and normal matter are not in the same place, and gravity is pointing towards the more massive dark matter. Most of the visible matter in those galaxies is in the form of hot gases that are slowed by drag forces during collision. The dark matter, which doesn’t interact with normal matter or itself, passes through without slowing [2].

“This is the type of result that future theories will have to take into account,” said University of Chicago cosmologist Sean Carroll in NASA press release, “As we move forward to understand the true nature of dark matter, this new result will be impossible to ignore.” [3].

The bullet cluster was observed for over 100 hours at Harvard’s Chandra X-ray observatory. The researchers mapped the gravitational field by observing its effects on light from more distant galaxies, a technique known as gravitational lensing [2].

References:

20 million people have visited an exhibition of preserved human bodies all around the world since 1995. Body Worlds is the creation of the German anatomist Gunther von Hagens, who developed a special technique for preservation of anatomical specimens that is called plastination. The exhibition includes more than 200 hu-
human specimens including individual organs, whole bodies and body slices.

The success of these specimens is the result of 20 years of research and an artistic medical vision. Simply, plastination is done by removing the fat and water in the cells without destroying the tissues and replacing them slowly with acetone. Then the acetone is replaced by liquid plastic that is hardened by gas or heat treatments. The solid plastic keeps the tissues and poses of the specimens preserved. For this exhibition, posing the specimens has been as important as preparing them. Visitors should not be intimidated by the specimens, especially the whole body plastinates. Inspired by the anatomical drawings from 16th and 17th century, von Hagens prepared the whole body specimens in aesthetically pleasant and familiar life-like poses. In this way, visitors could see a reflection of their life form instead of a dead person's body.

Before the exhibition became popular worldwide, von Hagens had trouble finding opportunities for public exhibitions of preserved corpses. Nevertheless the impression about the exhibition has been more accepting than he ever imagined. Even though there has been much criticism, there is still greater support and public interest. The exhibition is thought-provoking in many aspects; it provides people with a different perspective of their existence by making visible the individual parts of our whole selves. The exhibition touches on health issues by presenting a healthy organ next to a diseased one, by showing how prosthetics work with a human body and by simply showing what we physically are. Seeing the real organs takes the experience of seeing a picture of a smoker’s lungs or clogged artery a step further by presenting the real thing. Furthermore, the exhibition presents the taboo of death directly to people by making death the center of attention in the form of corpses. Death is rarely the main topic in conversations and it is one thing humans constantly try to prevent or forget about, but here it is actually enjoyed in the illusion of these specimens.

One controversial problem that arose with the popularity of this and similar exhibitions is the source of specimens. The Institute for Plastination founded by von Hagens provided evidence for the fact that their specimens were donated by informed people before their death. However according to a New York Times article [2], there are many small industries that prepare similar specimens for exhibitions or educational purposes. Even though their businesses are becoming more and more successful, questions on the source of their specimens and the industry’s ethics and legitimacy remain. Today, there are legal and governmental actions taken against these and similar illegal issues. Günther von Hagens’ work is not affected negatively from these regulations, as his work is done for research and educational purposes within ethical boundaries.

With its intense content, this exhibition and its remnants on our society will continue to surprise, stimulate and move people—whether they like the exhibition or not. There is as much to learn from this experience, as there is much to like and think about. The exhibition will be in the Museum of Science until January 6th and more information about visiting can be found at “http://www.mos.org/bodyworlds”.

References:

Death is rarely the main topic in conversations and it is one thing humans constantly try to prevent or forget about, but here it is actually enjoyed in the illusion of these specimens.
Particle physics is traditionally thought of as one of the most complicated and inaccessible fields of science. However its implications are remarkable: understanding of matter certainly has consequences throughout all fields of science. We now know that all things consist of molecules, and that those in turn are composed of atoms. In the late 19th century J.J. Thompson [1] discovered the atom, and Rutherford [2] deduced that atoms were composed of even smaller particles called electrons and protons. Today, more than a century later scientists are beginning to realize that there exist much smaller particles, like those that make up protons called quarks. Understanding the nature of these particles can provide an insight into the nature of mass and energy, and eventually unravel the mystery of the birth of our Universe.

