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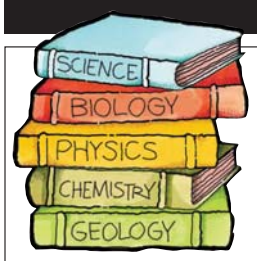

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NEW FRONTIERS IN STEM CELL RESEARCH

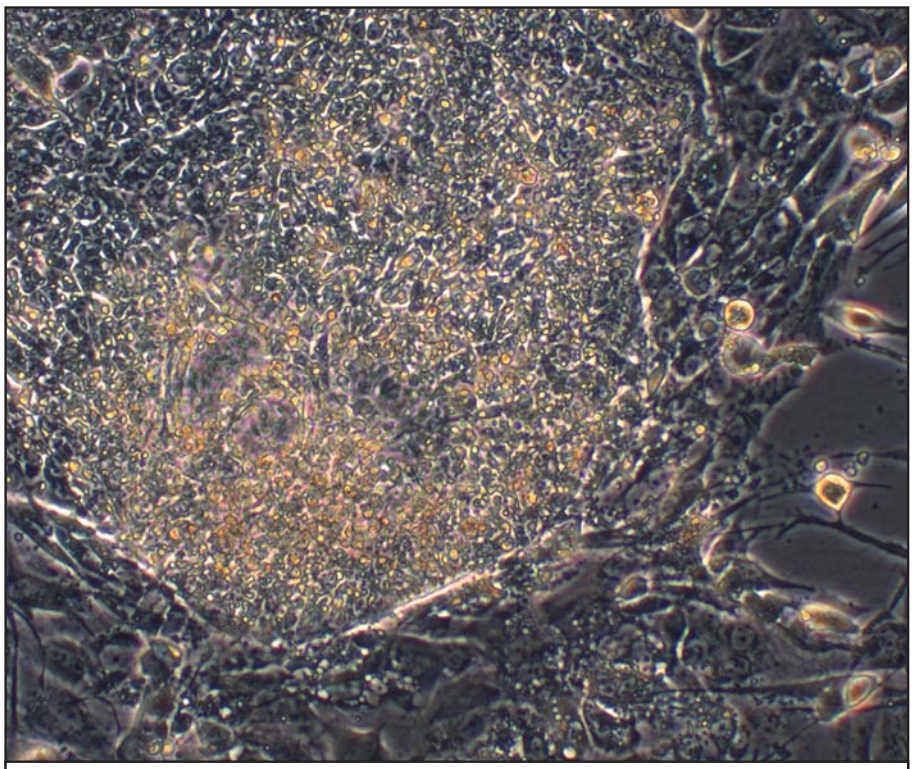


Image courtesy of Dr Ali Hemmati-Brivanlou Ph.D., Rockefeller University. Taken with the Zeiss Axiovert 200 inverted microscope and the AxioCam high resolution digital camera.

By now, everyone has heard of Stem Cell research and the associated debate between the government and the scientific community. There are strong arguments on both sides of the debate and no signs of a compromise in the near future. However, new and promising research that has emerged on the horizon may help to extinguish the debate, or at least offer some middle ground that everyone can be comfortable with.

Stem cells are pluripotent cells, meaning that they possess the ability to differentiate into many different cell types. Although they have the same complement of genes as every other type of human cell, the specific pattern of activity of their genes allows them to morph into whatever type of cell their destiny dictates. As stem cells mature, genes are switched on or off to create the appropriate pattern for the cell to become nerve, muscle, skin or some other specialized cell.

Twenty years ago scientists discovered how to obtain stem cells from mouse embryos. In 1998 after years of detailed study, they discovered how to isolate them from human embryos. Unfortunately, the process of deriving these cells destroys the embryos. This is the basis for the debate over research involving embryonic stem cells with the opponents claiming that life begins at fertilization and that by destroying embryos we are ending a potential human life. Proponents point out that current research uses frozen embryos created at in vitro fertilization clinics and donated for research by couples who do not want to have them destroyed as medical waste. Thus, they were never going to have the opportunity to be implanted into a woman to become a viable pregnancy. Why then wouldn't we use them for research that may some day have the potential to save lives?

Interesting Alternatives

The growing consensus in the scientific community is that stem cells could be made, and that we might be able to make them without using embryos. To achieve this, researchers emphasize that they will need continued access to embryonic stem cells in order to study how they are made inside embryos and possibly learn how to make the cells themselves. But exciting new research on different ways to obtain stem cells without having to use embryos is well on its way.

Adult Stem Cells

Stem cells also reside in some adult tissues such as bone marrow, muscle, and brain. They serve to generate replacement cells to repair damage from wear, injuries or disease. Although they are stem cells, they lack the unrestricted capacity to divide and differentiate that embryonic stem cells posess. Originally discovered in the 1960s, results of detailed, ongoing research has brought them back into the spotlight. Scientists are now finding these cells in more tissues than they had originally thought possible, leading to the hypothesis that they might be useful for transplants. In fact, one type of adult stem cell found in bone marrow has been used in transplants for 30 years. But, the newly discovered locations of stem cells in the adult body may open up more possibilities for these type of treatments. For example, if stem cells already exist in the adult human brain, then logically they would have the potential to be isolated and used to develop methods to repair damage in the brain more effectively than stem cells from the liver.

Amniotic Epithelial Cells

Two researchers at the University of Pittsburgh, Stephen Strom, associate professor of pathology, and Dr. Yoshio Miki, instructor in the pathology department, recently announced that they have discovered that the human placenta contains one type of cell that seems to be very similar to embryonic stem cells. These cells could have the potential to create pancreatic, liver, or nerve cells that could be used to treat things such as diabetes, liver failure, and Parkinson's disease.

The amnion is a thin sac made up of amniotic epithelial cells that contains the fetus and amniotic fluid during pregnancy. Scientists have known for some time that this membrane was rich in stem cells and have been using it as a type of bandage to aid healing after eye surgery. This is why Miki and Strom began to study the cells as a possible source of liver cells (hepatocytes) to use as alternative treatments for liver disease. When they found that they could indeed be used to create liver cells, they began to explore what else the cells could do and found that they are similar to embryonic stem cells in almost every way.

Amniotic Epithelial cells can be extracted from placentas, which are typically discarded after birth, eliminating the need for an embryo. Pitt's researchers also say that an added advantage is that these cells don't cause the tumors that have been found to be associated with embryonic stem cells.

Tricking Eggs

Dr. Robert P. Lanza, Vice President of Medical and Scientific Development at Advance Cell Technologies, and his group are studing a process for placing unfertilized human eggs in certain environmental conditions that would lead the egg to behave as if it were in fact fertilized. Thus, the egg would begin to divide and create embryonic stem cells. This raises some of its own ethical questions such as: Where are the eggs going to come from? Would women be able to sell their eggs? Can we really assign a value to human eggs? Lanza believes that egg donation is a viable source of eggs and says that he already receives many offers from women wishing to donate their eggs for research.

Teratoma

William Hurlbut, a bioethicist from Sanford, is promoting one of the most bizarre alternatives being examined. A teratoma is a naturally occurring tumor that arises from an egg or sperm cell. It produces stem cells but does not have the appropriate gene activity to develop into a human being. Hurlbut believes that cloned embryos could be genetically altered so that, like a teratoma, they would not have the DNA needed to fully develop into a human. They would begin their growth normally and produce stem cells but when a critical component such as a placenta didn't arise, they would die.

Janet Rossant at the University of Toronto has already achieved something like this using mouse embryos. She created embryos with DNA lacking the gene needed to form the outer membrane on the early form of the embryo. She was able to extract stem cells before the embryo reached the critical stage at which the failure of the membrane to form caused it to die. Critics point out that the stem cells collected would then need to be genetically re-altered to replace the gene that was knocked out. But, many scientists say, although extremely complex, it is possible.

Looking to the Future

Not everyone is thrilled about the alternative theories that are emerging. Many scientists fear that these projects will draw federal funding away from embryonic stem cell research. They feel that the funding should be concentrated on the research that has shown the most promising results, and that to divert money to look into alternative sources of stem cells will delay treatments that might be discovered through further work with embryonic stem cell lines.

The scientists performing the research into alternatives fire back that not only is their research a logical progression into the world of stem cell manipulation, it might also hold promise to extinguish the ethical debate if something just as good, or better than embryonic stem cells, is discovered.

1910–1985

PROFILE: VIVIEN THEODORE THOMAS

As the son of a carpenter, just before the Great Depression and in a time of segregation, Vivien Thomas was embraced by the American dream. His determination and talents led him to follow his heart, to become a doctor, and to revolutionize operating procedures involved in heart surgery.

Born in New Iberia, Louisiana on August 29, 1910, Thomas' family moved to Nashville while he was still a young boy. After graduating with honors from one of the nation's top high schools, Vivien went to work and saved enough money to enroll as a pre-med student at Tennessee Agricultural and Industrial College in 1929. Then, tragedy struck! The financial disaster in the fall of 1929 wiped out Thomas' entire life's savings and he was forced to withdraw from school.

In 1930, he took a position working for Dr. Alfred Blalock as a surgical assistant at Vanderbilt University Medical School. While his goals may have still included medical school, the Depression worsened and Thomas concentrated on the work at hand, putting in long hours in the laboratory. He was working to advance Blalock's theories on blood pressure and shock. Blalock was occupied with other obligations and spent less time in the laboratory, relying heavily upon Thomas to perform the complicated experimental surgical procedures and chemical determinations and then record the results.

To aid the surgical procedures they were developing, Thomas and Blalock developed new techniques and equipment that would allow them to apply varying amounts of pressure to the pulmonary artery. Blalock also did pioneering work on the nature and treatment of hemorrhagic and traumatic shock. His work demonstrated that surgical shock resulted primarily from loss of blood. He suggested that plasma or whole blood transfusions administered following the onset of shock would help to stabilize patients and prevent further deterioration. The impact of this discovery saved countless lives in military hospitals during World War II.

