Michigan**Science**

A publication of the Mackinac Center for Public Policy

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Larry Hembroff, Ph.D., joined the faculty of Michigan State University in 1987 after nine years in the sociology department of Radford University in Virginia. He established MSU's Office for Survey Research in 1988 and oversees the office's methodological approaches, including sampling designs, training, questionnaire development, data collection, data processing and analysis. He has published several monographs and numerous research articles in such journals as Social Psychology Quarterly, Social Forces and the American Journal of Sociology.

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MichiganScience is published quarterly by the Mackinac Center for Public Policy, a nonpartisan, nonprofit research and educational institute devoted to promoting sound solutions to state and local policy questions. MichiganScience is received by legislators and their staff; state agency personnel; radio, television news directors and producers; print news editors and reporters; educators; libraries; and civic organizations.
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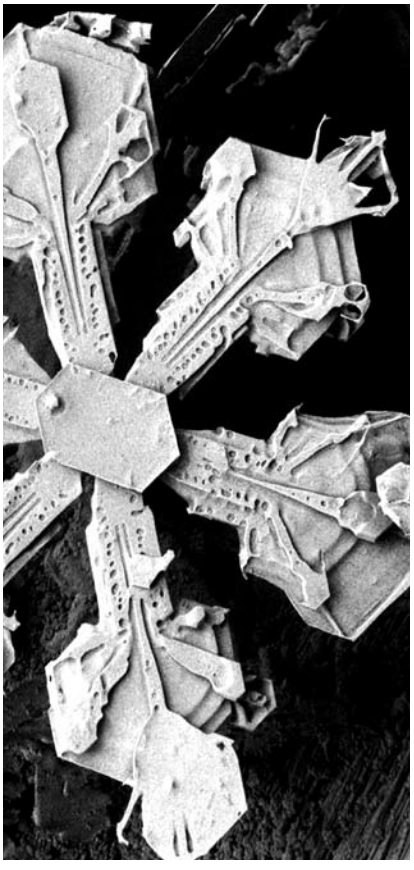


ON THE COVER
The snowflake photograph was taken through a Low Temperature Scanning Electron Microscope.
Source: USDA, ARS, EMU Erbe and Pooley

By The Numbers

Beyond propaganda and rhetoric, numbers tell the real story

The Dec. 22, 2007, edition of the **BRITISH MEDICAL JOURNAL** corrects seven medical myths commonly espoused by doctors and widely believed by the public. The following is an excerpt of the article, which is available at:

http://www.bmj.com/cgi/content/full/335/7633/1288?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&fulltext=medical+myths&searchid=1&FIRSTINDEX=0&resourcetype=HWCIT.

MYTH: YOU SHOULD DRINK AT LEAST EIGHT GLASSES OF WATER A DAY

FACT: Studies suggest that adequate fluid intake is usually met through typical daily consumption of juice, milk and even caffeinated drinks. In contrast, drinking excess amounts of water can be dangerous, resulting in water intoxication, sodium deficiency and even death.

MYTH: WE USE ONLY 10 PERCENT OF OUR BRAINS

FACT: Evidence from studies of brain damage, brain imaging, localisation of function, microstructural analysis and metabolic studies show that people use much more than 10 percent of their brains. Studies of patients with brain injury suggest that damage to almost any area of the brain has specific and lasting effects on mental and behavioral capabilities. Numerous types of brain imaging studies show that no area of the brain is completely silent or inactive. The many functions of the brain are highly localised, with different tasks allocated to different anatomical regions. Detailed probing of the brain has failed to identify the "non-functioning" 90 percent. Even micro-level localisation, isolating the response of single [neurons], reveals no gaps or inactive areas. Metabolic studies, tracking differential rates of cellular metabolism within the brain, reveal no dormant areas.

MYTH: HAIR AND FINGERNAILS CONTINUE TO GROW AFTER DEATH

FACT: Dehydration of the body after death, and drying or desiccation may lead to retraction of the skin around the hair or nails. The skin's retraction can create an appearance of increased length or of greater prominence because of the optical illusion created by contrasting the shrunken soft tissues with the nails or hair. The actual growth of hair and nails, however, requires a complex hormonal regulation not sustained after death.

MYTH: SHAVING HAIR CAUSES IT TO GROW BACK FASTER, DARKER OR COARSER

FACT: Shaving removes the dead portion of hair, not the living section lying below the skin's surface, so it is unlikely to affect the rate or type of growth. Shaved hair lacks the finer taper seen at the ends of unshaven hair, giving an impression of coarseness. Similarly, the new hair has not yet been lightened by the sun or other chemical exposures, resulting in an appearance that seems darker than existing hair.

MYTH: EATING TURKEY MAKES PEOPLE ESPECIALLY DROWSY

FACT: Scientific evidence shows that tryptophan is involved in sleep and mood control and can cause drowsiness. Turkey does not contain an exceptional amount of tryptophan. Turkey, chicken, and minced beef contain nearly equivalent amounts of tryptophan (about 350 mg per 115 g), while other common sources of protein, such as pork or cheese, contain more tryptophan per gram than turkey. Any effects of the tryptophan in turkey are probably minimized by consuming it in combination with other food, which would limit its absorption. Other physiological mechanisms explain drowsiness after meals. Any large solid meal can induce sleepiness because blood flow and oxygenation to the brain decreases.

MYTH: MOBILE PHONES CREATE CONSIDERABLE ELECTROMAGNETIC INTERFERENCE IN HOSPITALS

FACT: At the Mayo Clinic in 2005, in 510 tests performed with 16 medical devices and six mobile telephones, the incidence of clinically important interference was 1.2 percent. Similarly rigorous testing in Europe found minimal interference and only at distances less than one meter. Recent technological improvements may be lessening even this minimal interference. A 2007 study, examining mobile phones "used in a normal way," found no interference of any kind during 300 tests in 75 treatment rooms. In contrast, a large survey of anesthesiologists suggested that use of mobile phones by doctors was associated with reduced risk of medical error or injury resulting from delays in communication. ■

CRYSTAL CLEAR

The cold, hard facts about snowflakes

It's widely believed that no two snowflakes are alike — but it turns out that there are various forms of snowflakes, making the tale a bit more complicated. For better or verse, here's the whole story, including the lowdown on rain, hail and sleet.

