

APPENDIX

The mission of the Kentucky Academy of Science is to encourage scientific research, promote the diffusion of scientific knowledge, and unify the scientific interests of the Commonwealth of Kentucky. This is accomplished, in part, through programs sponsored and encouraged by the Junior Academy of Science.

The Junior Academy holds a meeting annually at which precollege students have the opportunity to share their experiences in investigative science with their peers and with more seasoned science educators and scholars. This meeting provides an excellent opportunity through which KAS fulfills a portion of its mission by ratifying the efforts of these fledgling scientists and acknowledging their accomplishments.

The *Journal* also plays a role in this process by broadening the exposure afforded these ini-

tial experiences in scientific investigation. In this section, sample abstracts from last year's Junior Academy program are presented. Please share with us the celebration of these early steps in science by the students whose work is summarized here. The Editorial Board of the *Journal* takes this opportunity to congratulate these students and their mentors. In addition, on behalf of the Academy's Governing Board, we encourage you to help advance the Academy's mission and to assist these student efforts by providing your encouragement and, if possible, mentorship in the development of projects and in the written and oral communication of project results.

Raymond E. Sicard, Ph.D.
Editor

Abstracts Submitted from the 2001 Kentucky Junior Academy of Science Meeting

Edited by Robert J. Barney

BEHAVIORAL & SOCIAL SCIENCES

The effect of rap and classical background music on math and reading comprehension test scores of high school students. CHRIS BISCHOFF, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

This study was conducted to determine the effect music might have on academic testing. The idea was to determine if listening to classical or rap music while performing math and reading comprehension tests would increase or decrease performance of high school students. The test group consisted of high school sophomores ($n = 30$) with ages ranging from 14 to 16 and gender having an equal representation. The testing situation was identically replicated for each subject. Classroom setting, individual headsets, preset volume, preset music selection and timed test were repeated for all. Three types of listening styles were tested: rap, classical and no music. Two types of tests were used, math and reading comprehension, each consisting of 10 questions. The data obtained during this study showed the control group, which had no music, scored an average of 87% on math and 71% on reading comprehension. Results from those exposed to classical music were 90% on math and 74% on reading comprehension. Those who listened to rap music scored an average of 88% on math and 59% on reading comprehension. This study clearly shows the effect these forms of

music have on test performance. Listening to classical or no music while performing math and reading comprehension tests had little or no significant effect on tests scores. Listening to rap music had little or no effect on math scores but severely decreased performance on reading comprehension tests.

A study of individual differences in theories of intelligence in high school students and teachers. EMMA ES-SOCK-BURNS, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

The purpose of this study was to better understand theories of one's self concerning both fixed and malleable intelligence in relation to development and confidence. Scholastically targeted high school age students were assessed on their intelligence self-theories which was compared to confidence level, goal orientation (performance or learning), and preferred subject area. A questionnaire gauging intelligence theory (entity/fixed or incremental/malleable) on a "changeability" and "ability" scale was administered to 186 high school students. Responses were related to "goal" (learning or performance oriented), "intellectual-confidence," "preferred subject" (Math/Science or English), gender, major, and year. A similar questionnaire was administered to 29 teachers with "failure" (likelihood of student not attempting a challenge after failure)

and "success" (likelihood of student re-attempting a challenge after teacher's entity-trigger praise) measured in relation to the subject and year taught. Students tended more toward entity as they got older (mean ability ranking: freshmen = 39%, seniors = 60%); yet girls were more incremental than boys (mean changeability ranking: girls = 4.3, boys = 4.1) and art was the most incremental major (mean changeability ranking: art = 4.57, math/science/technology = 4.00, high school university = 4.00). Intellectual self-confidence differed in sophomore year (mean changeability ranking: girls = 4.7, boys = 5.5), coinciding with the girls' highest entity thinking year, supporting Dweck's "helpless pattern." Student intelligence theory matched that of their preferred subject area teacher, possibly reinforcing each other. This study supports the idea that people retain specific intelligence theories, which continue to affect various facets throughout high school. Therefore, can these theories be targeted and changed with external stimuli creating a more sound and enriching persona?

A study of the effects of exercise on the symptoms of seasonal affective disorder. JILLYAN HARLAN and LISA MUDD, Math/Science/Technology Magnet, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Seasonal affective disorder (SAD) is a condition in which people seem to weaken during the colder months of the year. Its characteristics include a lack of energy and the ability to concentrate, increased appetite, hypersomnia, and withdrawal from family and friends. A study was conducted to find whether exercise has an effect on SAD. This study surveyed 104 athletes and 104 non-athletes about their emotional and physical observations between the months of November and April. After analyzing the data, it was found that 67.86% of non-athletes experience the effects of SAD while only 43.14% of athletes experience these same effects. Therefore, it was shown that exercise does have an affect on the symptoms of SAD in students.

The effect of time interval between sleeping and learning on memory retention. NGOCUYEN V. NGUYEN, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Behavioral studies have made it known that permanent memories are not created at the instant they are acquired. Rote rehearsal allows information which has remained in short-term memory long enough to be transferred into long-term memory, through coding processes. There are many theories involving the role REM sleep plays in the consolidation of long-memory, known to be stored in the cerebral cortex. Numerous factors have been known to affect memory retention, including sleep. This experiment was designed to test the effect of the interval between study and sleep on long-term memory retention. Four female subjects within the same age range were asked to participate for five nights. For each night, each was given a list to study and directed to get to bed at a specified

interval after their study time. It was hypothesized that a shorter interval will result in better memory performance. The hypothesis was not supported by the results of the experiment. There are many variations between data gathered from each subject and inconsistency in pattern, which suggests errors. The experiment also proposed amount of sleep as a possible influencing factor on subjects' performance, but this was not supported either.

A study of speech discrimination in children with Williams Syndrome. JENNIFER TINDLE, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

This project was designed to determine if Williams syndrome children discriminate speech sounds like normal functioning people. Williams syndrome is a genetic disorder caused by a deletion on the 7th chromosome. A symptom of this disorder is mild mental retardation and often attention disorders. People with Williams syndrome often experience other medical problems such as heart problems and heightened sensitivity to sound. The participants were tested by having them listen to two speech sounds, /ba/ and /ga/, 40 times each. The child wore a geodesic sensor net (124 electrodes) on their head to record the brain activity. While the stimuli were being presented the child's brain waves were being recorded using the net station. After the data were analyzed it was found that the Williams syndrome children analyzed the sound similar to normal functioning children, but at a slower rate.

Daily activity of *Tenebrio molitor* beetles. SHANNON TURNEY, Notre Dame Academy, 1699 Hilton Drive, Covington, KY 41011-2796.