In 1941, Blalock was offered the position of Chief of Surgery at Johns Hopkins. He asked Thomas to join his team in Baltimore. In a time when segregation was the norm, this proposal caused a minor controversy yet demonstrated the respect Thomas had earned from his mentor. At Johns Hopkins, they began working with pediatric cardiologist Helen Taussig to combine their shock research and her theories for correcting a congenital heart defect known as tetralogy of Fallot. Commonly called "blue baby syndrome," the condition was usually fatal for babies and young children.

To test their theories, they had to create a similar condition in dogs and then try to correct it using the techniques they had developed for heart surgery. The treatment was perfected on a terrier mutt named Anna whose portrait now hangs in the halls of Johns Hopkins as the only canine thus honored for her contributions to human health.

In his role as surgical assistant, Thomas had actually performed the procedures on their canine subjects more often than Blalock and had fine-tuned them during his laboratory trials. So, it was only natural that in 1944 when Blalock first attempted the surgery on a human child, Thomas was right behind him assisting him and making suggestions as the surgery progressed.

Thomas' role shifted to include teaching and advising medical students, and for over 35 years he supervised the surgical laboratories at Johns Hopkins. In 1976, he was presented with the Honorary Doctor of Laws by John Hopkins University and was named instructor of surgeries. Upon his retirement in 1979, Thomas became instructor emeritus of surgery. In retirement, Thomas began work on an autobiography, Partners of the Heart: Vivien Thomas and His Work with Alfred Blalock (ISBN 0812216342). He died in 1985 at the age of 75 and his book was published just days later.

THE GLOBAL CONCERN FOR ENVIRONMENTAL ISSUES

Environmental ambassadors from the US with students from the Chuanfangyu School in Tianjin

Three years ago, the United States Federal Environmental Protection Agency and the Tianjin Environmental Protection Bureau in China started collaborating to assess and improve management of Tianjin's principal source of drinking water, the Yuqiao Reservoir.

This past March, science teachers from Galileo Academy in San Francisco, Matsunaga Elementary School in Maryland, as well as representatives from Galileo's community partners traveled to Tianjin, China. They met with students, teachers, and community leaders in order to establish communications about environmental issues and culture.

They translated environmental information from LaMotte products (at right) into Mandarin in order to provide the students more hands-on activities. Future plans include working toward a high-speed Internet connection in order for students to directly communicate and share pictures.

Richard McDowell from the Galileo Academy of Science and Technology was kind enough to answer a few questions about their trip. For the complete interview, visit the literature section of **www.fisheredu.com.**

Q: What was your most surprising discovery?

A: I was amazed to find that the Chuanfangyu School has thematically integrated environmental science into each of their subjects. They have really taken integrated curriculum to heart. Culturally, it is very difficult to do this in the West.

Q: What seemed to be the most surprising discovery for the students?

A: We brought pictures of our students doing science to share with the students in China. The students in China were amazed. Unlike China, we have a very diverse student population. Not to mention the difference in the attire. I hope I didn't start a baggy pants trend.

Q: Can the watershed be saved?

A: Culturally, it is difficult to keep focused on environmental issues if there is not a heritage of environmentalism or environmental activism. Including the support of a school with an environmental focus in the restoration process is a great first step—very progressive.

Q: Did the students understand what has led to the current conditions of the watershed?

A: They were very proud to be able to answer our questions about the reservoir. They knew that excess nutrients from factory farms, human waste and old discarded batteries were hurting the reservoir. You can tell they were very enthusiastic to tell us about the tree planting they do each year in the watershed. I believe they are the generation that will really make a difference in the environment.

THE REASONS FOR THE SEASONS

The Myth

The Earth changes seasons because it travels around the sun.

Origin

With Johannes Kepler's discovery of planetary motion in 1609, scientists came to understand that the Earth travels in an elliptical orbit. Unfortunately, many people use this understanding to relate the changing of the seasons to the proximity of the planet to the sun.

Using this model, everyone on the planet would have days that are exactly 12 hours of light and 12 hours of darkness. This would sustain weather similar to what we see in the spring and fall all year long.

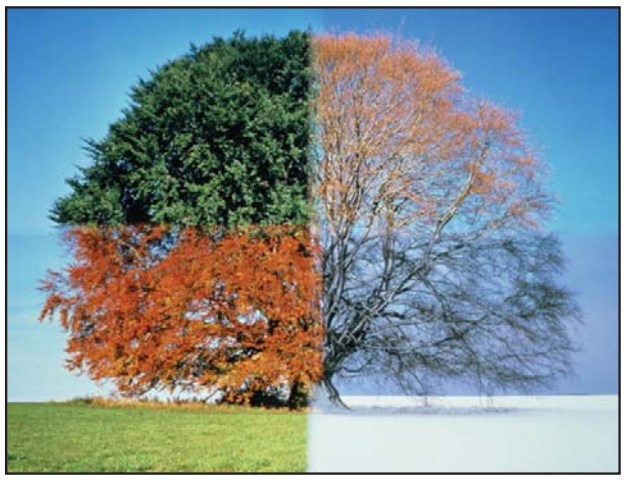
The Truth of the Matter

The Earth's trip around the sun would mean nothing if it wasn't for the axial tilt, also known as obliquity. Imagine an invisible line that passes through the center of the Earth connecting the North and South poles. This imaginary line is the axis, which the Earth spins completely around every 24 hours.

If this line were perpendicular to the plane of the solar system, we would have 12 hours of Sunlight every day as described above. However, the axis is tilted at 23.45°.

Throughout the course of the year, the axis remains tilted in the same direction. Therefore, when the Earth orbits the sun, the Northern and Southern hemispheres receive different amounts of sunlight.

When the Northern hemisphere is tilted toward the sun, we have long hours of direct sunlight,



the average daily temperature is higher, and we experience summer. At the same time, the southern hemisphere is receiving less than 12 hours of indirect light. This leads to cooler temperatures, also known as winter.

There are three bands of latitude that are very significant in relation to the seasons. In the middle of the planet, there is the equator that divides the Northern and Southern hemispheres. When the sun is directly overhead of the equator, we mark the fall or spring equinox. On those days, we actually do receive exactly 12 hours of day and night.

The Tropic of Cancer and the Tropic of Capricorn are each at a latitude of 23.5°. The Tropic of Cancer is in the Northern hemisphere and Capricorn is in the Southern. When the sun is aligned with these latitudes we recognize the effect as the summer or winter solstices. These days are marked as the longest or shortest days of the year.

The area of the planet between these two lines of latitude does not experience the same changing of the seasons that most of us experience. Their climate is very consistent all year long thanks to the fairly consistent tilt of our planet.

Coming Off Tilt

Our planet's obliquity is currently decreasing. Scientific evidence has suggested that the axis fluctuates between 21.5° and 24.5° every 41,000 years. At a rate of less than one ten-thousandth of a degree per year, there is little chance of any one person noticing these changes during their lifetime.

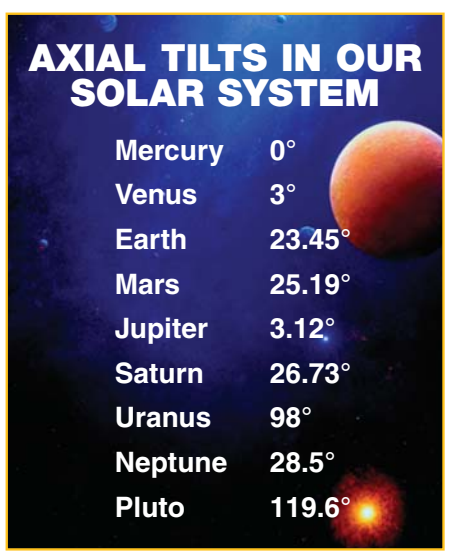
In August 2003, researchers at Penn State University simulated a variety of axial tilts in our current orbit. They tested their theories using an identical Earth as well as an imaginary planet with a different configuration of landmass than that which is seen on Earth. They compared tilts of 23, 54, 70, and 85 degrees. While their discoveries determined that life would be possible at these higher degrees, the extreme temperature fluctuations would only support simple forms of water-dependent life.

The moon's gravitational pull helps to stabilize Earth's obliquity and create the small degree of change in tilt. Without the moon, life may have never been able to develop past simple organisms. It is believed that Earth has the most stable axial tilt of all the planets in our solar system.

The Earth is much like a spinning gyroscope without gravity or air resistance to slow it down. Instead we have both the sun and the moon contributing gravitational pull and adding torque to our orbit. Add that to the fact that our planet is not a perfect sphere—we are a little wider in the middle than at the poles—and it means that our planet's orbit is affected by gyroscopic precession.

Like a toy top, our axis "wobbles" in the opposite direction of the planet's rotation. Imagine the toy top on a table. While the body is rotating too quickly to discern, the axis can be seen forming a cone-like illusion as it wobbles slightly off center.

Currently, the northern point of our axis faces away from the sun when we are in the closest orbit. This means that the Northern hemisphere experiences winter when it is closest to the sun. As the axis wobbles, we will eventually experience spring at that same point of the orbit. Every 25,800 years the seasons will complete one rotation through this Precession of the Equinoxes.