Because of the way that they grow,
Each frozen white crystal of snow
Is thought in our mind
To be one of a kind.
But guess what: It just isn't so.

When H2O molecules freeze,
Hexagons form with great ease
Molecular bonds
Like magical wands
Form the six-sided shapes snowfall sees.

Dendrite flakes, with their
six crystal wings,
Are among nature's loveliest things
These flakes are unique,
No two can you seek
Just the same in the white winter brings.

But at temperatures lower or higher
In air that's more humid, or drier,
Different shapes grow:
Less unique flakes of snow
That develop much simpler attire.

Needles, and Columns, and Plates
Are flakes with identical mates.
Like wheels on a bike
These flakes look alike.
Each type has quite similar traits.

But the turbulent winds of a storm
With temperatures both cold and warm
And mixed moisture sources
Create varying forces
That cause complex mixed
crystals to form.

So while some flakes can
all look the same,
Most are not nearly so tame.
They're all based on a "hex,"
But they're just as complex
As the Nature from whence
each one came.

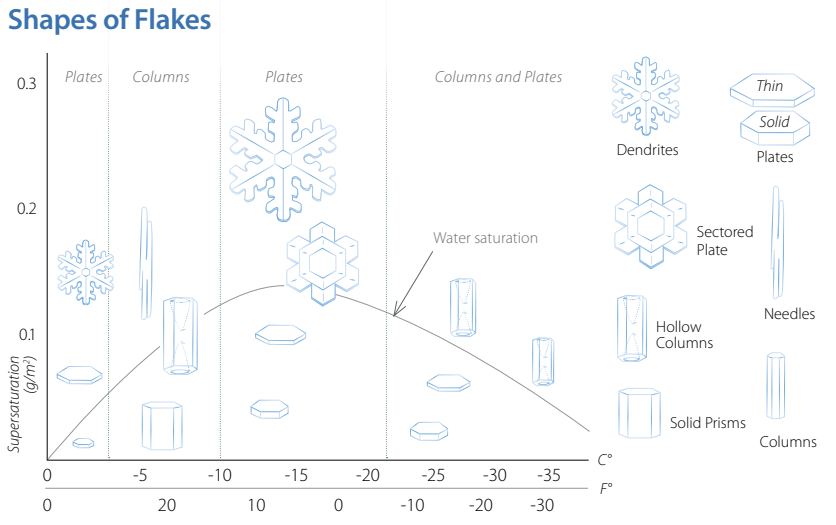
Now raindrops, and sleet, even hail
Are part of a simpler tale:
Though they vary in size
Like a bunch of french fries
Each forms the same way without fail.

Big drops fall from moist warmer air,
Or when smaller drops
join, way up there.
Hailstones will grow
When strong updrafts blow.
A thunderstorm has those to spare.

Sleet's just a raindrop that froze
Before it crashed into your nose
Wet rain that falls
And then freezes on walls
Is freezing rain. Traffic it slows.

Each type of cold precipitation
Has its own origination.
We suffer together
The wet winter weather
No matter our town, state, or nation. ■

Shapes of Flakes



The shape of snowflakes is a function of humidity and temperatures. Simpler flakes form when humidity is low and, conversely, higher humidity produces more complex shapes. Star-like flakes appear at both the lowest and highest temperatures, while needle-like crystals grow at temperature in the low-20s.

Field Trips

Area science museums host special programs of interest for budding scientists and their families


Photo: Seth Smoot

Mummies: Secrets of the Pharaohs

This IMAX documentary, narrated by horror film veteran Christopher Lee, combines original and historical footage, period recreations, computer-generated graphics and interviews with prominent Egyptologists. "Mummies" examines the techniques used to embalm and preserve the bodies, as well as the history of the rediscovery of their ancient tombs.

The New Detroit Science Center, 5020 John R St., Detroit, 313-577-8400. Center is open Monday through Friday, 9 a.m.-3 p.m.; Saturday 10:30 a.m.-6 p.m.; and Sunday, 12 p.m.-6 p.m. Tickets include general admission to the museum and are $11.95 for adults; $10.95 for children and senior citizens.

For more information go to http://www.detroitsciencecenter.org/theaters/IMAX.htm.

Science in Toyland

Children's everyday playthings can inspire learning about scientific principles. Science in Toyland is an interactive exhibit that develops scientific reasoning and research skills as students build bridges, construct houses, run a tournament of tops and use roller coasters.

Cranbrook Institute of Science, 39221 Woodward Ave., Bloomfield Hills, 248-645-3200. Museum is open Saturday through Thursday, 10 a.m.-5 p.m.; Friday, 10 a.m.-10 p.m. Exhibit free with regular admission.

For more information, go to http://science.cranbrook.edu/common/news_detail.asp?newsid=411297&L1=2&L2=4&L3=.

First Impression Room

The First Impression Room invites exploration and discovery for children ages 1-4. Activities involving magnets, light, gears, sand and water play are combined with social and language development activities. Younger scientists (infants and crawlers) are provided a protected space that assures a safe, stimulating environment. Also available is a quiet reading area complete with nonfiction science books, classic children's titles in English and Spanish, and resource books on child development.

Impression 5 Museum, 200 Museum Drive, Lansing, 517-485-8116. Museum is open Monday through Saturday, 10 a.m.-5 p.m.; Sunday, 1 p.m.-5 p.m.; workshops are from 10 a.m.-1 p.m.

For more information go to http://www.impression5.org.

National Engineers Week

National Engineers Week is an opportunity for students and teachers to gain hands-on experiences in math and science. The 2008 theme is Engineers Make a World of Difference. According to museum officials, activities will include Hoop Gliders, designed to engineer flight, and Paper Towers, in which participants build a tower that will support a golf ball using only one sheet of newspaper.

Feb. 18 through Feb. 22 from 10 a.m. to 3 p.m., Ann Arbor Hands-On Museum, 220 E. Ann St., Ann Arbor, 734-995-5439. Museum is open Monday through Saturday, 10 a.m.-5 p.m.; Sunday, 12 p.m.-5 p.m.

For more information, go to http://www.aahom.org/exhibits/index.html.

The Third Degree

Test your reading of this issue of MichiganScience.

Students in grades six through 12 can compete for a $100 gift certificate from Edmund Science Kit. The winner will be determined by a random drawing from entries with all the correct answers. Please send entries to katz@mackinac.org.