It is very difficult to monitor the motion of *Tenebrio* adults because the insects live in the dark. The purpose of this experiment was to measure the activity of the *Tenebrio* without using light. A Hall effect probe, used to monitor changes in a magnetic field, can detect movement of a magnet. Small chips of magnets were glued onto the backs of several *Tenebrio* adults. Individual adults were then placed, along with the probe, some bran, and a small piece of potato for moisture, into a small chamber consisting of a film tube with a hole in the side to position the probe. The Hall effect probe was interfaced to a computer and the magnetic field was monitored for 24-hours. The times when there were changes in the magnetic field corresponded to periods of motion. This made it possible to track the *Tenebrio* without using light. The *Tenebrio* adults were active approximately 31% of the time, 50% of which were between the hours of 8 pm and 1 am, when the insect was most active. The lower points of activity were between 6 am and 10 am. This supports the common claim that the beetles are nocturnal.

Electrophysiological indicators of phonetic discrimination in human infants. WILLIAM ROBERT USELTON III, Science Department, Louisville Male High School, 4409 Preston Highway, Louisville, KY 40213.

The purpose of this longitudinal study was to replicate

and extend previous studies to see if the infant brain can discriminate between various computer-generated consonant-vowel speech sounds and use the data to see if one can predict a person's ability to acquire language within 48 hours of birth. Seventy-six infants, from the Kosair Children's Hospital nursery, were recruited for testing through parents' permission. Testing involved playing the speech sound (ba, da, ga, bu, du, and gu) while the infant lay in a crib. While the stimulus was playing, a 128 channel geodesics sensor net, a very sensitive apparatus, recorded the ongoing EEG and the infant's brain response. Once the procedure was completed, the net was removed and the data analyzed. EEG files were segmented, averaged, baseline-corrected, and submitted to principal component analysis and analysis of variance. The results were in agreement with the previous studies and indicated that the infant brain reliably discriminates between various consonants and vowels ($p < 0.0001$). The next step will involve using the patterns of electrical brain activity in response to the sounds to predict a person's ability to acquire language.

BIOLOGICAL TOPICS

The effects of biobooster chemicals on the denitrification of water. EVAN BOYER and BRIAN GOODIN, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

A test was conducted to determine which biobooster chemical lowered the amount of ammonia and nitrite fastest. This has applications in aquaculture (the growth of aquatic species in contained systems) for determining the best chemical to use when growing species in recirculating systems. Aquatic species continuously raise levels of these toxic chemicals with their waste, so a way of disposing of the chemicals is needed. Twelve samples of water containing 3 ppm ammonia were set up and air was pumped through the containers for 2.5 weeks. Three samples (the control) contained no ammonia-lowering chemicals, three contained *Freshwater BioBooster*, three contained *Bacta-Pur*, and three contained *Zeolite*. All of these chemicals were said to lower the levels of ammonia and nitrite faster than an environment not using any chemicals at all. Over the test period, ammonia, nitrites, and nitrate levels were determined using standard tests. It was found that *Bacta-Pur* lowered the levels best, followed by *Freshwater BioBooster*, *Zeolite*, and finally the control group. All chemical companies were correct in claiming they lowered the levels of chemicals faster than an environment without the chemical, but *Bacta-Pur* was most effective and is, thus, better suited for use in aquaculture.

The effect of status epilepticus on the GABAergic synaptic activity in the hippocampal formation of the brain. SUZANNE N. BRYCE, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Status epilepticus is a condition that plagues nearly 200,000 Americans every year. Although this is a prevailing disease, minimal research has been done on the effects

of status epilepticus, what causes it, and how it can be prevented or cured. GABAergic neurotransmission in the hippocampus of the brain is believed to play a major role in termination of status epilepticus seizure activity. This experiment was conducted to determine whether the GABAergic activity increases or decreases during status epilepticus. It was hypothesized that the GABAergic activity in the hippocampus would increase during seizure activity. The tests were run on adult male, white Wistar rats. They underwent surgery to implant stimulating and recording electrodes in their brains. One week following this surgery, status epilepticus was induced on those animals which were to have their hippocampal tissue processed as "status" cells. Only animals which demonstrated predetermined ictal activity were used in the study. Tissue from both the "status" group and the control group was perfused and processed for GABA immunoreactivity. The number of GABAergic synapses for each group was quantified. It was determined that the total number of GABAergic synapses in the 98 control cells (305) greatly exceeded the total number of synapses in the 98 status epilepticus cells (268). The average number of GABAergic synapses per control cell was 3.1, while the average per status epilepticus cell was 2.7. It can be concluded that, instead of increasing, neural activity in the hippocampus decreases during status epilepticus, possibly because of the excitatory changes on the cell somas during the seizure activity.

The implications of age in relation to the hand development of string musicians. ERIN FINGER, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Dedicated musicians who learn to play stringed instruments early in childhood often develop growth abnormalities in their hands due to repetitive motions and stretching of their fingers. To determine if learning advanced techniques at a young age affects hand growth of musicians by causing abnormal development and increasing risk for repetitive strain injuries, an experimental group of 75 string musicians and a control group of 75 people who did not play string instruments were questioned. The survey population of musicians who played string instruments began playing their instruments at different developmental stages. Seventy-five percent of musicians who began playing under age 6 noted abnormalities in development of their hands compared to 16% of musicians who began at age 11. Fifty-one percent of musicians who started playing before the age of 10 experienced injuries. Learning advanced string instrument techniques at an early age is detrimental to the physical development of hands by causing growth abnormalities which can cause and aggravate repetitive strain injuries. Implications are that established methods like the Suzuki method may be better focused on the theory, musicality, and ear-training necessary for musical accomplishment, rather than advancing rapidly to a difficult repertoire that requires unusual stretching and hand movement before the joints and tendons are fully

developed. This will ensure that the body of the child is physically ready for the stretching involved in playing a stringed instrument and will decrease the risk of music-related repetitive strain injuries when the musician is older.

Change in placebo effect by diagnostic criteria in acute mania. ASHLEIGH HARDIN, Seneca High School, 3510 Goldsmith Lane, Louisville, KY 40220.

Bipolar I disorder, also known as manic-depressive disorder, is a mental illness in which the sufferer experiences extreme lows (depression) and extreme highs (mania or euphoria). It affects 1% of the U.S. population and is believed to be caused by genetic, environmental, and biochemical factors. The criteria used in diagnosing mania have changed over time. I have found that factors such as the length of trials, the source of funding, and possible lithium immunity also affect a change in the placebo effect. I researched several different studies of acute mania in which subjects were treated with either lithium, a placebo, or both. I also noted what methods the researchers used in diagnosing mania: RDC, DSM-III, or DSM-IV. I then tabled this information and found the mean of each method's response rate for both lithium and placebo. I found that placebo response was higher for RDC and DSM-IV methods. In addition, the lithium response rate was higher for DSM-III than for the others. I conclude that RDC and DSM-IV criteria are more compatible but may not be strict enough to prevent a relatively high placebo response.

Leukocyte surface expression of human HLA B-27 transgene in rats. STEPHANIE LOGSDON, Seneca High School, 3510 Goldsmith Lane, Louisville, KY 40220.

