



FAMILY NEWSLETTER

The Newsletter for Families of COSMOS Participants – Monday, July 26, 2010

Dear COSMOS Families and Friends,

It is hard to believe we've completed our third week of COSMOS and we are now headed in to our last week of final projects, speakers, outings and socials.

The third week was busy with many eventful social activities in the residence halls. Our scheduled events included activities such as tag football, make your own pizza night, tie dye, and Cluster Olympics (where the various clusters competed in events such as tug of war and a spoon egg carry). On top of these scheduled events many students have been feverishly working on puzzles provided in the lounge and participating in pick-up games of ping pong and soccer.

The week ended with the Cosmos Talent Show. Each cluster created and preformed an act for the rest of the Cosmos students. Various other talents were displayed by individual students as well. And even the residential staff put on a "talented" act. ☺

Saturday was the last weekend outing and we went to San Francisco to explore the Piers along Embarcadero and take a Bay Cruise. We sailed under the Golden Gate Bridge and around Alcatraz (also referred to as "The Rock"). Students also visited Ghirardelli Square. The weather was cool, but a nice break from the hot temperatures of Davis. It was a lot of fun.

Now, for an update on **Closing Day**. Students will be given direction from their RAs about returning keys and cleaning their rooms. Although, please keep in mind that any student who does not return their key will be charged \$50. Here is some important information for you:

Saturday, July 31

- 8:30-9:30 Parents/Guardians arrive at Castilian Hall South to move their student out of dorm. Students will not be able to return to the dorm so please do not forget anything.
- 9:30-10:45 Parents/Guardians and students arrive at the Activities and Recreation Center (ARC) for project viewing and buffet breakfast. *Please do not arrive before 9:30 as there will be no admittance until then. Parking may be an issue due to another large event in the adjacent building. Please look for signage.*
- 10:45-11:45 Closing ceremony in the ARC Ballroom. **Only two guests per student are allowed in the Ballroom.** Additional family members and guests must wait in the ARC lobby or on the patio. We apologize in advance for the inconvenience.
- 12:00 Airport shuttle will begin for students whose parents are not present and must depart from the Sacramento airport.



FAMILY NEWSLETTER

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If you have any questions, please email Emily Murdock at ejmurdock@ucdavis.edu.

Below, you will find a report for each Cluster. This information is compiled from weekly reports submitted by the Teacher Fellows.

Cluster 1

Last week, the students and faculty toured the Joint Genome Institute (JGI). We saw a fascinating array of sequencing machines and learned about 3 different types of sequencing which require different machinery. Students were excited to receive a deck of new JGI playing cards. Each card has a picture and brief description of projects conducted at JGI. We were one of the first tour groups to each get a deck of these new cards. We listened to a great presentation about sequencing and separated into two groups to see all parts of the facility with our friendly guides.

Students are continuing to monitor the spread of the virus with GFP that is invading the tobacco plants. Our African Clawed Frog tadpoles are doing well on a diet of green beans from the dining commons. We have begun testing food samples taken from the dining commons to check for genetically modified organisms (food sources). We are specifically targeting soy and corn products as we should be able to find that they have been genetically modified. The students are waiting to get their DNA back from the sequencing facility at UC Davis, and they will be finishing up the labs they have started and writing lab reports this week.

Students have been conducting oral practice of their PowerPoint presentations that they will present to the faculty on Thursday. We had the added pleasure of being observed by the external review committee for COSMOS. Four distinguished faculty from around the state sat in on our presentation practice. This allowed the students to experience presenting for experts in the field as there were professors of biochemistry and chemistry in the audience. The students are looking forward to showing their completed projects to you (their parents), but they are having so much fun, most of them are surprised we are already starting week 4.

Cluster 2

Wow, what a fun week of travel and science! On Monday and Tuesday, Niels instructed us in how to make atomic bombs using uranium or plutonium, and in Diego's lab we finished testing the photonic links that we constructed last week. Then we were ready for the main event...the trip to Los Alamos National Labs!

Wednesday morning we left the dorm around 4 AM (yikes!) to bus over to Sacramento Metro Airport and catch our flight to New Mexico. Abe Torres, our bus driver, picked us up in Albuquerque and toured us through beautiful Santa Fe on the way. Our early start got us to Los Alamos in time for Georgia, our Los Alamos tour guide, to take us on a walking tour of the historic sites where the Manhattan project produced the atomic bomb. We walked by the houses where Chadwick (discoverer of the neutron) and J. Robert Oppenheimer lived on "bathtub row" during WWII. After dining on Middle Eastern food we returned to the two hotels (one housing the gals and another, the guys) in time to collapse and try to catch up on our sleep before visiting the labs.