1. **How long does it take for a blastocyst to form following fertilization of an egg?**
   A. 2-4 days.
   B. 5-10 days.
   C. 6 weeks.
   D. 3 months.

2. **How many cells does a typical blastocyst contain?**
   A. 100-150.
   B. 10.
   C. 50-100.
   D. 25-50.

3. **How many embryos have been frozen and stored by fertility clinics since the 1970s?**
   A. 1 million.
   B. 750,000.
   C. 400,000.
   D. 50,000.

4. **How much funding for stem cell research has the federal government provided each year, on average, since 2003?**
   A. $600 million.
   B. None. Federal funding for stem cell research is prohibited by law.
   C. $5 million.
   D. $1 billion.

5. **In what year was the first public opinion poll conducted?**
   A. 1910.
   B. 1776.
   C. 1960.
   D. 1824.

6. **Which presidential candidate did the Gallup organization predict would win the 1948 election?**
   A. Theodore Roosevelt.
   B. Thomas Dewey.
   C. Franklin Roosevelt.
   D. Alfred Landon.

7. **How many wings are in a dendrite snowflake?**
   A. 5.
   B. 8.
   C. 6.
   D. 10

8. **What percentage of the brain does a typical person use?**
   A. 25 percent.
   B. 10 percent.
   C. 100 percent.
   D. 50 percent.

9. **How much does hair grow after death?**
   A. One-quarter inch.
   B. One centimeter.
   C. Not at all.
   D. One-half inch.

10. **How much is awarded to the winner of the MichiganScience essay contest?**
    A. $50.
    B. $1,000.
    C. $100.
    D. $500.

MichiganScience salutes the six Michigan students who have been named as semifinalists in the 67th Intel Science Talent Search, often regarded as the "junior Nobel Prize." A total of 1,602 students from 45 states, Puerto Rico and the Virgin Islands entered this year's contest to compete for $1.25 million in scholarships. Each of the 300 semifinalists receives $1,000, with an additional $1,000 for their school. The semifinalists from Michigan are:

Hari Senthil Arul, Age 17
DETROIT COUNTRY DAY SCHOOL
Project: Synthesis and Replenishment of Silver Nanoparticle-enabled Membranes for Biofouling Mitigation

Pavel Vladimirovich Chvykov, Age 17
WASHTENAW TECHNICAL MIDDLE COLLEGE
Project: Development of a Novel Ultra-Fast Laser Pulse Contrast Improving System

Philip Zhangfan Hu, Age 17
TROY HIGH SCHOOL
Project: Connectivity of Unidirectional Hyper-stars

Ana Marie Lyons, Age 17
MORLEY STANWOOD HIGH SCHOOL
Project: The Effects of Imidacloprid Soil-Drenching on Terrestrial Tardigrada of the Great Smoky Mountains National Park, Tennessee: Bio-Monitoring Insecticide Persistence

Shravani Mikkilineni, Age 17
DETROIT COUNTRY DAY SCHOOL
Project: Continued Fractions and Orbits of a Linear Fractional Transformation

Harrison Phu Nguyen, Age 16
DETROIT CATHOLIC CENTRAL HIGH SCHOOL
Project: Combating Muscle Atrophy: A Novel Study of Myofibril Turnover in Sternopygus macrurus

MichiganScience

STEMMING THE DEBATE

Advances in Stem Cell Research

By Diane S. Katz and Bruce Edward Walker

Medical research involving the use of stem cells[1] has prompted ethical and political debates among scientists, policymakers and the public. The most contentious aspect of the issue involves the retrieval of stem cells from human embryos, which are destroyed in the process. Legislation pending in Michigan would, if enacted, allow exceptions to the state's longstanding ban on the use of embryos for research.[2] This is an opportune time, then, to examine the science of stem cells.

Stem cells differ from other cells in the body in three fundamental ways: they are capable of regenerating for a year or more; they do not have a specialized function (as does a nerve cell or blood cell, for example); and they generate specialized cells.[3]

Stem cells also are distinguished by their source. "Embryonic stem cells" are derived from a "blastocyst," an embryo that is between five days and 10 days old and which consists of 100-150 cells that have developed following fertilization. Embryonic stem cells can generate a variety of specialized cell types throughout the body.

In contrast, "adult stem cells" start to emerge three to five days after a blastocyst is formed. They, too, generate specialized cells that maintain and repair tissue and organs. However, questions remain about the extent to which adult stem cells are capable of generating specialized cells other than those of the tissue from which they originate.[4]

Driving a good deal of research is the supposition that stem cells can be "programmed" to grow healthy cells and tissue with which to treat a variety of injuries and diseases, such as spinal cord injury, stroke, burns, heart disease, diabetes and rheumatoid arthritis. The ability to generate scores of identical stem cells could prove valuable in drug testing, too.

There also is hope that stem cell therapies may some day alleviate the chronic shortage of donated organs. However, expectations are tempered by the fact that the supply of human eggs from which to create embryos for stem cell retrieval is limited.[5]

Some progress in stem cell therapy has been achieved: adult stem cells collected from bone marrow are being used to generate healthy blood cells to replace those destroyed by leukemia, Hodgkin's disease and anemia, for example.[6] But a full complement of stem cell therapies has yet to be realized.

A primary obstacle to broader therapeutic applications is a lack of knowledge about the mechanisms that cause stem cells to develop into specialized cells. It has been established that cell specialization[7] results from the activation of particular genes within a cell. What triggers a specific genetic arrangement is not entirely known. The protein Oct-4 may play a role.[8] But without a full understanding of this process, researchers are limited in their ability to manipulate human stem cells to become the specialized cells that can repair specific tissues or organs.

1 Stem cells are the most rudimentary type of cell. They are capable of replicating for as long as a year, and they generate the specialized cells from which tissue and organs grow.

2 HB 4616 would amend the Public Health Code (MCL 333.2685), which currently prohibits the harvesting of stem cells from embryos. However, it is legal for scientists in Michigan to conduct research using embryonic stem cells that were retrieved from an embryo outside the state. For more information on the legislation go to http://www.legislature.mi.gov/(S(yuyehgnih1ztxz453u50tsfq))/mileg.aspx?page=getobject&objectname=2007-hb-4616.

3 National Institutes of Health, "Stem Cell Basics." Available online at http://stemcells.nih.gov/info/basics/basics1.asp.