The HLA B-27 gene in humans is directly linked with development of inflammatory diseases, spinal arthritis, immune disorders, and organ transplant rejection. The factors that influence the onset of the severity of the manifestations of the disease are unknown. Transgenic rats are a model of irritable bowel syndrome, and these unknown factors were investigated through the transgenic rats and their progeny of hybrid background strains. If the factors that control aspects of the disease are found, ways to manipulate them to slow the onset of the disease and reduce the severity of it can be developed. The success of inserting a B-27 transgene into a non-transgenic strain of rat has never been attempted to date, so adverse effects to the fetus could result. Transmission of human HLA B-27 transgene in each of two female rats was followed through one generation. Factors that may influence cell surface expression of this transgene were studied, such as fetal survival, gender, and age differences among the progeny. Rats were mated with a non-transgenic strain of brown Noway rat. All rats with the transgene are affected by the age of six months, but the severity of manifestations of the disease varies. Since the time to manifest disease exceeds the duration available for this project, we used cell surface expression of the HLA B-27 protein on rat

leukocytes as a surrogate marker of transmission, since greater expression correlates with earlier onset of the disease. I sought to study factors that may alter leukocyte surface expression of the transgene in progeny of matings between transgenic and normal rats. Analyses included the proportion of rat pups that receive the transgene and the intensity of its expression on leukocyte surface. From the resulting data, it can be concluded that the B-27 gene can be successfully entered into a non-transgenic strain of rat without harm to the fetus. Also, the data shows that the intensity of the transgene expression, and therefore the disease itself, is not age-dependent but gender-independent. Ongoing studies are being performed presently to test the effects of other rat genes on expression of the transgene.

The effect of magnetism on foot warmth during winter exercise. JESSICA H. LOWELL, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

The purpose of this experiment was to test the impact of magnetism on warmth and comfort in cold weather. It was hypothesized, for reasons outlined in the main section of the paper, that magnetism would not have a significant effect. The sample consisted of nine members of Team Louisville Bicycle Club, a competitive amateur cycling team. Each subject wore either a magnet or a placebo on each foot during two training rides in December or early January. The magnets were attached with Velcro to the insides of the "booties" worn by the cyclists. Each subject completed a response form evaluating the effects of their magnets. Three tests showed significant results—a test of the effects of north-seeking magnets worn during the first ride, a test of the linear relationship between outside temperature and the placebo effect, and a test of the effects of north-seeking magnets worn on the left foot. I offer several possible explanations for the results. One was that north-seeking magnets actually stimulate tissue, as stated by magnetic therapists. Another was that the primary orientation of the cyclists affected the magnets.

The effectiveness of selective serotonin re-uptake inhibitors on obsessive-compulsive disorder. STEPHANIE L. LUCKETT, Seneca High School, 3510 Goldsmith Lane, Louisville, KY 40220.

Obsessive-compulsive disorder (OCD) is an anxiety disorder which causes a person to have recurring thoughts (obsessions) and/or compelling feelings to perform ritual acts (compulsions) repeatedly. The disorder affects approximately 1.2 million people in the U.S. and is ranked in the top five mental illnesses in the U.S. Low levels of the neurotransmitter serotonin are predicted to be the cause of this illness. Current treatments for OCD are usually a combination of pharmaceutical medications and/or behavior therapy. Pharmaceutical medications include Prozac®, Luvox®, Paxil®, Zoloft® (all selective serotonin re-uptake inhibitors—SSRI), and Anafranil® (a tricyclic antidepressant). I limited my study to SSRIs. After gathering previously done research results and analyzing the

data it has been found that none of the medications have a greater or lesser affect on the patients and that all have proved to work equally well.

Inhibition of ribonucleoprotein enzyme telomerase correlates with antiproliferative activity of guanosine-rich oligonucleotides. NIKHIL MIRCHANDANI, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Telomerase uses the RNA component of its ribonucleoprotein enzymatic structure as a template to synthesize telomeric DNA (TTAGGG)_n directly onto the ends of chromosomes, thus stabilizing telomeres that protect the ends of chromosomes from degradation and preventing cellular senescence. This study explored the use of guanosine-rich oligonucleotides (GROs) as agents for inhibiting cancerous cell growth through elimination or down-regulation of the enzyme telomerase. In the first successful experimentation of its kind, immunofluorescent labeling procedures were used to locate telomerase in cancerous cells. DU 145 (prostate), PZ, CA, and MDA (breast) tumor cells were exposed to modified oligonucleotides GRO 29A and GRO 15B and 4% paraformaldehyde in phosphate-buffered saline (PBS), then washed. Cells were blocked with 5% goat serum in PBS and incubated overnight with anti-telomerase primary antibody at 1:50, 1:100, 1:200, 1:400, and 1:800 concentrations at 4°C. The cells were then placed in a humid chamber, washed, and incubated with secondary antibody in concentrations corresponding to the concentrations of the primary antibody. Cells were finally washed and mounted for viewing. It was found previously that GRO 29A had a potent growth-inhibitory effect on tumor cells. Immunofluorescent labeling showed that GRO 29A also decreased expression of the enzyme telomerase, while GRO 15B and PBS did not. This suggests that the antiproliferative activity of G-rich oligonucleotides correlates with inhibition of telomerase, possibly through direct binding.

The isolation and identification of rat neuroglobin cDNA using PCR and DNA sequencing. SUPRAJA PARTHASARATHY, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

This project was conducted to determine if a protein that carries oxygen to the brain, neuroglobin, was present in rat brain. Finding neuroglobins in rat brain may lead to advances in medications and research for brain related diseases such as stroke and Alzheimer's disease, because rat brains are one of the best models to use in brain research. Neuroglobin cDNA was isolated and identified in a rat brain cDNA pool using polymerase chain reaction (PCR). Putative neuroglobin cDNA was ligated with a bacterial plasmid called p-GEM T-easy vector and inserted into competent bacteria (DH5α) which were grown in optimum conditions. DNA was isolated from the bacteria and results showed that rat brain has neuroglobin. The neuroglobin cDNA contains 456 bases coding for 151 amino acids, starting with ATG (methionine) and ending with TAA (stop codon). The nucleotide sequences in mouse is

96.7% and in human is 94.7% similar to the rat nucleotide sequence. The amino acid sequences in mouse is 96.7% and in human is 87.7% similar to that of the rat. In conclusion, this finding of rat brain neuroglobin may help advancement towards new medications and treatments for brain related diseases.

Arteriole dimensions and aging: mechanisms of orthostatic hypotension. SUDIP K. SAHA, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

First order arterioles were isolated from the cremaster muscle of aged (n = 12) and young (n = 19) male rats. The arterioles were treated with varying concentrations of norepinephrine to ascertain constrictor responses. Step changes in pressure (0–170 cm H₂O) were performed in a calcium-enriched solution to measure the active curve. Varying concentrations of acetylcholine and adenosine were used to measure dilator responses. Step changes in pressure (0–190 cm H₂O) were performed in a calcium-free solution to measure the passive curve. Both aged and young rats showed a significant ($P < 0.05$) decrease in arteriole diameter as concentrations of norepinephrine were increased and significant increases in diameter when concentrations of acetylcholine and adenosine were increased. In the young, the dose response vessel diameter significantly increased as the dose of acetylcholine was increased. However, the dose response vessel diameter did not significantly increase as the dose of adenosine was increased in either the aged or the young. The myogenic response was seen to a greater degree in the young as opposed to the aged. The passive curve showed a significant decrease in diameter as pressure was reduced in aged and young rats. The wall thickness data showed no significant changes as a function of age. These findings suggest that vascular smooth muscle does not change with age. Additionally, there is no significant interaction between wall thickness and vessel diameter. The myogenic response, contractile mechanism, and the ability to release nitric oxide diminish with age. Norepinephrine could be used as an effective treatment for severe orthostatic hypotension.

