MOUNT SINAI SCHOOL OF MEDICINE

DEFYING GRAVITY

ENDURING LIFE IN SPACE

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Science and the City

by Daniela DiBiase

These days, in order to sell something you need a hook, and in New York it better be a good one. New Yorkers are tough customers and whether it's free minutes on a cell phone or a free soda with Chinese food, something must catch the consumer's eye. New York teens are no strangers to consumerism. They are the targets of million-dollar ad campaigns. Make no mistake; they know what they want, even when it comes to their education.

Here at Mount Sinai, the Defying Gravity Program is preparing to sell science. Its target audience: high school students and teachers. Its product: a new, science education, research-based curriculum. Its hook: space exploration.

But is the DG approach juicy enough to bait savvy New Yorkers? Program enthusiasts say "yes." Space is a sexy, mysterious frontier. DG uses the allure of space exploration and the technology of the Web to attract the interest of students and turn them on to the importance of a strong science education.

Sau Ling Chan, a biology teacher at the Manhattan Center for Science and Mathematics, says the DG curriculum is definitely interesting to students. "Space is something that people are always in awe of; they feel that its very mysterious and very challenging…only the best and brightest can work in the field of space technology." The DG curriculum spends part of its focus addressing the problems associated with a mission to Mars, which is a completely new area that has never been explored in the history of humans, said Chan. Learning about a trip to Mars might even be exciting enough to pique the interest of New Yorkers who think they are already at the center of the universe.

Neurovestibular Research at Mt. Sinai

Drs. Moore and André Diedrich prepare subject

Most people take balance for granted, but Dr. Steven Moore, a researcher at Mount Sinai Medical Center, does no such thing. He is part of a group of scientists devoting their research to neurovestibular function. Moore studies how systems of neurons in the body work together to maintain balance, stabilize vision and relay messages to the brain about the body's orientation.

Moore's research is particularly important to astronauts. When astronauts travel into space, their bodies must adapt to an environment with no gravity. They often become disoriented, confused and lose their sense of direction. Some astronauts suffer from motion sickness. These maladies are often serious enough to prevent astronauts from performing space walks during the first few days of their voyages. Upon reentry into Earth's gravitational field, astronauts may once again feel nauseated and disoriented. They may even have trouble walking.

These difficulties with balance are similar to the symptoms of vestibular and cerebellar diseases. In the United States, 90 million people are affected by balance disorders. Dr. Moore hopes his research will help counter some of the effects of microgravity on astronauts, and help treat patients on Earth.

Currently Dr. Moore is conducting a collaborative study with members of the Neurology Department. The experiments combine Moore's vestibular research with the work of other scientists who are monitoring the autonomic perineal nerve. The experiments involve the use of an elaborate chair apparatus that oscillates back and forth, or rotates like a centrifuge. The sub-

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DG Explores New York Hall of Science

The New York Hall of Science is located in Flushing Meadows, Queens. It was initially constructed as a pavilion for the 1964 New York World's Fair. The Hall became a museum in 1966. In 1986, after major renovations, the museum reopened with 25,00 square feet of new exhibition space, hands-on exhibits and an ambitious new staff. In 1996 the Hall underwent a $13 million expansion. Marvelous Molecules - The Secrets of Life opened as the first exhibit devoted to the shared chemistry of life.

On July 5, Defying Gravity participants visited the New York Hall of Science. Dr. Martin Weiss, the museum's Director of Science, was the group's tour guide. (Dr. Weiss will be featured in next week's edition.) The first of the visit was devoted to a group discussion; the topic was museum exhibits, their content and development as tools for learning, and their accessibility to the public. The second part of the visit was a tour of the museum that included a demonstration of gravity, a new exhibit on possible alien life forms and more discussion on creating comprehensive educational museum displays.

Dennis Bassin and Neil Farley debate whether God plays ball with the Universe

Defying Gravity pursues the creation of a comprehensive, hands-on and inquiry-based science curriculum. Museum exhibits are one way to educate the public

Neurovestibular Research at Mt. Sinai

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ject is placed in the chair, and various electrodes are attached to different points on his/her body. The chair is then put into motion and results are read from computer monitors.

"We believe that the otoliths [small organs in the ear that sense gravity]… drive the sympathetic responses," said Moore. There should be some correlation between linear acceleration, which stimulates the otoliths, and nerve activity of the leg, Moore added. "The oscillation of the chair will generate, hopefully, a reflex eye movement, and these should be in sync with the nerve recordings of the leg." The perineal nerve currently monitored by the scientists is a constrictor of vessels - a sympathetic response that affects blood vessels.