4 Ibid.

5 MIT Technology Review, "Human Therapeutic Cloning at a Standstill," Oct. 9, 2007. For more information go to http://www.technologyreview.com/Biotech/19488/.

6 National Institutes of Health, "Stem Cell Basics." Available online at http://stemcells.nih.gov/info/basics/basics1.asp.

7 The technical term for specialized cells is "differentiation."

8 National Institutes of Health, op. cit.

Private Support for Stem Cell Research Expands

A RECENT GIFT from Michigan philanthropist A. Alfred Taubman greatly expands private support for stem cell research in the state. The shopping mall magnate has donated $22 million to the University of Michigan Health System for an endowment to fund five stem cell researchers.

A new medical research institute will bear Taubman's name. The scholars, each of whom will receive a three-year appointment, were selected from scholars in the university's medical school whose research potentially will lead to the prevention or cure of disease.

The inaugural Taubman Scholars are:

VALERIE CASTLE, M.D., for work on pediatric solid-tumor cancers.

EVA FELDMAN, M.D., PH.D., for research on the use of stem cells and other approaches to treat amyotrophic lateral sclerosis.

DAVID PINSKY, M.D., for the study of proteins inhibiting the formation of clots inside blood vessels, which could lead to a new class of drugs to prevent strokes and heart attacks.

YEHOASH RAPHAEL, PH.D., for stem-cell development of ear implants for the hearing impaired.

MAX WICHA, M.D., for research into stem cells that prompt the growth of cancerous tumors.

The scholars will be eligible to apply for a renewal of their grants, while others may be considered as the endowment grows.

Separately, the University of Michigan established its Exploratory Center for Human Embryonic Stem Cell Research in 2003. It has received $3 million from the National Institutes of Health for embryonic stem cell research. Of the center's original 15 scientists, three have been granted additional funding from the federal agency.[1]

The university also broke ground in 2005 on its Center for Stem Cell Biology, with $12 million from the university budget.

1 Life Sciences Institute, "Research: Q&A." For more information go to http://lsi.umich.edu/facultyresearch/centers/stemcellbiology/researchqa.

In experiments with mice, researchers have created specialized cells from embryonic stem cells. However, the subsequent transplant of the specialized cells produced tumors caused by unchecked cell growth. The transplants also triggered rejection by the mice's immune systems.[9]

Embryonic stem cell research dates back two decades, when stem cells were first isolated in the embryos of mice. In 1998, a research team led by James Thomson at the University of Wisconsin isolated the first human embryonic stem cells.

The principle source of embryonic stem cells has been embryos created by in vitro fertilization[10] but not implanted in a woman's uterus. According to a study by the Rand Corp., nearly 400,000 embryos have been frozen and stored by fertility clinics since the late 1970s.[11] However, less than 3 percent of the embryos have been designated for research; the vast majority has been stored for future implantation, according to the Rand study. This limited supply, coupled with ethical concerns surrounding the destruction of the embryos, has prompted researchers to look for alternative stem cell sources. As a result, considerable attention is now focused on cloning.[12]

Cloning involves replacing the DNA of an unfertilized egg with DNA retrieved from a cell in the patient's body. The result would be an embryo from which stem cells could be generated. Because the resulting cells and tissue would carry the exact genetic makeup of the patient, the potential for immunologic rejection would be virtually eliminated.

Scientists have succeeded in cloning embryonic stem cells from mice, but a human egg has never been cloned. Some states ban human cloning, but attempts elsewhere are underway. For example, Harvard University and the University of California have inaugurated research programs to do so.[13]

Meanwhile, American and Japanese scientists recently announced a remarkable breakthrough in stem cell research that may obviate the need for embryos altogether. On Nov. 20, 2007,[14] two research teams — one led by Kyoto University professor Shinya Yamanaka and the other led by James Thomson of the University of Wisconsin — simultaneously and independently announced that they had created stem cells that are "nearly indistinguishable" from human embryonic stem cells without using either human eggs or human embryos.[15]

According to news accounts, the feat was accomplished by injecting a cocktail of four proteins into the nucleus of skin cells. The Kyoto team reported that

9 Mary Ann Liebert Inc., "Human Embryonic Stem Cell Lines Created That Avoid Immune Rejection," ScienceDaily, Dec. 21, 2007. For more information go to http://www.sciencedaily.com/releases/2007/12/071220123837.htm.

10 A technique that unites the egg and sperm in a laboratory, instead of inside the female body.

11 Hoffman DI, Zellman GL, Fair CC, Mayer JF, Zeitz, JG, Gibbons WE and Turner TG., "Cryopreserved Embryos in the United States and Their Availability for Research," Fertility and Sterility 79 (5): 1063–1069. For more information go to http://www.rand.org/pubs/research_briefs/RB9038/RB9038.pdf.

12 The technical term for the procedure is somatic cell nuclear transfer.

13 Michigan Citizens for Stem Cell Research, "Nuclear Transfer (Therapeutic Cloning) Questions." Available online at http://www.stemcellresearchformichigan.com/faq-somatic.html.

14 McCullough, Marie, "Stem Cells Without the Fuss? Possibly," Detroit Free Press, Nov. 21, 2007. For more information go to http://www.freep.com/apps/pbcs.dll/article?AID=/20071121/NEWS07/711210405/1009.

15 Dayton, Leigh, "Embryonic Breakthrough in Stem Cells," The Australian, Nov. 21, 2007. Available online at http://www.theaustralian.news.com.au/story/0,25197,22795650-2703,00.html.

they were able to grow brain and heart tissue from the lab-created stem cells. The Wisconsin scientists created eight new stem cell "lines"[16] for use in research.[17] However, both teams have warned that the procedure is far from perfected. Years of further testing must still be undertaken to ensure safety.

Currently, federal funding of embryonic stem cell research is restricted to lines created before Aug. 9, 2001. The embryos from which these lines originated had to have been created for reproductive purposes and subsequently classified as "medical waste." Donor consent — without financial inducement — also was required.[18] There were 71 embryos among 14 laboratories worldwide[19] that were generating stem cell lines in 2001.[20]

Federal Funding of Stem Cell Research 2003-2008
***(in $ millions;** figures have been rounded)*

Type of Research	2003	2004	2005	2006	2007	2008
Human Embryonic	20	24	40	38	37	37
Non-Human, Embryonic	113	89	97	110	110	109
Human, Non-Embryonic	191	203	199	206	206	205
Non-Human, Non-Embryonic	192	236	273	289	288	287
Total	**517**	**553**	**609**	**643**	**641**	**639**

Source: Congressional Research Service[21]

There is disagreement about whether existing lines of embryonic stem cells are sufficient for ongoing research. In June 2007, President George Bush authorized federal funding of research involving stem cells derived from sources other than embryos, such as amniotic fluid, umbilical cords and skin cells.