The validation of residual volumes for aspiration risk in clinically ill patients. JAMES A. STEFATER, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

There are many indicators that correlate with development of pneumonia in ICU patients. However, one of the most popular risk indicators, high residual volumes, has no research to validate its legitimacy. This study looks at the validity of residual volumes as a marker of increased or decreased risk of regurgitation or aspiration. Patients were randomly divided into two groups: feeds in controls were not stopped when residual volumes were less than 400 cc, while in study patients; feeds were stopped at 200 cc to reduce the likelihood of aspiration or regurgitation. It is thought that the group with a higher residual volume cut-off will be more likely to develop positive aspiration

or regurgitation. Feeding bags for both groups were injected with detectable calorimetric microspheres and inert blue food coloring. Secretions were taken from the patients' oropharynx and trachea every 4 hours for 3 days. These secretions were evaluated for visual presence of blue food coloring and the quantity of calorimetric microspheres present in each secretion. Residual volumes of less than 200 cc failed to correlate with aspiration or regurgitation. Study results conclude that holding feeds for designated residual volumes may impede rather than facilitate external feeding. Blue food coloring, after having no positive identification in all 144 samples, has been designated an ineffective marker due to its incredible insensitivity. These conclusions are extremely important pieces of information because it is the common practice of most hospitals to cut feeds at residual volumes between 75 and 150 cc.

An alternative color for lights that need to be seen at low intensities. SHANA STODDARD, Central High School Magnet Career Academy, 1130 W. Chestnut St., Louisville, KY 40202.

The minimum intensity of light detectable by the human eye was studied for different colors of light. The hypothesis is that there is a difference in the minimum intensity of light that is detectable by the human eye based on differences in wavelengths. Colors with longer wavelengths, like red, will be seen at lower intensities than colors with shorter wavelengths, such as blue. Seventy-five male and female volunteers aged 33 ± 19 years (range 10 to 85 years) were enrolled and completed the protocol. Subjects were stratified into five groups of 15 individuals on the basis of age: 10 to 15 years (Group 1), 16 to 25 years (Group 2), 26 to 35 years (Group 3), 36 to 50 years (Group 4) and ≥ 50 years (Group 5). The minimally perceptible intensity of red and blue light was determined using a light-intensity-unit constructed from my personal design. If the individual wore corrective glasses ($n = 32$), they were tested with their glasses on and off for both colors. For the entire group ($n = 75$), minimal intensity of light perceptible was lower for red (0.07 ± 0.09 lux) than for blue (0.09 ± 0.02 lux, $P = 0.024$) light. The minimally perceptible light intensity for red light was higher for Group 5 (0.12 ± 0.15 lux) than Groups 1 (0.05 ± 0.03 lux, $P = 0.025$), 2 (0.04 ± 0.03 lux, $P = 0.01$) and 4 (0.06 ± 0.05 lux, $P = 0.05$), but did not differ from that of Group 3. However, the minimally perceptible light intensity for blue light did not differ between groups. The lowest intensity of perceptible light was lower for red versus blue light in Groups 1, 2 and 4, but did not differ in Groups 3 or 5. These data did support the hypothesis that red light is seen at lower intensities than blue light. The potential practical importance of my project could relate to use of specific colors of light that are more readily detected in emergency vehicles such as ambulances, fire trucks, and police cars.

Improved pulmonary function by hypoxic preconditioning involves upregulation of endothelial nitric oxide synthase (eNOS) and monocarboxylate transporter (MCT1). EFFIE WANG, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

To uncover mechanisms underlying hypoxic preconditioning-mediated protection in the lung, tissue samples were collected from mice exposed to: 1) 21% oxygen; 2) 21% oxygen for 2-h after preconditioning (6 cycles of 10-min 6.5%/10-min 21% oxygen); 3) 5.7% oxygen for 6-h; and 4) 5.7% oxygen for 6-h following preconditioning and 2-h at 21% oxygen. Water content and lactate/glucose concentrations were measured. Also, total cellular protein and RNA were extracted for analysis of gene expression using Western and Northern blot analyses, respectively. Hypoxic preconditioning significantly reduced pulmonary edema caused by severe hypoxia (0.491 ± 0.111 vs. 0.894 ± 0.113 mg/mg dry tissue, $P < 0.025$; $n = 9$). This protection was associated with increased expression of eNOS protein in the lung (2.91 ± 0.13 vs. 1.00 arbitrary units, $P < 0.005$; $n = 6$). Further, hypoxia decreased (9.93 ± 6.09 vs. 33.94 ± 8.35 nmol/mg protein, $P < 0.025$; $n = 6$), whereas hypoxic preconditioning increased (91.78 ± 29.76 vs. 33.94 ± 8.35 nmol/mg protein, $P < 0.05$; $n = 6$) lactate concentration in the lung. The hypoxic preconditioning-induced increase in lactate concentration was associated with an upregulation of MCT1 protein in the lung (3.40 ± 0.29 vs. 1.00 arbitrary units, $P < 0.005$; $n = 6$). It was concluded that hypoxic preconditioning reduced the formation of pulmonary edema, hence improving survival during severe acute hypoxia. This protection involved upregulation of the eNOS gene. It was also concluded that lactate appeared to be the preferred source of fuel for the lung during severe acute hypoxia. Hypoxic preconditioning improved energy supply and cell integrity of the lung by stocking up lactate in lung cells through upregulation of the MCT1 gene. The latter also contributed to the reduced formation of pulmonary edema following hypoxic preconditioning.

BOTANY

Thermotolerance acquisition by raddish seedlings, *Raphanus sativus*. ANDREA MASON, Notre Dame Academy, 1699 Hilton Drive, Covington, KY 41011-2796.

Heat shock treatment could aid agriculture by reducing the threat of early frosts and may also help develop hardier plants by a natural process. It has been shown that by heat shocking many different types of plants, including tomatoes, beans, and cucumbers for a minimal time a few degrees above their optimum temperature for growth, one can ultimately increase their tolerance for thermal and chilling stress. The purpose of my experiment was to investigate whether heat shocking raddish, *Raphanus sativus*, seedlings for 10 minutes at 40°C would increase their tolerance to chilling. I found that the heat shocked plants at room temperature grew a little more than the control group for the first three days of the experiment. Then the average growths leveled off, until ultimately the difference

between the control and heat shocked plants at room temperature was negligible. The difference between the chilled and heat shocked + chilled plants was also minimal. I concluded that the rubber bands that I used to hold the growing apparatus together might have put undue pressure on the roots, causing them to grow sporadically.

