From mice to math, students demonstrate their science skills

By Jeff Ristine
STAFF WRITER

March 31, 2001

Every day for nearly two months, Marguerite Matthews pondered 38 lab mice and how their little minds work.

The Mt. Miguel High School senior was intrigued by research showing that new cells can be produced in an area of the brain important to memory functions.

Past studies have shown that physical activity and an enriched, stimulating environment promote the creation of cells that can increase learning, but Marguerite wanted to find out if one factor was more helpful than the other.

Her project found the answer, and was among those taking top honors at the Greater San Diego Science & Engineering Fair, which runs through tomorrow at the Balboa Park Activity Center.

Judges also gave senior-division sweepstakes awards -- the top prizes at the competition -- for projects involving visual processing, a computer program to solve advanced mathematical equations, and patterns formed by identical polygons. Each winner receives a $2,000 scholarship.

Marguerite's experiments stemmed from an internship at the Salk Institute, where a scientist provided the mice and equipment she needed.

An "enrichment" cage for some mice contained tunnels, toys and other stimulation, while separate groups of "running" mice were in cages with an exercise wheel. A third control group of mice was placed in plain cages.

Marguerite, 17, then tested their learning.

One experiment recorded how long the mice could balance on a rotating rod. An "activity chamber" measured how quickly they became

accustomed to new surroundings. A final test measured how quickly the mice found a hidden platform to stand on in a small "water maze."

The "enriched" group performed better than the "exercise" group on the rod; the results were just the opposite in the activity chamber. In the water maze, both groups did about the same.

But in all three tests, the test mice outperformed the unenriched, nonexercising control group.

One method "isn't really more beneficial than the other -- they can both be just as good for learning," said Marguerite, who also earned a $2,500 prize from the Biomedical Research Institute.

And so it may be that the more exercise adult humans do, the more cells will grow in their brains, Marguerite said.

Naveen Krishnan, a Torrey Pines High sophomore, took a sweepstakes award for an experiment in visual processing: the connection between vision and the brain.

Hoping to measure the fastest speed of perception, Naveen, 15, programmed a laptop computer to rapidly flash geometric shapes on its screen, alternating in organized rows and columns.

Test subjects then were asked whether they perceived the transformation from rows to columns, or just saw a jumbled blur -- an exercise designed to show how quickly a visual stimulus can register.

He determined that for most people, a flash lasting 133 milliseconds (a little more than a tenth of a second) was the limit of perception for an orderly grouping.

Naveen, who wants to become a neurosurgeon, got in touch with UCSD psychology professor Dr. Vilayanur Ramachandran, who allowed him to work with a graduate student in setting up the experiment and getting undergraduates as subjects.

In addition to the scholarship, Naveen receives a trip to the International Science and Engineering Fair in San Jose, where he will enter his project. Naveen dedicated his win to his high school teacher, Victoria Coordt.

Francis Song, who won a sweepstakes award in 2000 for a computer-science project, repeated the feat this year and also gets a trip to San Jose.

For his new project, Francis, now a 16-year-old junior at La Jolla High,

took a new approach to solving differential equations, mathematical statements that commonly occur in science and engineering and involve relationships between rates of change of variable quantities.

The program Francis wrote applies a type of algorithm called differential evolution, developed in the early '90s, to differential equations in a way he said has never been done before. In Francis' method, differential evolution allows computers to progressively refine and improve solutions to a mathematical problem.

Ruston Pack, a 10th-grader at San Diego High, won a sweepstakes award and the science fair's expenses-paid trip to Taiwan for work involving tessellations.

Tessellations are patterns in which identical copies of a polygon, such as a square or pentagon, fit together in a mosaic pattern with no gaps or overlaps. A honeycomb is an example from nature.

Ruston wanted to test whether he could create a difficult pattern built around an inner core of 18 pentagons.

Using paper cutouts and a computer program, he found it possible to create a partial tessellation, but it left a small, 18-sided polygon in the middle. A pattern with six polygon shapes at the core worked better, leaving no gaps.