Despite the restrictions on federal funding, research on embryonic and adult stem cells continues in many laboratories across the nation, supported by both private and public funds. Ten states currently fund embryonic stem cell research.

State Support of Embryonic Stem Cell Research

State	Amount
California	$3 billion
Connecticut	$100 million
Illinois	$15 million
Maryland	$15 million
Massachusetts	To be Determined
New Jersey	$10 million
New York	$600 million
Texas	$41 million +
Virginia	To be Determined
Wisconsin	$375 million

Sources: Stateline.org and Michigan Citizens for Stem Cell Research & Cures.[22]

Michigan's prohibition on the use of embryos for experimentation was enacted in 1978. Cloning is likewise banned. But state law does permit the use of embryonic stem cells in research within Michigan labs as long as they have been retrieved from embryos outside of the state.

House Bill 4616 would, if enacted, allow the retrieval of stem cells from embryos in the state if the embryos are classified as medical waste, i.e., not intended for implantation. The bill also would allow families to donate unused embryos for research. The legislation is tie-barred[23] to HB 4617 and HB 4618, which propose to increase the penalties for human cloning from 10 years in prison to 15 years in prison and a maximum fine of $10 million, while also raising such a violation from a Class D felony to a Class C offense.

As debate continues over stem cell research, scientific advances are occurring at a relatively rapid pace. The prospects have greatly improved for creating embryonic-type stem cells without destroying embryos. Thus, it may well be that science will solve the political and ethical dilemmas long before the politicians do. ■

16 A stem cell line consists of all the cells created by the continuous division of a particular group of stem cells.

17 BBC News, "Skin Transformed Into Stem Cells," Nov. 20, 2007. Available online at http://newsvote.bbc.co.uk/mpapps/pagetools/print/news.bbc.co.uk/1/hi/health/7101834.stm.

18 National Institutes of Health, Stem Cell Information, "Federal Policy." For more information go to http://stemcells.nih.gov/policy/defaultpage.asp.

19 The labs were located in the United States, Singapore, South Korea, India, Israel and Sweden.

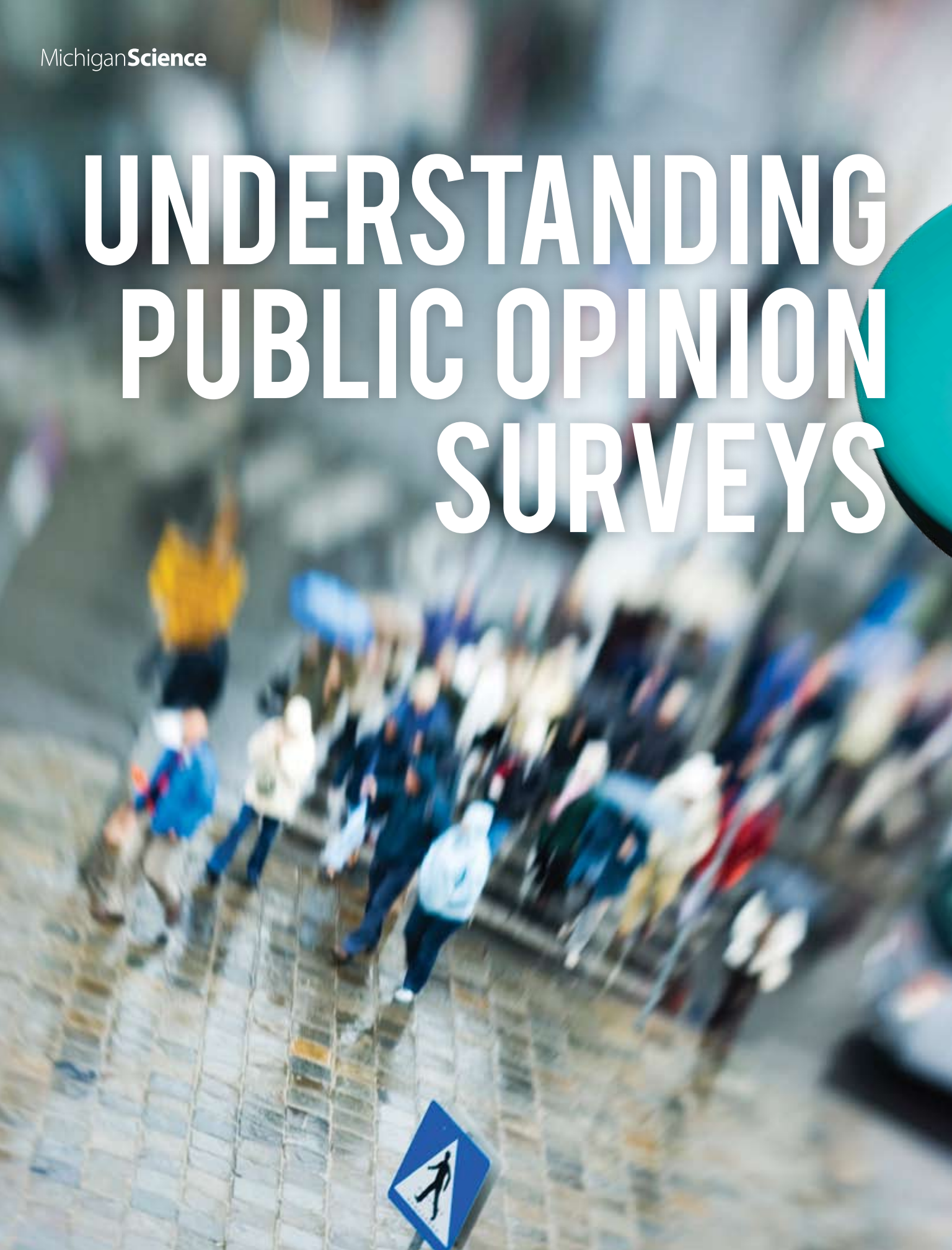
20 National Institutes of Health, op. cit.