Thigmomorphism in dwarf corn. MONICA SUMME, Notre Dame Academy, 1699 Hilton Drive, Covington, KY 41011-2796.

The purpose of this experiment was to discover the effects of mechanostimulation on dwarf corn, *Zea mays*, plants. Plants were subjected to stimulation by means of hand stroking or wind. Both the root systems and stems were affected. Root systems of windblown plants were quite asymmetrical with about 80% more growth present on the side opposite the stimulus. Root systems of hand-stroked plants also showed marked asymmetry. The strength of the sessile leaves and the stems were increased by the stimulation as well, as detected using a computer-interfaced probe to monitor force as a pin punctured the stem in a transverse direction. The average force needed to puncture a control plant's sessile leaf was 0.332 N. The average needed for a plant that was stroked was 0.485 N, while that for a plant subjected to wind was 0.524 N. Phloroglucinol staining indicated the presence of lignin. It was found that lignin content was highest in plants grown in constant wind and lowest in control plants. Hand-stroked plants showed an intermediate amount. The research establishes the fact that mechanostimulation affects this particular species of plant rather drastically. The plants respond by developing stronger stems and adjusting the root systems to compensate for the stimulus.

CHEMISTRY

The synthesis of ion selective silver sulfide electrodes. JAY ANDERSON, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

In the field of analytical chemistry, many different techniques are available to analyze soil samples. One of the more often used techniques is with ion selective electrodes (ISE). Current ISE electrodes are mostly manufactured by commercial companies and are not built to suit the individual needs of scientists. Ideally a hand held or backpack size model would be built to speed up analysis and allow data to be collected on site. For this to be constructed, the main part of the detection unit, the ISE, has to be customized to fit the needs of the developer. Using cyclic voltammetry, a varying voltage of 0 to +1.5 volts was applied to a silver electrode submerged in a 250 mL solution of NaOH at 0.1 mol with 40 mL of laboratory grade NaS₂. This added a black coating around the electrode believed to be composed of silver sulfide ions, which would allow it to detect sulfides. A potentiometric experiment was then undertaken to determine if the electrode reacted when a sample of sulfide was present. The coated part of the electrode was placed into a NaOH solution of 0.1 mol with a reference electrode on a stirrer plate. The

electrodes were connected to a digital multimeter and measured additions of a diluted 0.01 mol solution of NaS₂. The fragility, lifetime, and durability of the electrodes were low and the thickness of the coating varied, eliminating the feasibility of producing such electrodes.

COMPUTER SCIENCE & MATHEMATICS

Three-dimensional applications of Pick's Theorem. ADAM R. CHAWANSKY, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

George Alexander Pick published the theorem bearing his name in 1899. Pick's theorem states that the area of a simple lattice polygon equals $B(P)/2 + I(P) - 1$. This project sought to determine if a similar formula could be created for calculating volume for three-dimensional solids. For the purpose of this experiment, slightly different definitions of the variables B (boundary) and I (interior) were considered. Since three dimensions were being manipulated, it was believed another variable may have been necessary. The inclusion of an S (side) variable was used for the lattice points on the sides of a solid. The variables were also examined when B equaled all of the points on the edges and faces of the solid; I continued to equal all of the points inside the cube. However, this method quickly led to data devoid of a meaning. After defining the variables, different shapes were imaged using a pseudo-grid formed by K'Nex, and the variables and volume were computed using appropriate formulas. To simplify things, one or two variables were often used as controls while the remaining variables were examined for patterns. Patterns were found, but they were not coherent enough to form a general formula. Due to research conducted prior to the experiment, it is believed a general formula may be constructed with higher level mathematics than were available. Such a formula might allow simplified computation of volume in three or more dimensions.

Digital electroencephalograph recording and analysis: software for researchers. MARK GRUENTHAL, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Epilepsy is a common malady that disables thousands of people. Rats are the most common animals used by researchers to study epilepsy and its potential treatments. During an epileptic seizure, the currents emanating from brain cells (neurons) become synchronized and grow in strength and frequency. A device called an electroencephalograph (EEG) is used to record and analyze these electrical currents and seizures. Traditional EEGs use analog data that is displayed with ink pens on scrolling paper. Researchers rely on these paper traces to do their analyses, having to resort to hand measurements in order to detect the duration, frequency and severity of the seizures. Through a process called analog to digital conversion, analog data can be converted into digital data that can be stored by computer. However, these technologies have only been utilized for human EEGs and at great expense. The purpose of the current project was to create

a cost-efficient method for collecting digital EEG data on rats. Such software does not exist to date. Software was developed to input, save, and replay EEG data with a computer. Seizure duration can be automatically determined. After development of the software, testing was performed on rats to determine the effectiveness of the procedure. The conversion software produced accurate, reproducible results. This software may be a useful tool for the estimated 300 laboratories in the United States alone that study epilepsy with rats.

Golden mean and nature. JUSTIN LEWIS, Science Department, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

This research project deals with the Golden mean and how it relates to nature. The Golden mean is a number based on the Fibonacci Sequence (1, 1, 2, 3, 5, 8, 13, 21 . . .), which adds the last two numbers to get the next number in the pattern. This pattern was seen to occur several times in nature. But does it occur regularly? The hypothesis was that the plants studied would show the Golden mean and the Fibonacci sequence. The methodology involved examining 75 specimens of each of three plants (pine cones, cauliflower, and broccoli) and counting their spirals. Effort was made to get plants as close in size as possible. If one observes from the top of a pinecone or cauliflower, one will notice spirals that go in both directions (clockwise and counter-clockwise). This study found that the number of spirals in cauliflower and pine cones are always Fibonacci numbers, as well as Golden mean proportions. However, it was found that broccoli did not have any spirals and, thus, broccoli showed no pattern in this study. Therefore, it is concluded that the Golden mean does occur regularly in nature; but, not in everything.

Development of a computer database using Microsoft software. JIE MA, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

This project focused on the formation of a computer database using Microsoft Access and relevant programming languages such as Visual Basic (VB). The aim was to create a database with essential information in math, science, and computers to aid high school students in their education. Microsoft Access was chosen because of its aptness in size (for small business and personal use) and function (simple to use yet very powerful). The programmer first entered data into individual tables (here data is sorted), then created complementary forms and relevant queries were made. Tables and forms were then implemented by VB code in a user-friendly environment (a form) with interactive buttons and icons for user-convenience. The finished database featured substantial data of three subjects (general math, science, and C++ programming aid) with sub-menus beneath each icon. VB code was also used to program the buttons and other necessary links in the forms. The template for each form display is well-structured. Although no formal testing was done, several stu-

dent testers responded receptively to using the database in aiding their school work.

E-Commerce security. SOWMYA SRINIVASAN, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

After observing the recent rise in the usage of the E-Commerce market, it was seen that security has become a hot topic. In general, the public does not have fears about making transactions at stores or via telephone, but fears do arise while making transactions on-line. There is general anxiety about giving out credit card numbers through the Internet. This study focused on the different methods of securing servers to protect them from hackers and viruses, and to ensure that card numbers are not given out. These security methods include encryption, secure socket layer (SSL), secure electronic transaction (SET), firewalls, and smart cards. This research was then compiled and analyzed to suggest the best security method for the near future.