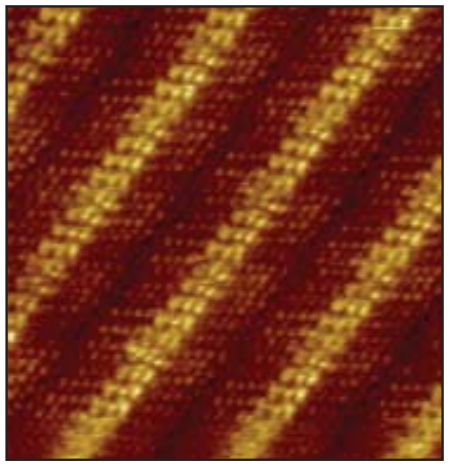


Image courtesy of Image Metrology, ApS

NANOSOCIETY

Nanotechnology Emerges

Flying in the face of gluttonous societies that clamor for bigger and better, many scientists are committed to creating techniques to improve things on a microscopic scale. Nanoscience is the study of theoretical manufacturing technology at the molecular level. The associated technology—nanotechnology—develops machinery that performs tasks too small for current technology to achieve. In basic terms, nanotechnology involves arranging atoms in such a way as to create machines at a nanometer scale. To lend some perspective of just how small this is, a nanometer is one thousandth of a micrometer—or one millionth of a millimeter.

There are two concepts associated with nanotechnology that will determine the usefulness and economic impact its products will have. They are positional assembly and self-replication.

Positional assembly focuses on the actual mechanics of moving a molecular particle to the correct relational place and then keeping it in place. It has been suggested as a technique to build molecular scale systems, devices and objects using molecular robots in an automated process that provides programmed paths for carrying out the construction process.

To expand on the scope of those processes, self-replication seeks ways of multiplying those positional arrangements in an automated fashion by having the devices create copies of themselves. It actually examines these challenges in two successive phases, both in the process of building a manufacturing device and again as the device manufactures a final product with a specific application.

Smaller is better

The most significant advances influenced by nanotechnology will almost certainly be seen in the computer industry which is always striving to create smaller and more powerful computing technology. Nanotechnology engineers could make massive computing systems that fit into smaller packages. For example, instead of a palm-sized PDA, imagine processing all of your tasks in a system the size of a ring.

Scientists are now exploring technologies that would create circuits on chips by placing one atom at a time to replace the etching process that is currently used. These devices would be much smaller since there would be no surplus material. Only particles with a purpose would be added to the chip. As a result, electrical conductors, called nanowires, would be only one atom thick and a data bit might be represented by a single electron. Large PCs would become a thing of the past and even our slimmest present-day laptop would seem impractical.

Nanotechnology not only plays a crucial role in the development of ever-more-powerful computing and communications systems, but they are also being used in more fascinating (and perilous) applications in medical science. Scientists are interested in employing nanorobots to act as programmable antibodies that seek out and destroy disease-causing bacteria and viruses that have mutated into drug-resistant variations. Theoretically, they could also be programmed to single out and kill cancer cells or even to clear blockages and repair tissue damage. As a research tool, they could be sent to remote regions in the brain to potentially unlock the secrets modern medicine has yet to unravel.

The Tools

Nanotechnology utilizes many techniques used to create structures at a size scale below 100nm. This wide variety of tools includes those used for fabrication of nanotubes and nanowires, those used in semiconductor fabrication such as deep ultraviolet lithography, electron beam lithography, focused ion beam machining, atomic layer deposition, molecular vapor deposition, and molecular self-assembly techniques.

Nanotechnology also uses atomic force and scanning tunneling microscopes to survey surfaces and move atoms around. By designing different tips for these microscopes, they can be used for carving out structures on surfaces and to help guide self-assembling structures. Atoms themselves can be moved with scanning probe microscopy techniques, but this technique remains somewhat time-consuming and is not very cost effective.

The Fears

It is believed the economic and societal impacts of nanotechnology breakthroughs may be more sweeping than those of the Industrial Revolution—but in a time span of only a few years. The potential for a rapidly introduced revolutionary technology to disrupt society and politics has been clearly demonstrated by steam engines, electricity, and railroads.

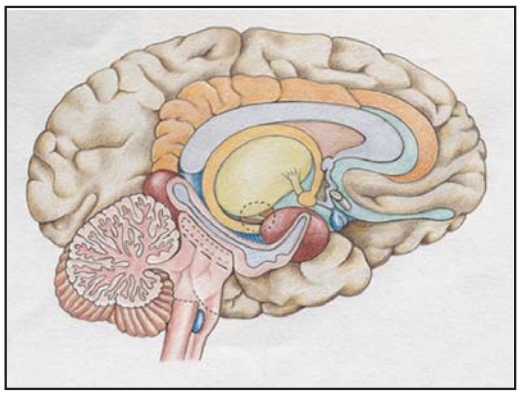
Critics of nanotechnology believe that it could possibly lead to such global problems as severe economic upheaval due to the availability of cheap manufacturing and the duplication of designs. Environmental damage is also a concern as the overuse of inexpensive products creates large quantities of waste. The armed forces would suddenly have many small, powerful weapons and surveillance devices at their disposal. Some theorize it could even spark an unstable arms race between two opposing nations.

For the near-term, critics are stressing the toxic potential of nanosubstances that could undermine the stability of cell walls or alter the immune system if airborne nanosubstances were inhaled or digested. They point to history and the unfortunate slow realization that inhaling substances such as carbon soot and asbestos fibers contaminated the lungs with often fatal consequences. They are also challenging scientists to provide proof that nanosubstances implanted as treatment for disease will do their jobs while remaining benign within the body. The full scope of how the human body would react to a nanoscale invader is still very much unknown.

How close are we?

On March 1, 2005 **News.com** reported that Intel was preparing to introduce processors with features measuring 65 nanometers. Intel has also provided photos of transistor prototypes measuring as little as 22 nanometers and spoke optimistically about the future for new processors measuring as little as 5 nanometers. While these developments may cause some critics to shudder with a sense of foreboding, most scientists involved in nanotechnology research are confident that the world's societies will weather the storm of nanotechnology and come out ahead.

PARASITE PUPPETEERS



The Flexible Parasite

In biology, a parasite is defined as a plant or animal that lives on or within another organism, and from which it derives sustenance or protection. Scientists generally view parasites as organisms that survive solely because a host provides them with food and shelter and which give nothing in return.

Beneath this simple definition, however, lies a world that is both ancient and complex. In the hundreds of millions of years it has taken for life to evolve and differentiate, parasites have developed their own complex world of specialization.

Thus, there are both plant and animal parasites that simply survive because they've evolved ways to co-exist with any available host. Yet others thrive by living off parasites themselves. And a few parasitic species have given up some of their purely parasitic aims for a kind of symbiotic relationship in which both parasite and host have evolved ways from which both benefit.

Perhaps strangest of all are the parasitic species that have found ways to live out their lives in quiet seclusion by effectively managing their host's behavior. In effect, they have learned how to adapt their host's activities to suit their own needs. Doing their job of camouflaging their presence so well that they might inhabit our bodies, even in our cells, without our sensing we're harboring unwelcome guests. This kind of parasitic invasion might be termed the "Passive Aggressor."

Brain Appeal

This is exactly the situation that may occur in the brain. Parasites can take advantage of the structures the brain has evolved that prevent the immune system's defenses from operating, at least in the early stages of infection. Add to that the presence of plentiful supplies of nutrients and oxygen, and the brain would appear to offer an attractive shelter for parasites.

One in particular can be very worrisome. Infecting some 50 million people worldwide, the tapeworm is normally associated with parasitic activities in the intestine. Carried into the digestive system of people who eat undercooked pork, the tapeworm attaches itself to the wall of the intestine and while growing to several feet in length, happily encourages its perpetually hungry host to constantly eat and thereby feed both organisms.

On occasion the tapeworm larva will change future homes, foregoing the easy sanctuary of the intestine for even more lucrative climes. Entering the blood stream for a ride, the tapeworm larva will eventually travel to the brain. Here it will lodge in the brain cavities, quietly absorbing the nutrients that pass through the brain's system. Its purpose is to live unmolested, encouraging the host to accept its presence, while feeding and sheltering it without resistance. The secret rests with the parasite's ability to feed and grow at such a low level of activity that it remains invisible to the brain's radar.

Yet when a parasite lodged in the brain is identified by the body's immune system, the resultant warfare can cause enormous and often irreparable damage, which is why the tapeworm is now considered one of the leading causes of brain seizures.

The Nasty Virus

Virus invasions are more predatory. When viruses come into contact with host cells, they attach themselves to a cell's membrane with the purpose of releasing their DNA into the cell. Once inside a host cell, viruses take over its machinery to reproduce. Viruses override the host cell's normal functioning with their own set of instructions that shut down production of host proteins and direct the cell to produce viral proteins to make new virus particles. Some viruses insert their genetic material into the host cell's DNA, where they begin directing the copying of their genes or simply lie dormant for years or a lifetime.

Among the smallest of all organisms, parasitic viruses have the useful ability of being able to invade other parasites and commonly take shelter in various species of bacteria. Sometimes viruses act like Dr. Frankenstein, changing a host's behavior so dramatically they can turn normally docile hosts into epidemic disease carriers. Thus, *Vibrio cholerae*, the bacterium that causes cholera, is harmless in itself. The disease-causing toxin that causes illness is actually made by a virus that at some point smuggled itself into its host's genome.

Symbiotic Relationships

On the other hand, parasites can often change their host's behavior simply by making their presence felt. This is the case with a bacterial parasite that inhabits the body of a squid. During the day the bobtailed squid, *Euprymna scolopes*, remains buried in the sand of shallow reef flats. As the sun sets, the nocturnal animal emerges from its safe hiding place and searches for food.

On a moonlit night, the squid would appear as a dark silhouette and would be easily detected by predatory fish from below. It is thought that the squid camouflages itself by projecting light downward from its light organ. Inside the light organ are luminescent bacteria, *Vibrio fischeri*, that produce the light.

This is an example of how a purely parasitic-host relationship has evolved over hundreds of millions of years into what researchers call a symbiotic relationship. The bacteria require a safe and sheltered environment and a constant source of nutrients, the host needs a means to feed and protect itself from predators, both of which are provided by light-emitting bacteria. All the parasite needs do in this case is to encourage the host to feed at night, when its light-emitting properties could be used to best effect.