In this particularly study Dr. Moore was observing pupillary constriction and dilation-a response to movement. During acceleration towards an object, the eyes tend to merge and accommodate, a technical term for eye adjustment.

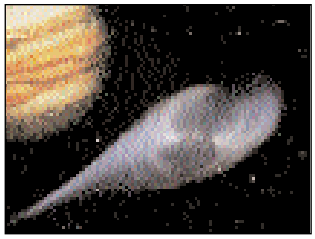
The experiment will eventually move the subject outwards on the arm to study the effects of centrifugation as an antidote to the deleterious effects of microgravity on the astronaut's body.

Applied Technology

Deep space travel has long been the stuff dreams are made of. The vivid imaginations of Gene Rodenberry, Arthur C. Clarke and others, devised creative and complex ways of transporting humans to worlds far, far away. Movies and books may no longer be the only habitat for this fantasy. With recent advances in the study of magnetic propulsion, the imaginary will soon be reality and dreams will come true.

The Mini-Magnetosphere Plasma Propulsion system has been gaining notoriety in the field of astrophysics. With this technology, space bound crafts will blast off Earth with little more than a whisper and travel in the heavens will reach unprecedented speeds.

"The technology seeks to do what



space does -- deploy a magnetized sail to travel with the winds," says University of Washington scientist Robert Winglee, who came up with the idea. Plasma is injected into a magnetic field supported by solenoid coils on the spaceship. The result is a large-scale magnetic bubble that harnesses the ambient energy of the solar wind.

Solar wind travels at 300-800 km/s. At this velocity, the distance between Seattle, WA and Washington, D.C. would be traversed in ten seconds or less. The M2P2 system will allow the vessel to "catch" the wind and travel at nearly equivalent speeds. With this new technology, planets once so far away now seem closer than ever.

Source:
http://www.discover.com/current_issue/index.html

Defying Gravity at New York Hall of Science

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outside the classroom. Dr. Weiss challenged DG participants to imagine an educational, transportable exhibit that would interest, teach and reach the public near and far.

One of the most interesting areas of research in current science events is the exploration of Mars. The DG group discussed what kind of life might exist on the Red Planet. To answer this, Dr. Weiss proposed that the students and teachers consider life in extreme environments here on earth. The most relevant example is bacteria existing at deep-sea hydrothermal vents. The vents exude 110o C water, a temperature several degrees hotter than most life is capable of surviving. However, thermophilic bacteria thrive in these hot temperatures, acting as the primary energy source for larger forms of life existing in friendlier temperatures at the vent edges.

Such life on Earth raises the possibility of life in such extreme conditions in space, such as on one of Jupiter's moons. Space probes sent from earth have detected signs of liquid water existing under miles of surface ice on Europa. The finding suggests a heated moon core and possible hydrothermal vents deep under the ice surface. If conditions permit, it is very possible that bacteria act as a primary energy source for small, or perhaps extensive ecosystems under the planet surface. These possibilities also beg the question of what kind of life might exist on Mars.

DG participants were asked: how would one create an exhibit to display these rare and extreme Earth life forms? Where should it be displayed to be most effective; what content would fill the exhibit; and how might the exhibit truly educate its viewers? As always, these questions were posed in order to elicit thought about improving public science education.

The group originated strong ideas on creating an educational exhibit: confront the issues of the public's prior knowledge, its misconception of the topic and its desire to learn new information; make an exhibit that can be demonstrated in the museum and at home; create fun, safe experiments to be supervised by parents at home; use the museum as a database for comparing simple experimental results; and set educational goals the museum must take into account when preparing a new exhibit.

Not only should these exhibits take these issues into consideration, but they should also be portable, many students and

Drs. Kheck, Gannon and Weiss.

teachers said. People who do not have the means or ability to travel to the museum should have the opportunity to benefit from educational exhibits.

There was also much discussion on the disparity between the AMNH Rose Center and the NY Hall of Science. Dennis Bassin, educator, mentioned that the NYHS is "in the business of provoking thought." Sau Ling Chan commented on the noticeable difference in the age of the target audiences for the two museums.

Overall, the DG members clearly learned just how challenging it is to create an educational museum exhibit.

Next Issue:
Interviews with Drs. Bernard Cohen and Martin Weiss. Updates on curriculum progress. Participant opinions.
Plus... Exciting developments in lab modules, Applied Technology, and more.