Dr. Craig Blocker, member of the High Energy Group at Brandeis, has dedicated his career to the study of subatomic particles. His group is part of a huge collaboration of particle physicists at Fermilab [3] where scientists collide beams of larger particles in order to investigate the smaller “bits” that result from these collisions. Despite their tiny size, such particles are incredibly difficult to summon under experimentally sustainable conditions. They need to be accelerated to speeds as high as 99.9% of the speed of light, which is achievable only by means of a setup called a particle accelerator. The largest existing particle accelerator in the world is located in Chicago, IL at Fermilab. In the past this is where Dr. Blocker and his Brandeis colleagues James Bensinger, Laurence Kirsch and Hermann F. Wellenstein had been performing their experiments. However their attention is now turning over to Europe, where in CERN [4] near Geneva, Switzerland, a new giant particle accelerator called the Large Hadron Collider (LHC) is being constructed and is scheduled to switch on in 2007. With this new accelerator, scientists would be able to achieve collisions at energies up to 7 times higher than those achievable today at the Fermilab.
The experimental potential of the LHC is truly astonishing; it promises experimental solutions to many profound problems in modern physics. One such problem that may find its answer at the LHC is what's called the Standard Model Theory. The Standard Model is the current hypothesis that explains the interaction of fundamental particles. However, it does not elucidate why fundamental particles have masses [5]. It does, however, account for the existence of an additional particle called a “Higg’s Boson” [6] which nobody has yet observed. At the LHC the transcendent boson may finally show itself to the long-awaiting scientists.

Related is another fundamental problem in physics, the one which Einstein after postulating his theory of relativity spent his life trying to solve – the Unified Theory. The Unified Theory concentrates around the search for one set of laws that would be equally applicable to the microscopic world (such as the particles Dr. Blocker is studying) and the macroscopic world composed of bodies as immense as our Sun. Today quantum mechanics combined with special theory of relativity describe the subatomic world, whereas macroworld is described by the general theory of relativity. The two theories fail to agree among themselves; the first steps toward a possible solution are manifested by the birth of the Superstring Theory. Although many scientists agree it is the first theory that could become the Unified Theory, it is indeed a very puzzling beast. Superstring theory only works in 10 dimensions, as opposed to our native 3, which most people find difficult to comprehend. The possible explanations of where the other 7 dimensions could be present an even greater challenge: one theory says that these extra dimensions are not flat dimensions (like infinite x, y and z planes), but that they are really small and are curled up in very tight circles. Another theory says that these dimensions are not so small, but that the reason we can’t see them is because particles such as protons, neutrons or photons can’t travel in these dimensions.

Whatever the explanation, the Superstring Theory suffers from the lack of experimental evidence: the LHC promises to help fill in some of these blanks. The Superstring Theory is not entirely deprived of experimental evidence. In fact most people are more familiar with it then they might think: when you turn on your TV set and you see the static on the screen some of it is radiation from the very early days – the Big Bang [7]. Remarkably, when the Universe exploded at it’s birth in what’s called the Big Bang, it resulted in a burst of bright visible light, but as it grew and expanded, the wavelength of that light kept stretching until it reached the microwave region. These microwaves, invisible to the human eye, are detected by the television antennae and result in noise on the monitor. This phenomenon is called the “Cosmic Microwave Background Radiation” and was discovered in 1965 by Arno Penzias and Robert Woodrow Wilson [8], for which they received a Nobel Prize in physics in 1978.

Although particle physics won’t help you invent a better toaster, it did have several major technological spin-offs, among them the proton radiation treatment used in particular types of cancer, which proved to be more efficient than traditional radiation therapy. Complicated mathematics employed by particle physicists are shared by condensed matter physicists; their principles are used to study astrophenomena such as high-energy pulsars and quasars. Perhaps the most fundamental use of particle physics does go back to the very early days of the Universe, when all of its energy was in the form of very small particles, much smaller than protons and neutrons. These particles were moving very fast and colliding with each other and making even smaller particles, which is just what scientists like Dr. Blocker and his high-energy colleagues are trying to mimic at Fermilab. Equipped with the power of LHC accelerator they will continue to investigate the nature of matter at its most fundamental level.

References:
2. Ernest Rutherford, 1st Baron Rutherford of Nelson (August 30, 1871 – October 19, 1937)
Wash Away Your Troubled Mind, Really.

Two Northwestern University graduate students, Chen-Bo Wang and Katie Liljenquist recently completed their work on associations between moral and physical cleansing methods [1], an intriguing extension of previous studies which had established similarities in the facial expressions [2] and brain function [3] of individuals experiencing classic physical disgust and moral disgust. Wang and Liljenquist performed a series of tests designed to evaluate the connection between bodily cleanliness and moral purity [1]. In the first part of the study, volunteers were asked to describe either an ethical or unethical event from their past and then to performed a word-completion task, filling in the missing letters of various words such as w_ _ h. Several of the words could be completed as either cleansing-related words, like wash, or as other unassociated words, like wish. It was observed that those who had described an unethical event derived more cleansing-related words than those who remembered an ethical event [1].

In order to see whether this result is a consequence of a personal urge to clean one’s body after an unethical event, the second part of the study asked the subjects to rate desirability of certain products after they hand/copied either an ethical or unethical story. Those who had copied over stories of disreputable or corrupt behavior were more likely to rate cleaning products, such as detergent, deodorant and disinfectant more desirable than products, such as post-its and batteries. The team concluded that, like the first phase of the study, the second phase of the study also demonstrated a desire for physical cleansing after a psychologically immoral event[1].