Another example of symbiosis evolving out of pure parasitism involves aphids, which are plant pests, capable of causing major agricultural damage. They feed on plants, resulting in a diet that is rich in carbohydrates and deficient in amino acids. The amino acids that cannot be synthesized by the insect itself are supplied by intracellular organisms dwelling in the aphids called *Buchnera aphidicola*. The interaction of the two partners dates back 150 to 250 million years and both have become so dependent on each other that they cannot exist separately.

The word "parasite" alone conjures up images of repulsive blood-sucking invaders. And, although some live up to that stereotypic image, not all parasites deserve the bad rap.

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tools for teaching

UNDERSTANDING THE AMAZING BRAIN

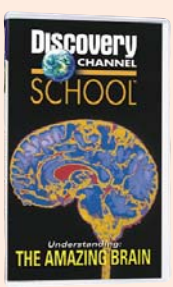
What's in your noggin? For years the brain was a mystery. But doctors and scientists are now using sophisticated technology to unlock those secrets. They're discovering amazing information about the neural connections that shape our personalities and make thinking possible. Understanding The Amazing Brain gives students a comprehensive look at how the brain works differently at different stages in our lives, how the functioning of a normal brain can be disrupted, and the medical technology physicians use to get a better look inside the brain.

MATERIALS:

- Understanding: The Amazing Brain DVD **(HS60470)** and DVD player
- A simple circuit with a light bulb or bell (Fisher Basic Circuits Kit **HS63323**)
- Resource materials on the brain and its different parts (Anatomical Chart, The Brain **HS24216PL**)
- Computer with Internet access

PROCEDURES:

1) Set up a simple circuit where all students can see it but do not connect the final wire that completes the circuit.
2) Have students watch as you connect the last wire to make the light shine. Explain that electrical impulses are traveling through the wires.
3) Ask students to compare this action with the workings of the human brain. Lead them to understand that electrical impulses travel through neural pathways, resulting in a thought or action.
4) Have students research how the brain works, the different parts of the brain, the function of each, and how the different parts interrelate and communicate. After they have completed their research, have them make a diagram of the human brain, labeling the different parts, and then write a short report summarizing the function and interactions between the parts.
5) Direct students to helpful resources on the human brain and allow them to share their information and discuss the implications behind their findings. The following Web sites will provide a good starting point:
   - BBC: Human Brain Map **http://www.bbc.co.uk/science/humanbody/body/interactives/organs/brainmap/**
   - PBS: The Secret Life of the Brain **http://www.pbs.org/wnet/brain/**



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Discovery SCHOOL

NEW LIGHT SHED ON FORENSIC SCIENCE

Forensic science has been one of the hottest news topics since the O.J. Simpson trial. Not a week goes by that there isn't some report of a criminal being convicted, or an innocent person being exonerated, through the analysis of DNA extracted from trace evidence. Scientists are able to determine the likelihood that a person was involved in a crime using detailed analysis of things as small as a single strand of hair or drop of blood.

However, what we don't always hear about is the technology that is used to make these determinations. Samples are run through a variety of instrumentation that can do everything from identifying a genetic code to matching fingerprints with those on file in a huge national database. One of the tools scientists use, Fourier Transform Infrared (FTIR) spectroscopy, is able to identify unknown samples or reveal the origins of known samples by determining the chemical functional groups in a sample and comparing them to electronic libraries of known "molecular fingerprints."

Compound Identification

FTIR spectroscopy is a common spectroscopic technique that is used by both organic and inorganic chemists. The power of infrared spectroscopy lies in the ability of infrared photons to couple directly to the specific vibrational modes of molecules. Using an instrument called a spectrophotometer, scientists are able to position a sample in the path of an infrared beam and then measure what wavelengths of the beam are absorbed by the sample. This allows them to determine what chemical functional groups are present in the sample.

Scientists are then able to identify the test substance by comparing its absorption spectrum to that of a known substance. In some cases where an exact match is not found, the spectra that are most closely related can be examined to help make the determination or to guide further testing. Computerized programs with searching capabilities aid the matching process. There are many reference spectra libraries available in electronic format for vapor and condensed phases, with many of them organized according to application areas such as Forensics. These results, combined with data from other testing procedures such as mass spectrometry, can yield a positive or near-positive substance identification.

FTIR spectroscopy is routinely used to study a variety of samples, including crops, soil, thin films, powders and biological materials. Forensic scientists are finding it useful for analyzing fibers and paint chips found at crime scenes, drugs in a victim's system, and the presence of explosives in trace amounts. Unfortunately, if the amount of sample being investigated is very small, as is typically the case with crime scenes, it is difficult to measure its infrared spectrum. The advent of infrared microspectroscopy (IMS) has helped to solve this problem and make identification of amazingly small amounts of material possible.

IMS combines two techniques, spectroscopy and microscopy, into one instrument that uses both visible and infrared light. Morphological inspections of the sample are made first to identify areas of interest that can be as narrow as 5µm. Then, a broad-spectrum IR analysis of that area is done to further classify the area by providing the IR spectrum. This combination of techniques has recently allowed scientists to derive the IR spectra for living cells in the process of mitosis and even for individual cellular structures, something that was impossible just a decade ago.

Reflectance, transmission, and grazing-incidence IR spectrum can often be obtained with minimal sample preparation. These techniques are also nondestructive; an important advantage for testing forensic samples as there is often only a small amount of material available for running multiple tests.

Combining IMS with an IR source called a synchrotron has advanced the IMS technique even farther by providing an IR source that is 1000 times greater than the best-known source. The synchrotron at Brookhaven National Laboratory in Upton, NY has powerful electromagnets that emit an intense, broad-spectrum photon burst. This pulse is emitted from an extremely small opening and applies light energy to an area that is about $25\mu m^2$. This intense IR source is still nondestructive and safe for use with organic material and even living tissue.

Valuable Witness

Forensics is definitely a driving force in the development of IMS and new synchrotron light sources. The technique has had stunning success and has established itself as a valuable tool for every forensics laboratory.

In one case, a woman was abducted on her way to work and murdered. The suspect in the case was seen sitting next to a fire under a bridge near the lake where the victim's body was found floating. Investigators recovered a small piece of cloth from the fire site and through the use of IMS, the FBI was able to confirm the similarities between the cloth and the company T-shirt the woman wore for her job. This analysis was a crucial piece of evidence used to convict the suspect.

Another case involved a policeman who was shot while wearing a protective Kevlar vest. A bullet was recovered from the scene and IMS revealed a thin layer of Kevlar on its tip. This irrevocably connected the suspect, bullet and victim, leading to a conviction in the case.

Perhaps the biggest news in IMS technology is the development of smaller, portable units with onboard digital libraries of IR spectra. Theoretically, these new instruments could be used in the field and would eliminate the risk of contaminating a sample during transportation.

More to Come

FTIR spectroscopy and IMS are truly impressive adaptations of decades-old techniques for use in exciting new applications. The ability to relate the morphology and chemistry of a sample to reveal its identity is unarguably a valuable tool for forensic science and law enforcement. As these technologies continue to grow we will almost certainly hear more about them and how they are used to solve forensic puzzles, thwarting even the best attempts by criminals to cover their tracks.

FORENSICS

MATERIALS:

– Baking soda – Water
– Cornstarch – Vinegar

BACKGROUND:

A world-famous restaurant has been ransacked—flour and baking soda were everywhere! The police have narrowed the suspects down to two people. At each person's house, a different unknown powdery substance was discovered.

PROCEDURE:

1. Before class, put baking soda in a plain container labeled "From Suspect 1" and cornstarch in a container called "From Suspect 2."
2. Working in small groups or pairs, have students "collect" four tablespoons of each substance and note the color, texture, and odor.
3. Be sure to instruct the students to waft the odor and to not taste either sample! Remind them that when dealing with an unknown substance, scientists exercise caution as a general rule.
4. Using a small cup of water, have students mix half of Substance 1 and record what happens.
5. In a separate cup of water, mix half of Substance 2 and record.
6. With the remaining halves, repeat steps 4-5 using cups of vinegar.
7. Using an overhead projector, display and discuss the charts displayed here.
8. Students compare their results with the overhead to determine that Suspect 1 is responsible.

CHARTS:

PHYSICAL PROPERTIES OF THREE MATERIALS

Substance	When mixed with water
Sugar	Dissolves; liquid is clear
Baking Soda	Dissolves; liquid is clear
Cornstarch	Does not dissolve; liquid is milky

CHEMICAL PROPERTIES OF THREE MATERIALS

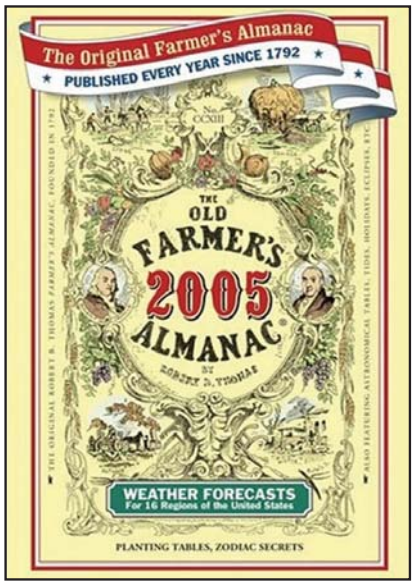
Substance	When mixed with water
Sugar	Dissolves
Baking Soda	Dissolves; makes fizzing noises
Cornstarch	Does not dissolve; liquid is cloudy

Cat No: HS68380 **Price: 119.95**

Discovery School Forensic Essentials Pack includes multimedia activities and information to help teach forensics.

Discovery SCHOOL

HOW 'BOUT THAT WEATHER?