Stock market vertigo and irrational reactions to index milestones. LAWRENCE M. WATKINS, Louisville Male High School, 4409 Preston Highway, Louisville, KY 40213.

We conducted an investigation into market activity during periods in which the Dow Jones Industrial Average is in close proximity to major market milestones. In contrast to predictions of asset pricing theory, we find that investors exhibit peculiar trading patterns, even among stocks that have very little correlation with those included in the 30-stock index. More specifically, we find that trading volume declines significantly as the Dow approaches each milestone and it increases significantly as the milestone is surpassed. In addition, return volatility tends to increase during these periods, and the standard volume/volatility relationships documented in the literature change direction in the presence of major milestones. Finally, for the Dow itself, there are significantly fewer price reversals when the index is in close proximity of a milestone. These results are found to exist among all three exchanges and among most size deciles within exchanges, even for those portfolios with assets that are not included in the calculating of the Dow. These results have compelling implications for option pricing, as well as the general debate on market efficiency. The data we used was collected by the Center for Research in Securities Prices Database, using daily stock returns from 1972 through 1999. This period was chosen because all 1,000 point market milestones were surpassed after this date.

The validity of using firewalls as intrusion detectors in computer systems. JUSTIN WIBLE, Seneca High School, 3510 Goldsmith Lane, Louisville, KY 40220.

A study was performed using the most up to date firewall to determine its validity as an intrusion detector in computer systems. The experiment was designed to show the overall accuracy of the firewall, as well as to determine

if there are ways to break through the wall or go around it. I expected to get through the perimeter code fairly quickly, but would be caught and ejected quickly once into the deeper parameter. I expected the firewall to catch my intrusions approximately 85-95% of the time. I found that the Sonicwall is approximately 97% effective at catching intrusion, and when used in a comprehensive network, it provides adequate protection.

EARTH & SPACE SCIENCE

Earthworms as natural decomposers. JOHN MEI-GOONI, Morton Middle, 1225 Tates Creek Rd., Lexington, KY 40502.

In this project the effect of earthworms on the germination and growth of grass seeds was measured. Measurements were performed by comparison of grass heights with different numbers of earthworms, to grass height without earthworms. Four planting pots were labeled as control (no worms), 3 worms, 6 worms, and 10 worms. These pots were filled with topsoil up to 2 inches from the top. Then earthworms were added to each pot according to the labels on the pot. One-quarter cup of grass seeds was added to each pot and another quarter cup of topsoil was added on the top of the seeds. Each pot was given one cup of water. All pots were placed in the basement in front of a window and were watered every other day. Growth of grass seeds and other observations were recorded after germination. The growth of the grass was measured from the top of the soil in the pots to the average tip of the grass. After 22 days, the height of the grass was found to be 15 cm, 16 cm, 18 cm, and 20 cm in the pots with control, 3 worms, 6 worms, and 10 worms, respectively. The results of this project had shown that grass heights were 33%, 20%, and 6.7% taller in the pots with 10 worms, 6 worms, and 3 worms, respectively. Also, more seeds germinated in the pots with the larger number of worms. This experiment was repeated again under the same conditions and ended with the same results. Therefore, the earthworms did act as natural decomposers.

Stratification in granular materials. ALLISION MORRIS, Notre Dame Academy, 1699 Hilton Drive, Covington, KY 41011-2796.

When an originally homogeneous mixture is poured into a quasi-two-dimensional cell, spontaneous stratification occurs. This experiment involved a 50/50 volume mixture of sand particles ranging from 841 to 1190 micrometers and sugar particles ranging from 10 to 170 micrometers. Both types of grains had an average aspect ratio of 1.4. When these grains were poured slowly into a vertical Hele-Shaw cell, regions of stratification and segregation formed. The dark sand stripes were somewhat broader than the light sugar stripes. The purpose of my experiment was to test the effects on the stratification when the cell was tilted away from vertical. As the cell was angled further from vertical, the stratification became less apparent and three-dimensional segregation occurred. There was an increasing concentration of sand on the top

of the cell and sugar of the bottom of the cell. This probably occurred because when the cell was tilted, the speeds of the rolling particles were reduced. This allowed more time for the small grains to fall to the bottom of the cell.

Investigating variables in the universal soil loss equation. CHRIS REZVANIAN, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Many agriculturists use the universal soil loss equation (USLE) to predict average annual soil loss. This experiment was conducted to investigate and revise the USLE to account for soil moisture and seasonal rainfall variations. A revised equation was created to evaluate circumstances of natural weathering from summer through fall (June 20, 2000–December 22, 2000). A sine regression that fits the plotted data of average monthly rainfall in Louisville was successfully found using a TI-83 calculator. Using this sine regression, the rainfall factor (R factor) in the USLE as well as the soil erodibility factor (K factor) were manipulated to create a revised soil loss prediction equation that can be applied to short term erosion prediction. The rainfall in the summer and fall of 2000 were very similar to the average rainfall. This increased data significance in my project. The revised USLE was compared to the standard USLE and found that the revised USLE was much less than half of the standard predicted soil loss for Louisville, KY; therefore wholly supporting my hypothesis. After the 26 weeks of natural weathering on the ditch, it was found that approximately 490 pounds of soil eroded from the surface of the ditch. The revised USLE predicted that the ditch would displace 483.17 pounds of soil over the 26-week period. These results are very significant and fall under the 0.05 probability level using a T-test.

ENGINEERING

Effects of abscisic acid and gibberellic acid on tensile and compressive strength of bamboo. JULIE WOLFE, Notre Dame Academy, 1699 Hilton Drive, Covington, KY 41011-2796.

Bamboo, *Phyllostachys aureosulcata*, has many practical uses. It is used as a building material in developing countries, but displays some structural weaknesses. The purpose of my research was to see if adding a plant growth hormone to the bamboo's water supply would influence its strength under compression and tension. Abscisic acid (ABA) and gibberellic acid (GA) solutions (10^{-5} M) were used to water bamboo plants in an attempt to change the physical characteristics of the bamboo. Once new bamboo shoots had appeared after application of the chemicals, they were tested for their strength under compression and stretching. An apparatus was designed to record both force and position data while stems containing three nodes were compressed longitudinally and stretched transversely. Slopes of the graph of distance vs. force during initial deformation were calculated for each hormone and the control. The ABA stalks compressed an average 0.99 mm/N of applied force, while the GA compressed an average

of 10.2 mm/N. The ABA was substantially stronger than the control and the GA. When GA plants failed it was usually from buckling and the ABA from longitudinal splitting. When their tips were pulled upward, the ABA plants rose an average of 193 mm per N and the GA 184 mm/N. Both of these deflected more readily than the control.

ENVIRONMENTAL SCIENCE

Water quality assessment of St. Asaph's Creek, Stanford, KY. MICHAEL J. BAILEY, Lincoln County High School, Stanford, KY 40484.