FAMILY NEWSLETTER

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Thursday morning we began with a visit to the Bradbury Museum to learn more about the mission of the Los Alamos National Labs (LANL), to maintain a safe, secure, and reliable nuclear deterrent for our nation, and we took a group photo next to the mockups of Little Boy and Fat Man, the bombs dropped on Hiroshima and Nagasaki. Then LANL employee Kelly escorted us through security to the Los Alamos Neutron Science Center (LANSCE) where Kevin Jones conducted us through the facility. There we learned the science behind how scientists accelerate either hydrogen or hydride ions down a quarter mile accelerator to smash them into a tungsten target, spalling off a lot of neutrons. We visited one of the many laboratory buildings that radially surround the tungsten target, and then use the "hot" (fast) or "cold" (slow) neutrons to investigate the characteristics of all kinds of materials.

LANL is actually a large number of separate buildings scattered around the Parajito Plateau, so after the security dog sniffed our bus to ensure we had no explosives, we drove to the National High Magnetic Field Lab. Jonathan Betts showed us the magnets and huge capacitors and electric generator used to power them, culminating with the device producing the world's strongest magnetic field at 100 tesla. Every time that device is used it explodes the copper coil carrying the current, but without damaging the sample material that is being tested. We got back to the hotel by 5:30 PM, and bussed to De Colores Mexican Restaurant where they put together a table for the 26 of us near windows through which we could watch the thunder storm!

Friday morning the weather was clear as we checked out of the hotels. Georgia rejoined us to tell us about the geological and social history of the region as we toured nearby Bandelier National Monument. Georgia led us on a more than 3 mile walking tour of ruins left by the Ancestral Pueblo people. We crammed into rock chambers, trying to picture what it would be like to be a cliff dweller. It was a 140 foot vertical climb up ladders and stairs to the large Kiva on one cliff, but even the most acrophobic among us faced her fears and Ananth climbed with his sprained ankle in a boot as we all made it up and down.

Our route back to the airport took us through a lot of beautiful parts of New Mexico, including the grassy Valles Caldera, but eventually we climbed aboard our US Air jet and retraced our flight to Phoenix and Sacramento. The professors, RAs, TA, and Teacher Fellow agreed that this group of Cluster 2 students were excellently behaved, and asked top quality questions of the scientists in the labs they visited. Their conduct and attention reflected honor on COSMOS, and they are a remarkably energetic and fun group of young people. Parents, you should be proud of them.

Cluster 3

On Monday & Tuesday we heard lectures about Hydrogen production from David Kashevaroff. We learned that hydrogen could be produced using steam reformation, autothermal reformation and electrolysis. We also discussed the 1st and 2nd Laws of Thermodynamics and the Carnot Limit Derivation. After learning about hydrogen production we learned about Fuel Cells types (alkaline, polymer electrolyte membrane, & phosphoric acid) that are used for power sources. David also took us to his lab where he is working on projects involving hydrogen fuel cells.



FAMILY NEWSLETTER

The Newsletter for Families of COSMOS Participants – Monday, July 26, 2010

On Wednesday, Prof. Hafez gave us a list of what we would be covering in the classroom for the rest of the COSMOS lectures. (Satellites, Rockets, Airplanes, Propulsion, Fluid Mechanics, GPS, and Spin-Stabilization) After lunch, we were very much entertained by Prof. Motohico Mulase with some very interesting topics from mathematics. (Riemann Hypothesis, Torus, Gaussian Curvature, Euler's Formula, Euler's Product Formula). His closing equation was *Nature = COSMOS + Chaos*.

On Thursday, the cluster made a trip to the Hydrogen Fuel Cell partnership in Sacramento, sponsored by numerous competing car companies, providing an optimistic, unifying perspective of alternative energy. We rode in the hydrogen fuel cell powered cars and learned about the complications of incorporating alternative energy into mainstream use.

On Thursday afternoon, everyone in the cluster received the "Pump Rocket" and Air Hogs air pressurized airplane. The rockets flew as high as 150 feet. (Naoki's rocket had the best flight according to Prof. Hafez.) The planes exemplified the abstract concepts of lift and drag for the class to provide a better comprehension of aerodynamics.

On Friday morning Prof Hafez lectured on Satellites, GPS, Spin-Stabilization and Rockets. It's really amazing at how much we can learn in such a short time. After lunch everyone in the cluster reported on the progress of his or her projects. You will be amazed at how much everyone has learned in such a short time.