Families talk about the weather during dinner. Co-workers discuss it over cubicle walls. Strangers use it to stir up conversation in elevators. Weather affects how, when, and where we travel; what we wear; and how we feel.

Folklore and Natural Predictors

There are hundreds of proverbs, myths, and folklore in weather forecasting. Here are a just few examples...

The Old Farmer's Almanac. Since 1792, the Almanac has been giving wise words of weather. Founder Robert B. Thomas thought that sunspots influenced the Earth's weather, and he used a series of natural cycles to develop a secret formula for weather prediction.

Animal Behavior. Many people believe that animals' conduct or appearance are good indications of what weather is to come. An old German tradition states that if the sun makes an appearance on Candlemas Day, the mid-point between the Winter Solstice and the Spring Equinox, a hibernating animal would emerge and cast a shadow, thus predicting six more weeks of winter. German settlers brought this tradition to the new world with them and it is still observed every February 2 on Groundhog Day.

Some believe that a drop in barometric pressure affects the digestive system of cattle, making them prefer to lie down instead of grazing before a storm hits. Even the wooly bear caterpillar with its black and brown stripes is believed to be a prognosticator. According to the myth, if the brown stripe is narrow, then expect a wild winter.

Red skies. As the saying goes, "Red sky at night, sailor's delight; red sky in the morning, sailor take warning." Nick Walker from The Weather Channel notes that during a clear western sky, the sunset shines through much more of the lower atmosphere, which contains particles that disperse the shorter wavelengths of light (violets and blues), but allow the longer wavelengths (oranges and reds) to pass through. The sinking air of a high-pressure system holds contaminants near the Earth, making the sunset more red than usual. Conversely, if the sky is red in the eastern morning sky, then the high-pressure system has most likely already passed from west to the east and an area of low pressure may follow. High-pressure systems usually bring fair weather while low-pressure systems usually brings clouds, rain or storms.

Early Forecasting to the Masses

The Surgeon General of the Army started to gather weather reports in 1814. The Army Signal Service Corps created the first official national weather network in 1870 and began to publish forecasts on February 19, 1871. During the 1900s, the Signal Service changed its name to the Weather Bureau and then to the National Weather Service. Daily forecasts didn't enter homes until 1936 when the BBC offered text-only information. In 1941, a New York TV station featured the first weathercaster.

From Low to High Tech

While early forecasters used rain gauges, anemometers, thermometers, barometers, and hygrometers, modern meteorologists have more high-tech instruments at their disposal. Doppler radar determines wind speed by gauging the speed at which precipitation is moving horizontally toward or away from the radar antenna. Geostationary satellites orbit at the same rate that the Earth spins and provide meteorologists with valuable information about the development, movement, and dissipation of weather fronts.

Polar orbiting satellites pass over the North and South poles on each orbit and photograph the entire surface of the Earth every 12 hours. The result of all this technology is that your daily forecast is now a highly researched report that consists of readings from many different instruments.

How reliable are forecasts...really?

Nature never behaves perfectly; weather can change drastically in a matter of moments. We can only present an estimation as to what weather hazards may occur during a certain period in a general area. Equipped with the appropriate weather jargon, even you can become a top-notch prognosticator. Dust off your rain gauge, hang your thermometer, and study Doppler radar online. You'll be able to impress your family, friends, and co-workers with your weather knowledge!

tools for teaching

WONDERS OF WEATHER

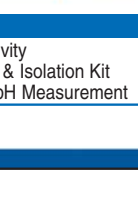
The weather is a constant source of amazement, amusement, and wonder. From the jet stream to the Gulf Stream, discover where the weather comes from and why.

MATERIALS:

- Wonders of Weather video **(HS90471)**
- Liquid detergent
- Food coloring
- Small plastic objects

PROCEDURE

1. Watch video to inform students about tornadoes
2. Each group fills a bottle to one inch from the top
3. Add one tsp. of salt and shake until dissolved
4. Add one drop each of liquid detergent and food coloring
5. Cover and swirl bottle, compare visualization to storm conditions
6. Add small object to bottle and repeat step 5
7. Discuss the relationship between their bottle tornado and a real tornado



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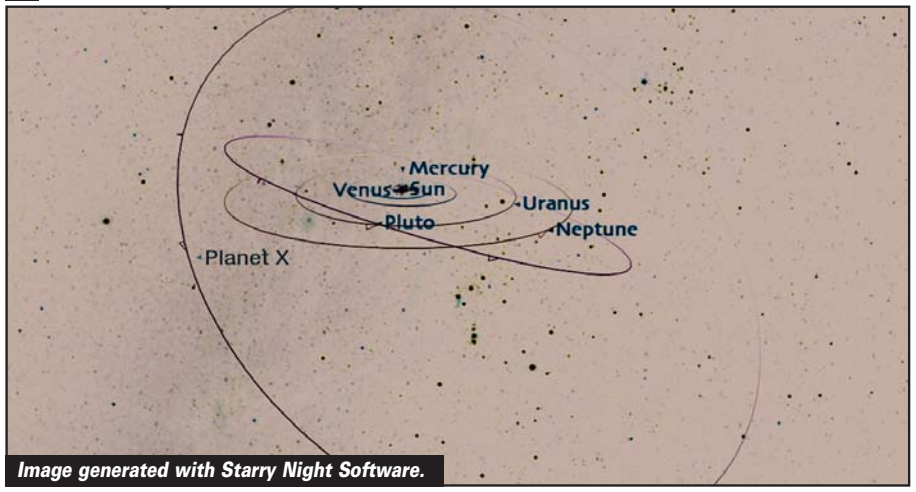

Image generated with Starry Night Software.

ON BEYOND PLUTO—*Report #1*

This series of reports will describe astonishing new discoveries in planetary science—within our Solar System and far beyond. The series comes from IMAGINOVA, makers of Starry Night software and Orion telescopes and binoculars, as well as the wesites **SPACE.com** and **LiveScience.com.**

The New View

One of the coolest things about science is that, every so often, what we thought we "knew" has to be completely overhauled. You can really feel just such an upheaval right now in the branch of astrophysics known as planetary science. So great is this tide of change that even the word "planet" itself is rapidly and radically coming to mean something very different. It's truly a revolution.

In the past decade, the number of "planets" detected has jumped from nine to more than 150, and most of them orbit other stars. Latest, and most surprising, is the discovery of Planet X; what NASA initially called the "tenth planet" orbiting our Sun. But, as Mike Brown, leader of the team that discovered this world said: "The word 'planet' is simply not a scientific word; it is a cultural word. Scientists have failed to realize that the term 'planet' no longer belongs to them."

Hiding in Plane Sight

Amazingly, Planet X could have been spotted with telescopes built more than 75 years ago. So how come nobody found it until January 2005? In simple terms: because nobody looked. And there are two main reasons why they didn't.

First, very few scientists thought that large objects orbiting the Sun would be found so far out of the plane in which the large "major" planets orbit. Imagine that you could take a compact disc and expand it to be the size of the orbit of Neptune (the most distant large planet from the Sun). Now imagine that you are looking at that disk "edge-on." Neptune and all the other major planets would revolve comfortably within the thickness of that disk. But not Pluto—it swings around inclined 17° to the other eight. And not Planet X—researchers found it 14° below the plane. And its orbit takes it as high as 45° out of this "plane of the ecliptic."

Secondly, Planet X exerts no noticeable effect on the orbits of the previously known planets. Actually, neither does "planet" Pluto, but it was a suspicion of such an effect on Neptune's orbit that motivated Pluto's discoverer, Clyde Tombaugh, to search. He found Pluto in 1930, a little world in a long elliptical orbit.

But by the late 1980s, a few specialists were beginning to suspect that Pluto and its moon Charon might not be all alone out there at the end of the Solar System. Since 1930, astronomers such as Fred Leonard, Ken Edgeworth and Gerard Kuiper had been predicting that a belt of icy junk left over from the formation of the Sun and planets might reside beyond Neptune. The first photons of evidence that this cosmic debris was clumped in large, round balls found their way onto the digital camera chips of astronomers Jane Luu and David Jewitt in 1992. Since then, nearly 1000 such "Kuiper Belt Objects" have been detected—which isn't easy as most of them are darker than dirt, usually bouncing back less than 10% of the already anemic sunlight.

Astoundingly, Pluto, Planet X and the others may only represent "the tip of the iceberg." The population of large, round Kuiper Belt Objects could exceed 10,000 objects. And some of them could be very large indeed. Several serious researchers have said they would not be surprised to find Mars-sized planets and perhaps even a few on the scale of Earth and Venus!

Digital Imaging of the Universe

It's likely that these worlds have been there since the formation of the Solar System about 4.5 billion years ago. So why did the team who discovered this world start looking now? Well, because they could. They had built one of the world's biggest digital cameras: 160 mega pixels! The imager in a digital camera is at least 20 to 50 times smaller. They coupled this monster camera to the uniquely wide-field Schmidt telescope at Palomar Observatory in the mountains near San Diego, California. The Schmidt instrument's main mirror is 48 inches in diameter and collects light across a viewing area of nearly 36 square degrees. With such width to work with, the team can snap highly detailed mapping shots of the entire northern hemisphere sky. So they can scan for planets much more efficiently than any competing observatory. But once they find an object, other telescopes with other specialized capabilities are used to tease out the details of these secretive worlds. And one very important detail about Planet X is its size.

NASA's space-borne Spitzer Space Telescope is great at seeing the "heat-light" (infrared energy) of dim, dusky, distant objects in space. But Spitzer can't see Planet X. So we know it can't be much bigger than about 3000 kilometers (1864 miles) in diameter. Pluto's diameter is perhaps 2274 kilometers (1410 miles). Could Planet X be bigger than Pluto? No one yet knows precisely how much of the dim and distant Sun's light is reflected off of Planet X's surface. But scientists have measured enough to say it's large. "It's definitely bigger than Pluto," says Mike Brown, co-discoverer of Planet X, "even if it reflected 100 percent of the light reaching it, it would still be as big as Pluto; probably one and a half times the size."