Six sites along St. Asaph's Creek were monitored monthly from November 2000 to January 2001 to determine the water quality of the creek. Temperature, pH, dissolved oxygen, total hardness, nitrates, phosphates, and coliform concentrations were recorded for each site. When water quality results were compared to the criteria given by Project Clean Stream, the creek, which is of major historical importance, was ecologically healthy, though undrinkable. The creek can support fishing. To monitor future health of this creek a website was developed for students and teachers to use in a high school science curriculum.

Structural characteristics of hair as determiners of oil adsorbing ability. MARGUERITE BLIGNAUT, Notre Dame Academy, 1699 Hilton Drive, Covington, KY 41011-2796.

The purpose of this experiment was to discover which external characteristics of hair affect its ability to adsorb oil. NASA has done preliminary tests on the feasibility of using hair to clean up oil spills. This experiment was done using seven samples, each of which contained six switches of a different type hair. A mixture of oil and water was poured over the switches and the amount of motor oil adsorbed per gram of hair was determined. These averages ranged from 0.154 to 1.32 g oil/g hair. Pit depth and spacing on the hair surface were measured using *NIH Image* software. The average diameter of each hair type was calculated using laser diffraction. It was found that diameter, color, and waviness did not affect the hair's ability to adsorb oil. Pit depth and pit spacing did affect oil adsorption. The average pit depth ranged from 4.7 to 11.4 DN units and the average pit spacing from 2.5 to 3.7 μm . The greater the pit depths were, the more oil could be adsorbed. The greater the pit spacing, the fewer the pits available for adsorption. A possible predictive indicator, "Surface Factor," was defined as the quotient of the pit depth and the pit spacing. The "Surface Factor" correlated well but not perfectly with the hairs' ability to adsorb oil. Surface area has not yet been taken into consideration because of lack of time. At this time it is known that pit depth and pit spacing markedly affects a hair's ability to adsorb oil.

Substrate impairment vs. water quality in macroinvertebrate communities of Beargrass Creek. AMANDA

LEISTER, Seneca High School, 3510 Goldsmith Lane, Louisville, KY 40220.

The purpose of this project was to see how substrate and water quality in creeks affects macroinvertebrate organisms living there. By surveying aquatic invertebrates in Beargrass Creek it will be possible to assess the quality of the creek. Observations on the stream site and the watershed will allow identification of environmentally damaging practices or conditions. This was done with the use of inexpensive, simple equipment to make my biological assessment of Beargrass Creek. The placement of Hester-Dendy devices at three different sites in Beargrass Creek was to ensure accurate results along with determining if organism diversity was low due to lack of substrate or poor water quality. The Hester-Dendy device is a type of artificial substrate that is submerged under water for macroinvertebrate animals to adhere to. Along with the Hester-Dendy devices, substrate and water quality were tested. This was to give quantitative data in the case of nothing attaching to the Hester-Dendy devices. This was also done to show why all the organisms that attach to the sampler were from the taxa three category. (Organisms that are pollution tolerant and can be in any quality water.) If organisms grow on the Hester-Dendy devices and there are no organisms in the substrate when it is tested, then the water quality of Beargrass Creek is fair enough for organisms to live in, but the substrate is poor. If the organisms on the Hester-Dendy devices are from the taxa three category of macroinvertebrates, then water quality is also poor. Depending on the results the substrate could very well be poor too. This means the creek needs, not only to fix the water quality, but also to have what man has done to the creek taken out (channelization) to fix the substrate impairment. If there are organisms on the substrate but not on the Hester-Dendy devices, then the water quality is good along with the substrate. This means nothing needs to be done to Beargrass Creek. The water quality at each site has remained moderately constant and is overall fair quality, and the substrate quality tested to be fairly poor. There were abundant macroinvertebrates attached to all six Hester-Dendy devices. Considering the water quality was fair, according to the Kentucky Water Watch Network, this shows the substrate is what is poor in Beargrass Creek. Poor substrate is the cause of a scarce amount of macroinvertebrates. The Beargrass Creek Preserve is currently utilizing approximately 1.8 million dollars to improve water quality. As a result, it would be expected that the diversity of macroinvertebrates would increase. I hypothesize that substrate has more influence on macroinvertebrate diversity than the current water quality in Beargrass Creek.

Tested water samples of Big Pine Key, FL. KELLY THAYER, Taylor County High School, 300 Ingram Avenue, Campbellsville, KY 42718.

The research was conducted to test pollutant levels in Big Pine Key, FL, and how they affect coastal ecology. Salt water samples were taken from three sites in Big Pine

Key, FL. These sites were a mangrove shoreline (Site #1), Looe Key Reefs (Site #2), and the boating dock of the Newfound Harbor Marine Institute (Site #3). These samples were tested for levels of iron, nitrate, dissolved oxygen, and pH. Five milliliters of salt water were collected from each site. Samples were treated with two chemical reagents to test iron content. Results were then compared to an Iron Octet Comparator. In all cases, iron was found to be in the range of 0 to 0.5 ppm. The pH levels were then tested. Again, 5 mL of water from each site was obtained. Indicator solution was added and the sample was then inverted. Site #1 had a pH of 7.5, Site #2 was 8.3, and Site #3 had a level of 6.3. Dissolved oxygen was also tested. Samples were prepared and several chemical solutions were added to the water samples. The three sites produced levels found to be 7 ppm. Nitrate (NO_3^-) levels were tested with fixed salt water samples. Nitrate reagents were then added to each sample and the samples were inverted. After completing the test, the Nitrate-N Comparator showed levels at the three sites that ranged from 0 to 0.25 ppm.

MICROBIOLOGY

The magnitudes of bacteria inhibition caused by divergent mouthwashes. ANNE CHMILEWSKI, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Mouthwash is one of the most convenient ways to cleanse the mouth of bacteria. However, the variety of mouthwashes is phenomenal and a myriad of ingredients is available. This experiment was a quest to find the mouthwashes that will inhibit the growth of bacteria commonly found in the mouth. Antibiotics are often tested on a plate of bacteria before being given to a patient to insure that the bacteria will respond to the antibiotic. This is known as sensitivity testing. This experiment slightly modified that idea and tested mouthwashes, instead of antibiotics, against the bacteria *Staphylococcus epidermidis* and *Viridans streptococci*. Seven mouthwashes were tested with herbal, enzymatic, and alcohol ingredients. The results show that hydrogen peroxide mouthwash does a tremendous job against *S. epidermidis* and *Viridans streptococci*. Scope Original Mint and Herbal Mouth and Gum mouthwashes partially inhibited the bacteria. Tea Tree Oil provided inhibition for *Viridans streptococci* only. The other three mouthwashes did not exhibit inhibition. The experiment is limited in its conclusions. It may be that the test used allows alcohol to evaporate before it completes its job. The experiment also only tested two bacteria species, while the variety of bacteria in the mouth is innumerable. Further research would facilitate more conclusive and useful results.

Enhancement of the radiation effect on DU-145 cancer cells using curcumin. DAVID MEIGOONI, Paul Laurence Dunbar High School, 1600 Man O'War Blvd., Lexington, KY 40513.