Susan L. Wearne, PhD, DG Program Associate

Susan Wearne, PhD is an assistant professor in the Department of Biomathematical Sciences and the Arthur M. Fishberg Center for Neurobiology. Her general research interest is mathematical neuroscience. This involves the use of analytic, geometric and computational techniques in understanding how single neurons interact with networks of neurons produce functionally relevant brain and CNS activity.

Dr. Wearne is uniquely suited for her position as Program Associate for the Defying Gravity research institute at MSSM. She was an integral part of the production of a magazine published by the

Mathematics Department at the University of New South Wales, Australia. The goal was to encourage talented high school students to pursue mathematics by giving them a sample of the kinds of "fascinating questions we address in research mathematics." The publication was a success resulting in the arrival of many new students at the UNSW math department.

Dr. Wearne brings to Defying Gravity her expertise in the field of Biomathematics and her experience in motivating young students to pursue successful careers in science and research.

Q & A with Dr. Steven Moore, DG Scientist Participant

1. How did you become involved in this type of research? When did it occur to you that this was an important field of study?
I was working as a biomedical engineer in the neuro-otology department at Royal Prince Alfred Hospital in Sydney, when someone mentioned how they would like to measure the small torsional eye movements (rotation around the line of sight) which can be used to study the otoliths (the vestibular apparatus which senses gravity). I had previously worked on machine vision applications for industry, so I designed a prototype system to measure these eye movements using a large clunky security camera and a PC in my spare time. I ended up doing a Ph.D. on measuring 3D eye movements with video at Sydney University, and then was offered a job with Dr. Cohen to work as a co-investigator on the Neurolab project. As a result of this experience I proposed my own centrifugation study to NASA which was selected for funding this year. It's hard to say when I thought this line of research was important - I sort of fell into it (although I have always loved the whole idea of space travel).

2. How were you able to compare the results of your centrifuge studies on Earth to results in space?
Our Neurolab experiment was the first to fly a centrifuge on the space shuttle, and the first application of artificial gravity during space flight. The centrifuge we have at

Mt Sinai, which was used for the pre- and post-flight testing of the four astronaut subjects, is functionally identical to the flight centrifuge (the main difference is a weight differential of around 1000 lbs). The rotational stimulus was the same on the ground and inflight - the only difference between the two was the lack of gravity inflight. So, we were able to compare otolith function with and without the constant acceleration of gravity.

3. How long do you think that astronauts would need to "spin" on the centrifuge in order to counter the effects of microgravity? Do they feel sick from the spinning?
That is a difficult question that will need much more research (ideally with some form of centrifuge on the space station to allow longer studies than possible on short duration shuttle flights). Our Neurolab data, which is based on only a small number of subjects, suggests that exposure to 1-g from intermittent centrifugation for periods of 25 min every second day during flight appeared to have a positive effect on maintenance of otolith-ocular reflexes, which are a measure of otolith function.

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Curriculum Development

written with Dennis Bassin

In 1976, in an attempt to improve its educational system, California created the Minimum Competencies, a standard of student learning. At around the same time, other states implemented their own standards; New York created the RCTs; Florida and Georgia, the Expected Learning Outcomes. The result of these efforts was disappointing: Poor and mediocre students showed little or no improvement and good students reported no advantage.

In 1995, the TIMSS (Trends International Math/Science Study) Report gave the United States a poor grade for educational competency. Subsequently, the National Science Education Standards were developed with hopes of raising the bar for American students. In 1996, New York State developed its own state-specific science standards based on its national predecessor.

In 1999, New York City followed with a local effort: the Science Performance Standards. The new guidelines for NYC science and math curricula were connected to the original movement by the shared drive to establish "standards based education."

Conventional educational methods focused on memorization of facts. The new standards stress the importance of understanding science conceptually; of thinking like a scientist.

The Standards are divided among the following concentrations: Physical Science Concepts, Life Sciences, Earth and Space Concepts, as well as Scientific Connections and Applications stress the acquisition of fact-based science knowledge such as understanding the cell, evolution, geochemical cycles, and the fundamental atom. Scientific Thinking, Tools and Technologies, Communication and Scientific Investigation stress the conceptual aspect of comprehensive science education. Cause and effect, analysis, problems and solutions, data representation and controlled experiments are tools in the explication of the theories and methods of scientific investigation.