In our next Report, we'll see how some of these faraway planets were found. And make some educated guesses at what else is out there.

By Dave Brody
Executive Producer, IMAGINOVA
SPACE.com Science Writer

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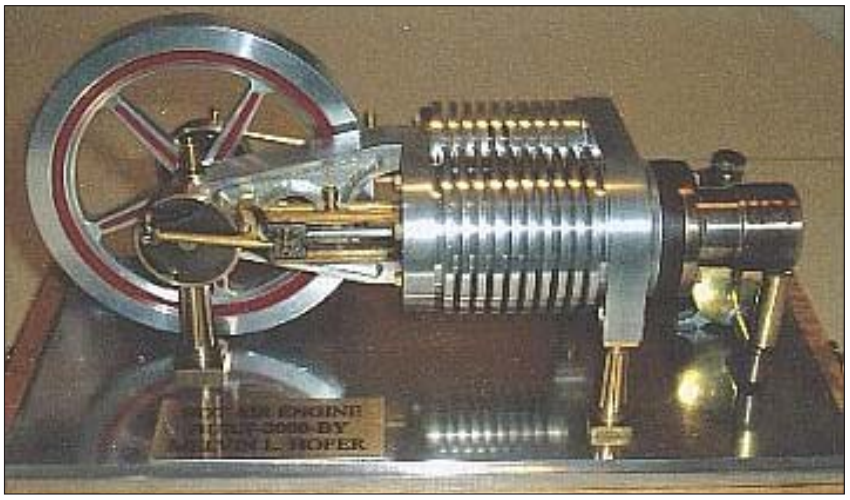

In The Beginning

The Stirling engine is an old technology that has been changing in exciting new ways, making it a viable alternative energy source with the potential to provide cheap and renewable energy for people all over the globe.

The creator of the Stirling engine, Robert Stirling (1790-1878), was a Minister of the Church of Scotland. He attended Glasgow and Edinburgh universities, where he studied Latin, Greek, logic, metaphysics, math, and rhetoric. In 1816 he received a patent for an "air engine" and although there had been previous attempts to build similar engines, his was by far the most successful.

Stirling engines competed with steam engines until electric and internal combustion engines replaced both at the turn of the 20th century. Stirling engines have only been used in very specialized applications ever since; for example, in the 1960s a tiny Stirling engine was developed to power an artificial heart and today they are commonly used to provide the cooling for infrared guidance systems in missiles. However, with the increased focus on environmental concerns and our quest for cleaner, more efficient power sources, the Stirling engine is back in the spotlight as a viable power source for wide-scale use.

It's Hot Outside!

Repeated explosions inside the engine power all internal combustion engines, like the ones found in most cars. The Stirling engine is commonly referred to as an "external combustion engine" because its heat source is external to the engine itself. But this is not an accurate label because Stirling engines do not even require combustion to operate. They contain a fixed amount of gas, often in two cylinders, one for heating and one for cooling. As the gas inside the cylinder is heated by the external source, the internal pressure rises and it pushes a piston outward. The gas is then transferred to the cooling cylinder where the pressure drops and the gas becomes easier to recompress. This results in a net gain in power going to a driveshaft. Most science students are familiar with the equation PV=nRT. For a fixed volume, an increase in temperature will raise the pressure.

Because Stirling engines rely on a constant external heat source instead of a series of explosions, their operation is much more continuous than internal combustion engines. They never become clogged with the products of combustion because this is kept separate from the moving parts of the engine. They are much quieter and require almost 50% fewer parts than internal combustion engines because they do not need spark plugs, inlet and exhaust valves, fuel injection, carburetors, etc.

Green Machines

Unlike internal combustion engines, Stirling engines can carefully control burning for complete combustion and low emissions so that they release far fewer pollutants into the atmosphere. They can also take advantage of wasted heat to produce electricity, like the heat of landfills or factory incineration rooms. Stirling engines can also easily use renewable sources of energy, such as biomass like wood chips or cow dung and can even be powered by solar energy. In fact, solar-powered Stirling engines are nearly twice as efficient as most photovoltaic solar cells.

A very promising use of Stirling engines is cogeneration, where they produce both heat and electricity for homes. If the excess heat produced by Stirling engines were directly used to replace furnaces and water heaters in homes, this would yield a dramatic increase in energy efficiency. This is especially useful for "off-grid" applications where people are too far from power plants to get electricity over cables. Many companies are currently looking into using Stirling engines to replace the current systems in refrigerators. Driven in reverse, Stirling machine pistons manipulate the contained gas to affect temperatures outside the machine. Stirling engines would use as much as 50% less electricity and even more importantly, they do not require CFCs for cooling. One company, Global Cooling, is prototyping a solar-powered Stirling refrigerator that could be used in the developing world for keeping food and medicine cool.

The Future

The most exciting Stirling technology is currently being developed at Los Alamos National Laboratory. Their new engine uses intense acoustic energy instead of pistons for the heat transfer. Constructed of welded pipes, the engine is remarkably simple, efficient, and inexpensive. "The efficiency of conventional engines is limited by both the laws of thermodynamics and practical concerns over the cost of building and operating complex engines. Typically, the highest efficiencies can only be obtained from expensive engines like the large turbines used by electrical utilities. "Our engine is neither mechanically complex nor expensive," says Scott Backhaus, one of the inventors. An innovative use of this engine is to reclaim wasted natural gas. When companies drill for oil, they also run into deposits of natural gas. They often have no way of transporting the gas and instead it is just "flared" or burned. Researchers at Los Alamos are currently working to design a Stirling engine that would cool the gas so that it becomes a liquid, which would make it much easier to transport in conventional pipelines.

What Next?

Perhaps the greatest challenge facing Stirling engines is the popularity of internal combustion engines. Designers of Stirling engines will need to offer incredible advantages to be able to attract manufacturers away from gasoline engines. In addition, new materials need to be developed for the hot parts of the engine; this is the part that is most likely to wear out. Once they are mass produced, the cost of Stirling engines will come down greatly and their popularity should increase. Don't be surprised if you see one soon!

Article submitted by Adam Papania at A3BS.

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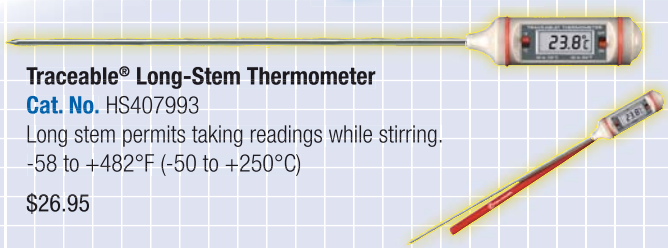

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FARMING THE WIND

From as early as the beginning of the first Millennium, humans were building machines to harness wind energy. In 100 A.D., Heron of Alexandria, a Greek inventor and philosopher, recorded his observations about an early windmill he is believed to have seen in Persia. In the centuries that followed, the idea of replacing animal and water energy with wind power slowly spread and by the time of the Crusades, windmills were being constructed across Northern Europe.

The men who built the windmills, the millwrights, became highly valued craftsmen. Their skills were particularly prized in Holland and Britain where, by the middle of the 18th century, the British were boldly experimenting with ways to automate parts of the grinding process. From here it was just a short step to developing steam power. However, it soon became apparent that steam, being more predictable, would also be a better investment than betting on the uncertain power of the wind.

Today, while windmills are still operating, their value lies more in their visual attractiveness, though a few in Holland, the U.S., and Britain still function as water mills, grain mills and low-volume electricity generators. Despite the windmill's decline, the principle for which it evolved—harnessing the energy of the wind—remains as viable as ever.

The Case for Wind Power

Unlike conventional power plants, wind power doesn't require burning natural gas, coal, or oil. On top of the depletion of these limited resources, many scientists believe the byproducts of burning fossil fuels may be changing the climate through global warming and air pollution.

When compared to nuclear power, wind energy comes out on top. There are less risks related to accidents, waste storage, and the possibility of terrorist attacks.

In addition, wind turbines produce energy without harmful emissions such as carbon dioxide and nitrogen, which are associated with acid rain pollution and the green house effect.

Wind Power Economics

Pursuing wind power as part of our move toward clean energy seems to make good economic sense. Its cost has dropped dramatically over the past two decades because of greater knowledge of how to build, install and operate turbines more effectively. Prices will likely decrease further as the technology improves.

In fact, wind turbines are constantly being improved to raise their potential energy output. The result is that modern wind turbines are growing taller and their turbines are expanding in size. For example, back in the 1980s, the average capacity of large wind turbines was around 150 kilowatts (1 kW equals 1,000 watts). Now, a typical capacity is at least 750 kW, with one and two Megawatt (1 MW equals 1,000 kW) capacity turbines becoming common and turbines as large as 6 MW in development.

To enable turbines to maximize their capture of wind energy, the economy of scale is employed. (The larger the operation, the more that is produced at the most efficient cost.) Thus, large wind turbines are grouped together into giant wind farms. North America, with the world's greatest potential for wind energy, possesses the three largest wind farms on the planet. The Altamont Pass wind farm in northern California contains more than 7,000 wind turbines.

Scientists at Stanford University, who have been studying the impact of wind farms around the globe, suggest that harnessing just 20% of the wind would generate eight times more power than the world used in 2000. Wind is already the fastest-growing source of energy on the planet, with new wind farms adding 34 percent of extra capacity each year. In 2004, economists estimated that wind power had become a $6 billion industry directly employing thousands of people and delivering increasing volumes of low-cost energy.