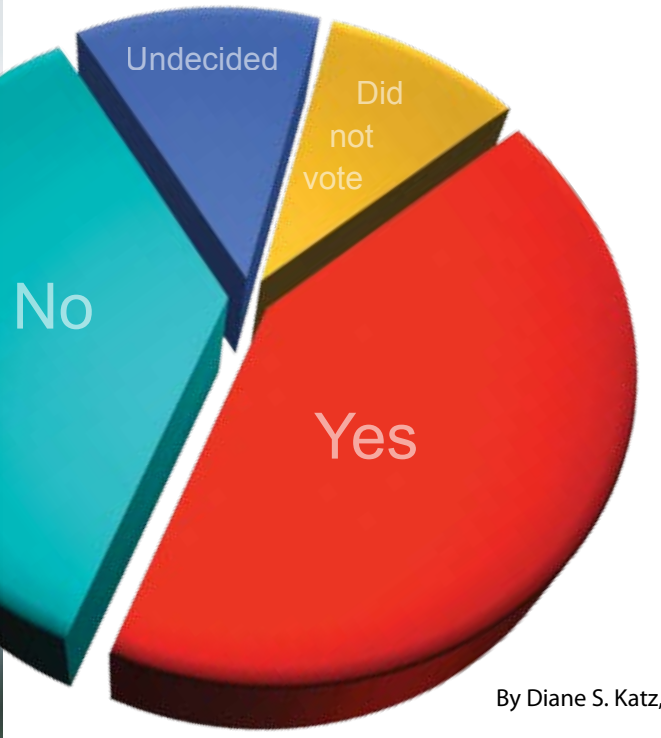
21 Congressional Research Service, "Stem Cell Research: Funding and Oversight," April 18, 2007. For more information go to http://www.fas.org/sgp/crs/misc/RL33540.pdf.

22 Stateline.org., http://www.stateline.org/live/details/story?contentId=218416; Michigan Citizens for Stem Cell Research & Cures, http://www.stemcellresearchformichigan.com/currentlaw.html.

23 Tie-barred legislation requires all bills to pass, or none do.

UNDERSTANDING PUBLIC OPINION SURVEYS





By Diane S. Katz, Nathaniel Ehrlich, Ph.D., and Larry Hembroff, Ph.D.

Election season is upon us, and there's no shortage of polls telling us what we think. But judging the accuracy of all these numbers requires a basic understanding of the science of polling.

The first known opinion poll was a presidential "straw vote" conducted by the Harrisburg Pennsylvanian in 1824. The newspaper simply surveyed 500 or so residents of Wilmington, Del., without regard to demographics. The results showed Andrew Jackson leading John Quincy Adams by 66 percent to 33 percent.[1] (William Crawford, secretary of the treasury, and Henry Clay, speaker of the U.S. House of Representatives, also were candidates.)

The poll accurately predicted the outcome of the popular vote, but none of the candidates actually won a majority of the electoral vote. Consequently, the election was decided by the House of Representatives, which chose Adams.[2]

Election polling was popularized in the 20th century by the Literary Digest, a weekly magazine published by Funk and Wagnalls. Beginning with the re-election of Woodrow Wilson in 1916, the Digest correctly predicted the result of every presidential campaign until 1936. Its polling consisted of mailing millions of postcard "ballots" nationwide (along with a subscription form) and tallying the responses. Many considered the Digest poll to be unassailable.

So it seemed until 1936, when the Digest forecast a landslide win by Alfred Landon over Franklin Roosevelt.[3] In contrast, a young George Gallup predicted a Roosevelt victory based on a "representative sample" of 50,000 people — that is, a group that resembled the population at large. Yet his prediction was widely ridiculed as naive.[4]

In hindsight, the Digest's error is easy to spot: Its mailing list was comprised of households with telephones, cars and magazine subscriptions. In the midst of the Great Depression, those with money to spare for such relative luxuries hardly represented the voters who would favor Roosevelt and his New Deal.

The Literary Digest folded soon after Roosevelt's election. What was true then is true today: A flawed sample cannot be corrected simply by increasing the number of respondents.

The Gallup organization suffered its own embarrassment in 1948, when it

predicted a victory by Thomas Dewey over Harry Truman. Gallup claimed the error resulted from ending his polling three weeks before Election Day. Others faulted his use of "quota sampling," by which respondents were targeted based on gender, age, race and income. This type of sampling can be useful when comparing differences of opinion between specific demographic groups; it is not accurate, however, for estimating how many people within an entire population hold a particular viewpoint.

The use of quota sampling for elections was largely replaced after 1948 by "random sampling," in which all segments of the population have a reasonably equal chance of being surveyed.

SAMPLE METHODS

Whereas the Literary Digest used postcards and Gallup posed questions face-to-face, most polls today are conducted by telephone. Calls are typically made by "random digit dialing," the process by which computers generate wireline telephone numbers. This method improves the chances of reaching households with unlisted numbers or new service. But the substitution of cell phones for traditional land lines among some segments of the population has lately raised questions about the ability of random digit dialing to produce an unbiased sample.

The term "sampling error" refers to instances in which the poll results from a particular sample differ from the relevant population just by chance. For example, a majority of respondents in a particular sample might have supported Alfred Landon even if a majority of the overall population supported Franklin Roosevelt.

To achieve more accurate findings, pollsters adjust their results to more closely reflect key demographic characteristics of the overall population. For example, if a survey is written to measure political views, and if 40 percent of all registered voters at the time of the survey are Democrats, the results will generally be more reflective of the entire population if the sample is "weighted" so that Democrats effectively make up 40 percent of the responses to any given question.

In the following table, the "unweighted" column contains the number of respondents in the sample according to their party affiliation. The "weighted" column, in contrast, contains the number of respondents after weights are applied to more accurately reflect the actual population.

	Unweighted	Weighted
Total Republicans	358	328
Total Democrats	366	388
Total Independents	412	420
Total Respondents	1,136	1,136

Survey results based on samples that have been heavily weighted are generally considered less reliable. Consequently, it is helpful to know how a sample has been weighted in order to judge the precision of the poll.

Most polls are reported with their "margin of error." This is an estimate of the extent to which the survey results would vary if the same poll were repeated multiple times. If a pollster reports that 75 percent of voters are dissatisfied with Congress, a ±3 percent margin of error usually means that there is a 95 percent chance that the true measure of voter dissatisfaction falls between 72 percent and 78 percent.