The NYC standards were created with good intentions, but how do city teachers and others around the nation find the tools with which to teach to these new benchmarks? Part of the answer lies in Defying Gravity, its first phase: 2001: A Space

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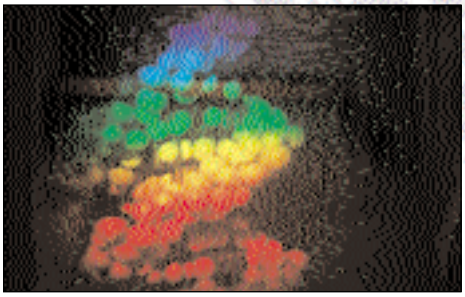
Research Odyssey.

Defying Gravity is an Educational Outreach program funded by the NSBRI with the objective of developing hands-on and inquiry-based curricula to be used in the classroom and on the Internet. Utilizing a cross section of New York City's public school students and teachers, along with the resources of Mount Sinai School of Medicine, the Defying Gravity program enlists the aid of seasoned scientists already in pursuit of space biomedical knowledge to develop new ways of grabbing student's interest and developing their learning skills. Student, teacher and scientist work together in the laboratory to produce a curriculum that highlights NSBRI research at MSSM. Along the way, the methodology most effective in eliciting interest, dedication, and retention of information and conceptual understanding in the student is isolated, analyzed and recorded to facilitate development of an improved science curriculum in the near future. Through the Defying Gravity program, the way students learn is studied and put to work on a larger scale. In the coming months and years, New York City students and teachers may look forward to visits from NSBRI scientists in their classrooms. Ultimately, the new standards for science education in the City and across the nation will be met via methods discovered during direct interface between accomplished scientists and students who are at the beginning of their academic journeys.

Fifteen year-old Fatima is a patient subject.



The NYHS displays 3D chemistry of life.

LAUNCH!

by Jason Schneiderman

I've found a new homepage for my browser and it's www.space.com. Space.com is a web portal about everything related to outer space. Space.com's coverage of current and upcoming space exploration missions, both manned and unmanned is spectacular. The site provides in-depth and current news articles as well as videos, pictures and audio files. I found myself getting sucked into their SpaceTV section for hours, watching footage about everything from the crews of the International Space Station to historical footage of the Apollo program.

Space.com is easy to navigate via the menu on the left side of the page, and is well organized, providing information on a wide variety of topics, from space education in the TeachSpace section to information about the latest in space technology. For the younger crowd, Space.com's SpaceKids provides information in an easy to digest manner for youngsters. Kids of all ages will find the Entertainment and Games sections full of fun, allowing you to quiz your space knowledge, build your own alien creature, or fly a simulated aerial explorer over the surface of Mars. For science fiction buffs, Space.com has recently added a sci-fi section, StarPort, to their site. If you want to outfit your computer with space stuff, Space.com's download section provides you with free wallpapers and screensavers, as well as a mix of free and preview versions of astronomy and other space-related software for your computer.

As the .com in their name suggest, Space.com is run by a private company, Space.com Inc., which other then running Space.com publishes SPACE Illustrated magazine and the astronomy software package Starry Night™. This means that you will have to put up with some advertisements, for both Space.com Inc.'s products, and other outside advertisers, but it's a small price to pay for the wealth of information and entertainment that Space.com provides.

Dr. Moore, Continued from Page 3

4. Do you think it's feasible to counter some/all of the effects of microgravity through your research and the research of others in this field?
That is our goal. The results of our next project, which will compare data from astronauts who have not been centrifuged in space with the Neurolab crew, will hopefully provide some support for this hypothesis.

5. How is your research applicable to people on Earth?
Many people suffer from vestibular-related balance problems, especially the elderly. The NIH has recognized this as a growing concern due to the aging of the general population. Our centrifugation research, coupled with the locomotion studies in our lab, are trying to identify the physiological basis
for normal locomotor and vestibular function, which is crucial for understanding these system when problems occur.

Opinion

After visiting several science museums, I have seen many informative exhibits, but it's too bad I cannot remember any of them. Part of the mission of any museum is that the visitor remembers the exhibits, stores the new knowledge in long-term semantic memory, and is able to refer to it in the future. How can museums achieve this goal most effectively? Well, the exhibit should be hands-on ... and it must be interactive. Everyone has a preference, but pictures and words just don't help me learn. I need to be immersed in the information. One museum exhibit that meets my requirement is The Touch Tunnel at Liberty Science Center in NJ. By being in a one hundred foot long, completely dark tunnel, I can discover just how acute the human sense of touch can be. Simply because the exhibit is interactive doesn't mean it should be limited to young children or the uninformed populous; everyone can enjoy and actively participate in the learning process.

- Clarke Gradinger is a student at Townsend Harris HS.