Fight Against the Wind

Those opposed to wind power fall into several camps. Some refuse to accept that any alternative source of energy can make a useful difference to a nation's power needs. After all, they point out, nuclear power is clean and supplies a much larger percentage of power to countries' electric grids than alternative energy could dream of doing for many years to come.

Other opponents have concerns specifically about wind power, and also about the aesthetics of wind farms. Some theorize that altering the path of the wind may disrupt weather patterns. This argument has been gaining popularity due to emerging technology that creates larger, taller turbines to harness more wind power and the fact that wind farms maximize their capture of wind power by concentrating the largest number of wind turbines at higher elevations where wind flows are most intense. This causes another controversy since these are too often prominent, scenically beautiful sites. Whether in California or Britain, wind farms are typically found on hilltops or in coastal areas where they are attacked for damaging the view.

Just as controversial, wind turbines are accused of causing large numbers of bird deaths. Wind turbines create something of a wind tunnel, the effect of which can be to suck flying birds into the blades. But the evidence at the Altamont wind farm contradicts the scale of deaths claimed. In fact, the 7,000 wind turbines at Altamont produce a total rate of just 0.2 birds killed per turbine, per year. Compare this with the rate of bird fatalities from flying into tall buildings in cities such as Chicago, where 10,000 to 15,000 birds die every year colliding with skyscrapers. Studies pertaining to bird mortalities are ongoing, with one European study seeming to provide evidence that migratory birds learn to avoid the turbines shortly after a wind farm becomes operational.

Wherever the Wind Blows

As an alternative source of energy, the wind is a sustainable energy that does not require fuel, create pollution, or consume scarce resources. Our future relationship with this form of solar power holds endless possibilities. For now, we will continue to improve our technology in hopes of harnessing this powerful force of nature.

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DESCRIPTION	CAT. NO.	PRICE
Atmosphere in Crisis Kit	HS19451	87.00

tools for teaching

WATER POLLUTION

What are the effects of human industry on our planet? How can we change our ways to improve its health? Examine the causes and effects of air, water, and hazardous waste pollution as well as the impact of recycling and conservation.

MATERIALS:

- People & the Environment video **(HS90472)**
- Glass or plastic jars with tight-fitting lids
- Food coloring, blue and red
- Vegetable oil (½ cup per group)
- Piece of cork (1 per group
- Liquid soap (2 oz. per group)
- Piece of sponge

Cat. No: HS90472 **Price: $59.95**

PROCEDURES

1. Watch video and discuss pollution and energy sources
2. For each student group, have two jars filled about halfway with water. Put several drops of blue food coloring in one jar and several drops of red in the other.
3. Pour the vegetable oil into the blue jar
4. Seal and shake jar. Observe and discuss results
5. Pass out cork pieces. Examine texture and hypothesize what will happen when it is added to the jar.
6. Add to blue jar, seal, shake, and put jar aside until next class period
7. Add liquid soap to red jar
8. Repeat steps 4-6 using sponge in place of cork pieces
9. Start next class period by observing blue jar
10. Carefully remove cork.
11. Compare texture to yesterday's observations and hypothesis
12. Repeat steps 9-11 with red jar and sponge

CONCLUSION

Compare the cork to a seagull, pelican, duck, or even fish in water pollution. Compare the sponge to plants and animals that live in polluted water.

Discovery SCHOOL

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MODEL	SPECS.	PRICE	CAT. NO.
FE-123	120g x 0.001g	$510	**HS68705**

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MODEL	DESC.	PRICE	CAT. NO.
FB-5*	pH Meter	$345	**HS68737**

* Kit includes meter, power supply and plastic-body electrode

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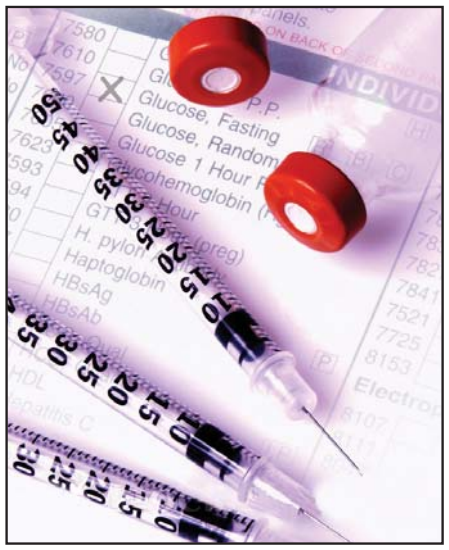

THE SUGAR SICKNESS

Around the second decade of the 20th century, Elizabeth Hughes, the daughter of the New York state governor, lived the life of a very rich little girl. She had everything money could buy: servants, friends, parties, and what should have been a glittering future. Except for the fact that Elizabeth didn't look particularly healthy.

Coming home from birthday parties, she would instinctively gulp down glass after glass of water without ever seeming to slake her thirst. Moreover, even though she'd eat as much as any of her friends, she didn't appear to gain any weight. In fact, she looked as though she were wasting away.

By now an emaciated-looking 11-year-old weighing barely 75 pounds, Elizabeth was making her parents so anxious they sought medical advice and turned to Dr. Frederick Allen in Morristown, New Jersey. Considered the foremost authority on the kind of wasting condition that was ravaging Elizabeth's health, Allen immediately diagnosed diabetes. He told her parents she would survive no more than three years. He also recommended starving her for a week, then putting her on a diet that would reduce her calorie intake from a normal daily ration of 2,500 to around 600 calories or so.

Two years later, Elizabeth's weight had fallen to a mere 50 pounds. By the kind of coincidence that transforms medical advances into popular miracles, two Canadian researchers, Frederick Banting and Charles Best, had just announced they had isolated insulin, a treatment for diabetes. Fearing Elizabeth would die without this specialized help, her parents rushed her to Toronto.

She was immediately given an insulin injection. Within seven days, her calorie count had jumped to 1,200 and it doubled again in another week. Three months later she weighed 100 pounds. In the decades that followed, Elizabeth Hughes did not merely survive but grew strong enough to get married, raise three children and live happily into her seventies.

Insulin Deficiency

Diabetes afflicts between 10 and 14 million Americans. Although first described and named 2,000 years ago by Greek philosophers, the disease was not directly associated with the pancreas until the latter part of the 18th century. Almost 100 years later, in 1869, medical researchers identified the malfunctioning pancreas as the culprit in diabetes.

Diabetes, known as *diabetes mellitus*, is a disease in which the body is unable to produce or unable to properly use and store glucose (a form of sugar). Glucose backs up in the bloodstream—causing blood glucose (sometimes referred to as blood sugar) to rise too high. This is why the disease was once referred to as "the sugar sickness."

There are two major types of diabetes. In type 1 (formerly called juvenile-onset or insulin-dependent) diabetes, the body completely stops producing any insulin, a hormone that enables the body to use glucose found in foods for energy. People with type 1 diabetes must take daily insulin injections to survive. This form of diabetes usually develops in children or young adults, but can occur at any age. Type 2 (formerly called adult-onset or non insulin-dependent) diabetes results when the body doesn't produce enough insulin and/or is unable to use insulin properly (insulin resistance).

Finding a Treatment

In 1921, working in a poorly equipped lab in an old medical building in Toronto, Dr. Frederick Banting and Charles Herbert Best began their research. They had approximately eight weeks to achieve their goal—to prove Banting's theory that the pancreas contained a "magic" substance that prevents diabetes.

To provide some working capital, Banting sold his car, and the two researchers started their experiments. Initially, the results were disappointing. Finally, as the seventh week of research arrived, a breakthrough occurred. Experimenting with diabetic dogs, Banting isolated the "anti-diabetic factor" and demonstrated its blood-sugar lowering ability. By now, Dr. John James MacLeod, who provided the research space and James Collip, who would purify the anti-diabetic factor, had agreed to participate in the work.

As soon as the group accepted that the insulin they had produced really worked, they announced the results of the discovery and began to accept diabetic patients. Among the first was Elizabeth Hughes.

Banting was awarded a Nobel Prize for medicine along with MacLeod for his discovery. Later he was knighted, becoming Sir Frederick Grant Banting. In 1922, Banting and Best accepted an offer from the Eli Lilly Pharmaceutical Company and the commercial production of insulin, for human use, began.

Who Gets Diabetes?

Diabetes can occur in anyone. However, people who have close relatives with the disease are somewhat more likely to develop it. Other risk factors include obesity, high cholesterol, high blood pressure, and physical inactivity. The risk of developing diabetes also increases as people grow older. People who are over 40 and overweight are more likely to develop diabetes, although the incidence of type 2 diabetes in adolescents is growing.

Diabetes is more common among Native Americans, African Americans, Hispanic Americans and Asian Americans/Pacific Islanders. Also, people who develop diabetes while pregnant (a condition called gestational diabetes) are more likely to develop full-blown diabetes later in life.

People with diabetes frequently experience certain symptoms, such as being very thirsty, frequent urination, weight loss, increased hunger, blurry vision and extreme unexplained fatigue. In some cases, there are no symptoms—this happens at times with type 2 diabetes. In this case, people can live for months, even years without knowing they have the disease. This form of diabetes comes on so gradually that symptoms may not even be recognized.

Research and improved treatment methods for diabetes have continued from the day when Banting announced his discovery. For example, researchers have identified the gene responsible for suppressing the body's production of insulin. And today, doctors no longer have to rely on impure insulin production from an animal pancreas. They can now use highly purified insulin typically drawn from human sources.