The margin of error accounts only for a potential error in the random sampling, not for survey bias or miscalculations. The margin of error is typically formulated based on one of three "levels of confidence:" 99 percent, 95 percent or 90 percent. A 99 percent level of confidence (the most conservative) indicates that the survey results would be "true" within the margin of error 99 percent of the time.

In comparing the results of two or more surveys, it is important to recognize that the margin of error that would apply to both sets of results taken together would be greater than the margin of error for either of the surveys alone.

SURVEY WORDING

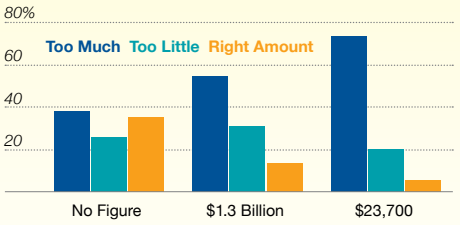
The wording of questions is crucial to interpreting poll results. Individual responses often depend on the way in which survey questions are posed. The three questions below, developed by researchers at Michigan State University, demonstrate how wording can affect poll results.[5]

1. Does Michigan spend too much, too little or the right amount on corrections?
2. Is $1.3 billion spent on corrections annually too much, too little, or the right amount?

3. Is spending $23,700 per prisoner annually too much, too little or the right amount?

From a budgetary standpoint, expenditures of $23,700 per prisoner and $1.3 billion in total are equivalent. Yet public opinion about the appropriateness of each figure varies remarkably, as does the result when no figure is cited.

Different Wording Elicits Varying Responses



Similarly, it is helpful to know the range of responses to understand fully the poll results. For example, in the table of hypothetical data below, it could be accurately reported that 45 percent of Americans have an unfavorable impression of the Federal Emergency Management Agency. In the absence of information about the range of responses, readers could easily conclude that 55 percent of Americans have a favorable opinion. An entirely different impression would be conveyed were it reported that less than one in five say their impression of FEMA is favorable.

Very Favorable 2%
Somewhat Favorable 17%
Somewhat Unfavorable 20%
Very Unfavorable 25%
Haven't Heard Enough..... 31%
Don't Know/Not Applicable ... 5%

Ideally, all of a survey's wording and responses will be made available to the public when the survey results are published. When survey language is not made public, however, it is useful to know who sponsored the poll to help judge the survey's reliability.

RESPONSE BIAS

Survey results may also be affected by "response bias," in which respondents' answers do not reflect their actual beliefs. This can occur for a variety of reasons:

- The "Bandwagon Effect," in which respondents base their answers — intentionally or otherwise — on a desire to be associated with the leading candidate or cause.
- The "Underdog Effect," in which respondents formulate their opinions out of sympathy for the candidate or the cause that appears to be trailing in support.
- The "Spiral of Silence," in which respondents feel under social pressure to give only a politically correct answer rather than their actual opinion.

CONCLUSION

When conducted properly and understood correctly, polls provide a useful snapshot of popular opinion. If manipulated or misinterpreted, polls can distort reality. Voters would do well to evaluate polls based on the following 10 questions.[6]

1. Who paid for the poll?
2. How many people were interviewed for the survey?
3. How were those people chosen?
4. Are the results based on the answers of all the people interviewed?
5. When was the poll done?
6. How were the interviews conducted?
7. What is the margin of error for the poll results?
8. What is the level of confidence for the poll results?
9. What questions were asked?
10. What other polls have been done on this topic? Do they say the same thing? If they are different, why are they different? ■

1 Terry Madonna and Michael Young, "Politically Uncorrected: The First Political Poll," Franklin & Marshall College, Lancaster, Pa. Available on World Wide Web: http://www.fandm.edu/x3905.xml.
2 Ibid.
3 The U.S. Survey Course on the Web, "Landon in a Landslide: The Poll That Changed Polling," City University of New York and George Mason University. Available on World Wide Web: http://historymatters.gmu.edu/d/5168.
4 Sally Sievers, "The Infamous Literary Digest Poll, and the Election of 1936," Wells College, Aurora, N.Y. Available on World Wide Web: http://aurora.wells.edu/~srs/Math151-Fall02/Litdigest.htm.
5 Institute for Public Policy and Social Research, 1997. State of the State Survey, "Attitudes Toward Crime and Criminal Justice: What You Find Depends on What You Ask," No. 97-20, Michigan State University, East Lansing, Mich. Available on World Wide Web: http://ippsr.msu.edu/Publications/bp9720.pdf.
6 Adapted from Sheldon R. Gawiser and G. Evans Witt, "20 Questions a Journalist Should Ask About Poll Results," National Council on Public Polls. Available on World Wide Web: http://www.ncpp.org/?q=node/4.

HAPPY FEET

Running rings around the facts

Misinformation about a presumed environmental threat was the subject of the winning submission to our "Scientific or Not?" essay contest. Linglu Zhou, 16, a junior at Lakeview High School in Battle Creek, will receive a $500 scholarship from MichiganScience for her essay "The Science Behind Happy Feet."

The contest requires students in grades 6 through 12 to analyze in 500 words a scientific fact or fallacy from a book, movie, song or other pop-culture medium. The contest is sponsored by MichiganScience and Edmund Scientifics, a premier supplier of science kits and other educational materials.

The movie "Happy Feet" focuses upon several "green" topics, including marine debris that poses hazards to wildlife. Zhou described how a Rockhopper penguin by the name of Lovelace is trapped in a six-pack ring carrier that threatens to choke him as he grows.

In fact, according to Zhou's research, it has been illegal under federal law to distribute non-degradable ring carriers since the Environmental Protection Agency crafted regulations in 1994 at the direction of Congress.

"Studies have shown that ring carriers in marine environments will lose 75 percent of their strength within days, and disintegrate entirely in 3-4 weeks," Zhou wrote. "Therefore, Lovelace the penguin would be able to rip through his plastic necklace easily as the rings became increasingly prone to breakage."

Aside from becoming an expert on ring carriers and photodegradation, Zhou learned another important lesson: "I need to do more research on what actually is dangerous to the environment," she said. "I need to be more knowledgeable."

Zhou learned about the essay contest from Walt Erhardt, her AP chemistry teacher at the Battle Creek Area Math and Science Center, which provides accelerated enrichment instruction to students in grades 9 through 12. The bulk of her research was conducted online.