The final two parts of the study sought to link the observed desire for physical cleansing to actual behavior. Following recall of an ethical or unethical event, subjects were offered a pencil or antiseptic wipe. Approximately twice as many of those who had recalled unethical events as those who had recalled ethical events chose the wipes, showing a moral threat activates the need for cleansing [1].

The culmination of Zhong and Liljenquist's studies measured the impact of physical cleansing after an unethical recall on subjects’ willingness to perform a selfless act, assisting another researcher without being paid. The researchers hypothesized that those who offer to help would be those more “in need” of a good deed to help cleanse their mind. Washing one’s hands led to decreased levels of self-reported feelings of guilt and to fewer offerings of assistance, further evidence of a link between physical and mental purification [1].

The research performed by Zhong and Liljenquist could set the stage for future studies of the influence of hygiene on human behavior. However, it remains to be elucidated whether cleanliness promotes good behavior or whether people use cleaning as a coping mechanism to allow them to commit what they would otherwise consider unethical.

References
A topic of public debate since the 1980s, global warming remains at the forefront of environmental research but results have often been inconclusive. Within the 20th century, the average temperature of the earth’s atmosphere has risen by 0.6 degrees Celsius [1].

Central to the debate is whether the temperature increase is part of a natural phenomenon or if it is attributable mostly or entirely to human activity. The atmospheric concentration of carbon dioxide, which helps maintain earth’s average temperature by absorbing solar radiation that would otherwise be reflected back into space, has increased between 1750 and 1999 by 31%, from 280 to 367 parts per million [2] largely due to burning of fossil fuels and deforestation. Correlating global warming solely to this increase, however, is an oversimplification which should be avoided in the presence of other factors.

A recent study, however, illustrates that solar output (total solar irradiance), has not increased but is undergoing variations as a result of 11-year cycles. Sunspots -depressions on the surface characterized by intense magnetic activity, low temperature, and low luminosity-fluctuate in number leading to small changes in the Sun’s energy output [3]. The sunspots block heat flux by storing energy beneath the Sun’s surface [3]. Paradoxically, the increase of sunspots at the peak of each cycle results in solar brightening. This is because they are surrounded by larger clumps of concentrated magnetic field and luminosity known as faculae (Fig. 1) [3]. Total solar irradiance is measured as the product of the spots’ area and its radiation output relative to that of surrounding areas [3].

Although the study currently rules out solar irradiance as a cause of global warming, it is unknown whether a shift resulting in net increase is possible in the future [3]. It is also emphasized that other patterns of the Sun’s activity require further investigation. The Sun’s ultraviolet flux, for example, also undergoes variations that have not been thoroughly studied and incorporated into climate models [3]. The effects of solar winds and galactic cosmic ray flux, which affect cloud cover, may play a role [3]. Further research on the Sun’s activity may make valuable contributions to increasingly sophisticated models that consider multiple variables and are able to make accurate climate predictions.

References:
Pluto’s Plight

by Josh Daskin

I once was a planet,
Pluto is my name,
They took my status away from me,
In the planet naming game.

They said I am too small,
That I’m just a tiny ball,
Of frozen stuff I think is nice,
Though I’m just an orb of ice.

Now I’m really angry here,
Just a boring orbiting sphere.
I’m so far away from the Earth,
With its astronomers, for what they’re worth.
I’ll get my status back some day,
I’ll do it I tell you,
I’ll find a way.
I think that maybe I can grow,
I’ll be a planet,
I’ll have you know.

Organic Reactions

by Shoshanna Barnett

If you’re an acid
And he’s a base
You could combine to make water.
Though, of course,
It depends to which side of the equilibrium you shift.
And if you halogenate his alkane,
You must beware of something more basic
Sneaking up behind for substitution.

This could turn everything inside out--
Invert it, so to speak.
And with lots of alcohol
Under acidic conditions,
You might have an affair with Williamson and bond together.
But then, you could just end up with yourself.
That reminds me:
If there’s a ring involved,
Make sure it’s stable.
Otherwise, any little thing,
Even a hydride,
Could break it up.

Of course,
I failed the last midterm,
So I’m probably not the best one to ask for advice.
ACROSS
1. Hypothetical theory with one set of laws applicable to all matter.
7. The name of a pair of colliding galaxies.
11. Coolest magazine at Brandeis.
12. A mysterious celestial phenomena identified by gravitational pull.
17. Unethical behavior by scientists.
18. Cells with most pluripotent ability.

DOWN
2. The total output of the sun.
3. New branch of mathematics.
5. Particles that make up protons.
6. The major benefactors of the new Science Complex.
8. Spectroscopy.
10. Undifferentiated cells.
13. Personal cleanliness that may affect psychological behavior.
15. Depressions on the surface of the sun.
16. No longer a planet.

*For solutions, check our website http://people.brandeis.edu/~scope