VIDEO REVIEW

Discovery School: *Biomes VHS set*

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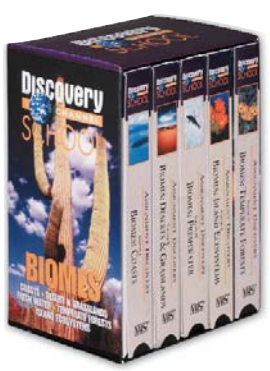
Freshwater —Witness the remarkable adaptations of animals living in East Asia. Cherry salmon spend winter in the fast-flowing mountain waters, and bears, seals, and cranes rely on the freshwater habitat for survival

Temperate Forests—Experience life in a temperate deciduous forest of northern Japan and learn the strategies organisms use to survive seasonal change.

Island Ecosystems—Many islands in Southeast Asia have been isolated for thousands of years, forcing wildlife to adapt and evolve in strange, even startling, ways. Three islands in different stages of development show how life changes as an island ages.



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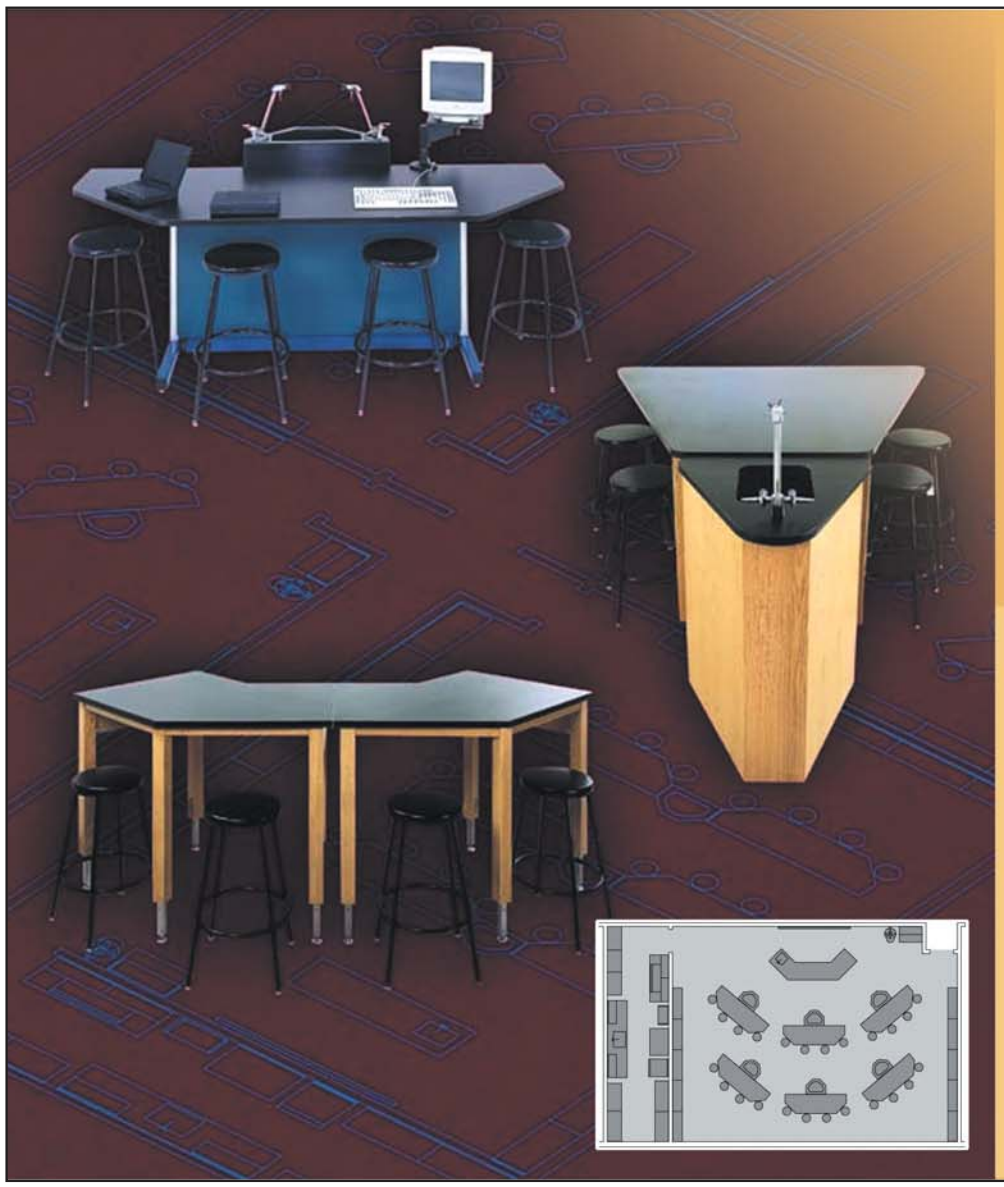

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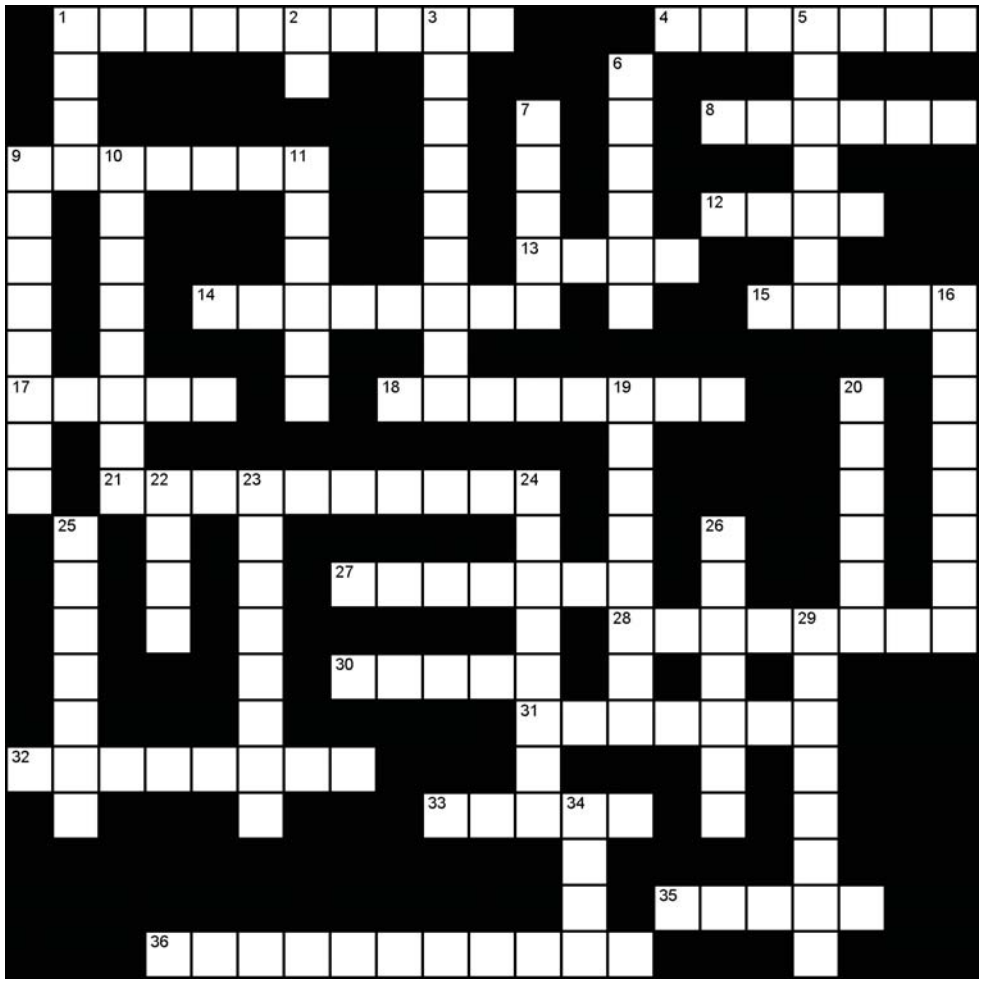

Across

1. Assimilation by chemical or molecular action (p. 6)
4. Newly discovered planet in our solar system (p. 8)
8. Discovered planetary motion (p. 3)
9. Excessively tired (p. 14)
12. ____ baby syndrome, or tetralogy of Fallot (p. 2)
13. Type of pluripotent cells (p. 1)
14. Organism that survives by living off of another organism (p. 5)
15. Determines what stem cells will become (p. 1)
17. Nanotechnology creates mini-machines using these (p. 4)
18. Stirling engines use one for heating and one for cooling (p. 10)
21. Protect the body from bacteria and viruses (p. 4)
27. Mechanism for harnessing wind power (p. 12)
28. Organism that can cause brain seizures (p. 4)
30. Company making great strides in nanotechnology development (p. 4)
31. Hormone that enables the use of glucose from food (p. 14)
32. Malfunctioning organ that causes diabetes (p. 14)
33. "Red sky at ____, sailor's delight..." (p. 7)
35. Partners of the _____ (p. 2)
36. Energy from the flow of electric charge through a conductor (p. 12)

Down

1. Unique animal portrait at Johns Hopkins (p. 2)
2. Equation: ___=nRT (p. 10)
3. Planet's axial tilt (p. 3)
5. Outermost planet remaining on the plane of the ecliptic (p. 8)
6. Northern hemisphere season when closest to sun (p. 3)
7. First stem cells obtained (p. 1)
9. Weather prediction (p. 7)
10. Naturally occuring tumor from an egg or sperm cell (p. 1)
11. Solar is one type of alternative ____ (p. 12)
16. An array of wavelengths (p. 6)
19. The sugar sickness (p. 14)
20. Tianjin's principal source of drinking water (p. 2)
22. US Space organization (abbr. – p. 8)
23. Wavelength longer than visible light but shorter than microwave radiation (p. 6)
24. External combustion engine (p. 10)
25. Wise book of weather predictions (p. 7)
26. Weather radar (p. 7)
29. A collection of wind turbines (two words – p. 12)
34. Unaware supporter of parasites (p. 4)

Answers can be found at **www.fisheredu.com** in the Literature Section.

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