Science aptitude certainly runs in Zhou's family; both parents are chemists. "I get a lot of it around the house," she said. For example, Zhou and her father currently are researching how Vitamin E affects the oxidation of food. Last year, they analyzed the various factors affecting the degradation of Vitamin C. She also participates in her school's Science Olympiad.

Although science figures prominently at school and at home, Zhou actually favors history and she is considering a career in international relations. She founded the Save Darfur Club at her school to raise awareness about the Sudanese genocide, and she participates in Model UN and Peace. "I want to help people and help to prevent genocide," she said.

The new essay contest will be announced in the next issue of MichiganScience. »

Linglu Zhou

By Linglu Zhou

Environmental Science Fiction in Antarctica

Aside from charming audiences with its sweet singing penguins, the blockbuster movie "Happy Feet" addresses several "green" topics. One point the movie makes is that marine debris poses hazards — the 6-pack ring carrier, in particular.

Throughout the movie, a Rockhopper penguin by the name of Lovelace wears a ring carrier around his neck as a "souvenir" bestowed upon him by the "mystic beings" (i.e., humans). As Lovelace grows, the plastic rings become tighter and nearly choke him to death.

A major manufacturer of the ring carrier, Illinois-based ITW Hi-Cone, has complained that the movie sends the wrong message about its product. According to the company, the ring carrier is both non-toxic and photodegradable, thereby posing little risk to wildlife.[1]

So what's the scoop on these rings? Are Hi-Cone executives merely trying to conceal unflattering characteristics of their product? Or, did the "Happy Feet" producers fail to do their homework on the environmental impacts of ring carriers?

The ring carrier has been in the environmental spotlight since the late 1970s. People often associate it with animal entanglement. But it has been illegal under federal law to distribute non-degradable ring carriers since the Environmental Protection Agency crafted regulations in 1994 at the direction of Congress. All three major manufacturers of ring carriers currently produce them with 100-percent photodegradable plastic.[2]

Photodegradation means that exposure to the sun will break the bonds of the polymers that comprise plastic. Scientists have incorporated weak links in the polymer chains — carbon monoxide molecules, in the case of ring carriers — to make the plastic more sensitive to sunlight and, consequently, more vulnerable to breakage.

When the polymer is exposed to the ultraviolet rays in sunlight, the carbon monoxide molecules absorb the energy and transfer it throughout the chain, which then fractures. Over time, the plastic becomes weak and brittle, and disintegrates.

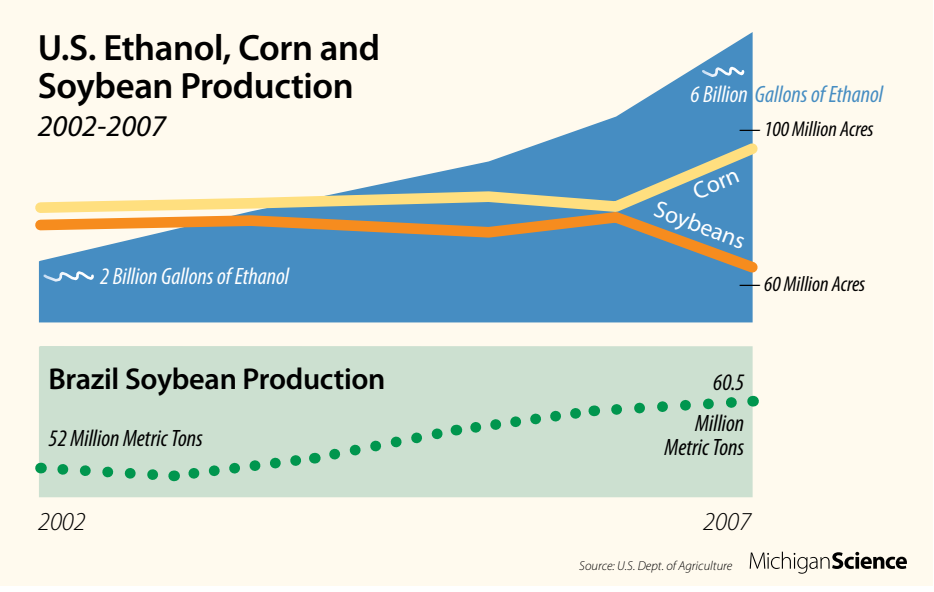
Studies have shown that ring carriers in marine environments will lose 75 percent of their strength within days, and disintegrate entirely in 3-4 weeks.[3] Therefore, Lovelace the penguin would be able to rip through his plastic necklace easily as the rings became increasingly prone to breakage. In addition, this story is set in Antarctica, where thinning of the ozone layer increases exposure to ultraviolet radiation. Therefore, the ring carrier would be even more susceptible to photodegradation.

What's more, Lovelace is later seen hanging on for dear life as a killer whale who has clamped onto the necklace thrashes him in and out of the Antarctic waters. Surely the necklace would shatter under such circumstances!

It's hard to say how producer George Miller could justify "Happy Feet's" portrayals of the ring carrier in light of these facts. But audiences should be happy to hear that the plastic ring carriers aren't actually hurting those happy dancing penguins after all. ■

1 Spiegel, Rob, "Happy Feet Gets Its Eco-Science Wrong." Feb. 5, 2007. For more information go to http://www.designnews.com/article/CA6408333.html.
2 "EPA Sets Degradability Standards for Plastic Ring Carriers," 1994. For more information go to http://www.p2pays.org/ref%5C02/01034.pdf.
3 TW Hi-Cone, "Details and FAQ about our Environmentally-Safe Products and Recycling Program," 2002. For more information go to http://www.hi-cone.com/Environment/environment-carriers.htm.

With this issue of MichiganScience, we launch a new feature that will highlight data relevant to current events. Readers are welcome to send suggestions for future topics to katz@mackinac.org.



Nearly 7 billion gallons of ethanol are now produced annually in the United States, an increase of some 250 percent in the past five years. The data above illustrate how policy choices can produce unintended consequences.

The vast majority of ethanol produced in the United States comes from corn, which has prompted a significant shift away from soybean production to corn.

The prices for soybeans increase as the supply declines. The higher prices prompt farmers in Brazil to plant more soybeans. Consequently, the rate of deforestation in Brazil has worsened. ■

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