The purpose of this project was to investigate enhancement of the radiation effect to prostate cancer cells using

curcumin. This may help to reduce the amount of radiation needed to treat prostate cancer patients. In this project, enhancement of radiation effect on PC-3 and DU-145 prostate cancer cells was determined by comparing the survival fraction of cells receiving radiation alone to that of cells irradiated after addition of 2 μM or 4 μM curcumin. PC-3 and DU-145 cells were plated in 25 cm^3 flasks and the surviving colonies were stained and manually counted 14 days after the treatments, by utilizing colony-forming assay. The ratio of the number of colonies counted to the number of cells plated multiplied by the plating efficiency was used to obtain the survival fraction. A linear-quadratic model was used to analyze the survival fractions for each treatment. The results of this investigation have shown that the survival fraction of PC-3 was 0.435 for 2 Gy of radiation alone. The survival fraction was decreased to 0.224 and 0.027 by adding 2 μM or 4 μM , respectively, of curcumin. For DU-145 the survival fraction was 0.682 for 2 Gy of radiation alone, and was decreased to 0.565 and 0.434 by adding 2 μM or 4 μM , respectively, of curcumin. The final results indicated that the radiation effect on PC-3 was enhanced by a factor of 1.45 or 8.7 when 2 μM or 4 μM , respectively, of curcumin was added prior to irradiation. However, the effect of radiation on the DU-145 cell line was enhanced by a factor of 1.04 or 1.14 when 2 μM or 4 μM , respectively, of curcumin was added prior to the irradiation. Based upon these results, curcumin sensitizes prostate cancer cells to radiation.

Response of *Physarum* to various sugars. ANGY MOUNIR, Notre Dame Academy, 1699 Hilton Drive, Covington, KY 41011-2796.

Plasmodial slime molds are basically enormous single cells with thousands of nuclei. During the active stage of their life cycle, slime molds exist as motile plasmodia that are capable of "flowing" toward nutrients. They feed on a variety of organic material, decaying organic matter, bacteria, and protozoa. The purpose of this experiment was to test the ability of the slime mold, *Physarum polycephalum*, to distinguish among different types of sugar. Agar cubes, containing various sugars (sucrose, lactose, glucose, and levulose), were placed on one side of a sterile petri dish and a plain agar cube was placed on the other. The slime mold was streaked on non-nutrient agar in the center and grew toward its preferred nutrient source. It was found that *Physarum* consistently moved toward glucose and sucrose. When presented with levulose on one side and glucose on the other, the *Physarum* migrated towards glucose. No attraction for lactose was evident. *Physarum* seems to be able to distinguish between different types of sugars.

PHYSICS

Effect of low frequency vibrations on strength of magnetic fields on flexible spinning discs. OLUMAKINDE ADEAGBO, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Magnetic fields on flexible rotating discs may be weakened by vibration. Since magnetic discs are prevalent in sound recording and data storage, it is important that the information is not lost. Floppy discs are a good example of such discs. As a current passes through the head of the drive, a magnetic field is created around it and the medium. In the same way, reversing the direction of current reverses the polarity of the field. When the magnetic field is too weak, the head cannot "read" the fields. The amplitude and frequency of vibration will have different effects on magnetic fields. The amplitude should create a very small change in the magnetic field, but the frequency should have a far greater effect. This hypothesis was tested with an apparatus that oscillated a floppy disc drive, spinning a disc at variable spin rates at frequencies ranging from 0 Hz to 100 Hz and amplitudes from 0.01 to 0.05 inches. The number of sectors on the disc was measured before and after the test to see the error rate on the disc. The hypothesis was supported by the data collected. As the frequency of the vibration approached 100 Hz, the error rate began to increase around 60 Hz. The error rate reached 0.7% at amplitudes of 0.02 and 0.03 inches. At the higher amplitudes of 0.04 and 0.05 inches, the error rate stayed below 0.1%.

In situ measurement of rupture forces between biotin and streptavidin with atomic force microscopy. VINITA ALEXANDER, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Nature can distinguish between molecules via recognition of multiple noncovalent bonds and their unique and inherent intermolecular forces. Based on these specific forces, it is possible to determine cellular behavior and immunological response. The atomic force microscope has the ability to map the topography of nanoscale matter as well as to measure intermolecular forces that govern nature. In the future it will function as a biosensor and a means to detect nerve gases. But first, the forces that will govern each molecular pair must be irrefutably established. The streptavidin-biotin (S-B) complex is a highly adhesive ligand-receptor pair whose forces have yet to be precisely measured with research-endorsed force measurements ranging from 200–393 piconewtons. In this study of the S-B complex, polyethylenimine (PEI)-polyethyleneglycol (PEG) films were formed atop silicon cantilevers. The liquid cell and PEG esters were used as barriers against the inclusion of nonspecific interactions in the detection of specific forces. In each run, a precoated streptavidin slide was employed as the substrate, and M-PEG, a blocker of endogenous activity expected to expe-

rience no force, was a control. Force findings between the S-B complex were expectedly low (220 piconewtons), attributed to the PEG and liquid cell, while those detected in the case of M-PEG were unexpectedly high (330 piconewtons).

ZOOLOGY

Effect of red dye #40 and methyl orange on the pulsation rate of a worm, *Lumbriculus variegatus*. LISA SOOPER, Notre Dame Academy, 1699 Hilton Drive, Covington, KY 41011-2796.

The purpose of this experiment was to determine the effects of dyes on the pulse rate of a worm, *Lumbriculus variegatus*. A chamber was constructed of parafilm and a microscope slide into which a worm was placed and videotaped using a flexcam. The worm was then exposed to red dye #40 or methyl orange (0.01%) and videotaped. Using Videopoint Capture software, pulsation duration was determined and beats/min were calculated. Red dye #40 significantly increased ($P < 0.05$) average pulsation rate in two out of three trials. The muscular wave going through the dorsal vessel appeared visually less orderly and much weaker than in the control. Methyl orange had the opposite effect with three out of four trials showing a decreased pulsation rate. No visual changes were apparent.

Ecological studies of tardigrades in Cherokee Park, Louisville, KY. ZOE ZHANG, duPont Manual High School, 120 W. Lee St., Louisville, KY 40208.

Tardigrades are microscopic invertebrates of the phylum Tardigrada. Very little is known about tardigrades; only 800 species have been identified. Five samples of stream-side, ground, and tree moss were collected during the first day of the month from September to December 2000. Tardigrades were collected and classified. The number of tardigrades in each habitat was approximately the same as was the number collected each month. This did not support my hypothesis that the stream-side moss would have the largest number of tardigrades. Though the number of tardigrades remained the same throughout the period of observation, the development changed greatly. In the September and October samples, the majority of tardigrades found were adults. In November and December, the majority of tardigrades found were eggs or larvae. This supports my hypothesis that, as winter progressed, the tardigrades would lay their eggs and the majority of the adults would then die. There were 14 individuals of *Macrobiotus hufelandi*, two *Echiniscus gladiator*, two *Pseudobiotus* spp., and two *Thulinia* spp.



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