Cluster 4

Cluster 4 explored California's fresh water reserves this week, and learned how climate change could compromise our most valuable natural resource. We discussed the complex natural and artificial systems that transport the snows of the Sierra Nevada, the raging currents of the Colorado River and hidden aquifers beneath our feet to our kitchen tap.

Students designed and built an experimental levee system on our stream table and tested it against a simulated flood. Then we visited our state's largest and most complicated waterway, the Sacramento-San Joaquin Delta and explored the backwaters, guided by delta expert Jeff Hart.

Students have also made considerable progress this week on their carbon footprint assessment projects. Teams visited their target businesses—ranging from a bank to a supermarket to a children's museum—and began crunching numbers to understand how to translate normal business operations into climate impact. Next week students will complete their assessment and present their findings along with suggestions for carbon footprint reduction.

Cluster 5

Last week the students made significant progress on their final robotics projects during the lab sessions. Each project group proposed their own independent project goals and robot designs. In this third week, they designed and assembled the main structure of those robots. Now, they are busy testing sensor inputs and motors and writing the software to control the systems. Across the room, you can see the robots chasing down objects, dancing, grasping objects and even dealing out cards.



FAMILY NEWSLETTER

The Newsletter for Families of COSMOS Participants – Monday, July 26, 2010

In biophysics, the students continued to write simulations to explore the dynamics of molecular motion in the cell. They tracked collisions with cell walls and time taken for molecules to find targets. On Friday, the students had a short break from the computers to explore properties of matter at low temperatures with the aid of liquid nitrogen. They dunked balloons, leaves and Red Vines candy in the liquid nitrogen to see effect of temperature changes to the different phases of matter. They also immersed samples of a high-temperature superconductor in the liquid nitrogen to observe Meissner effect -- where the superconductor began to expel magnetic fields, forcing a magnet sitting on the superconductor to levitate.

Cluster 6

We had a busy and fruitful third week in cluster 6. In the Combinatorics class, we continued our study of advanced mathematics. However, we broke away from the standard counting problems involving combinations and permutations to get a strong introduction into sets, mathematical induction, number theory, and recursive formulas. Many of the problems that we encountered this week involved a combination of these different, but related ideas.

In Topology class, we continued our study of knots and strange shapes, like the torus, the Klein bottle and the Poincaré dodecahedron. Although Topology is usually considered pure mathematics, we saw that these ideas are at the forefront of answering important questions about the size and shape of the universe and properties of DNA that could impact all of our lives.

We were very excited that the COSMOS-wide guest speaker this week, Dr. Motohico Mulase, gave a lecture about mathematics on Wednesday. While many of the ideas were very advanced for the non-math clusters, cluster 6 was able to follow along with most of the talk, which was about the importance of the zeta function discovered by the great mathematicians Euler, Gauss, and Riemann.

Cluster 6 had a change of plans for our outing this week. Instead of going to Berkeley, we stayed in Davis and saw the Pixar animated movie Toy Story 3 on Thursday. This was very enjoyable and it served as a nice introduction into the mathematics behind the animation. We learned of the some basics of vectors and linear algebra that is required to create the animated characters. We also visited an engineering laboratory on campus where they take large sets of data and use computer animation to create color and movement in a way to make the information more understandable and entertaining.

Much of our time in the Writing and Communications course this week was used to get a good start on our final projects. Most of us in cluster 6 have chosen a topic and are doing a wide range of research to complete our projects. Be sure to ask your student how the Friday evening talent show and the San Francisco cruise went on Saturday.

Cluster 7

We can hardly believe it's already been 3 weeks! For these last two weeks, we have shifted our focus a bit from veterinary medicine to human medicine, though we continue to integrate the two as much as possible.



FAMILY NEWSLETTER

The Newsletter for Families of COSMOS Participants – Monday, July 26, 2010

On Monday, students discovered the causes and terrifying effects of septicemia and meningitis; additionally, they learned some great words, like “iatrogenic” and “nosocomial.” Be sure to ask your teen what they mean! Our 5 veterinary student TAs did a panel discussion to tell our students their stories about why they wanted to become a veterinarian and what they did to achieve their dreams. We also saw a riveting documentary following the lives of several Harvard doctors for seven years, from med school through residency.

Tuesday’s agenda began with a trip to the UC Davis Medical School, where Cluster 7 explored the virtual care center (and got a chance to “cure” a high-tech robot that was exhibiting symptoms of an asthma attack). Additionally, students learned how to administer CPR to the song “Stayin’ Alive” as well as administer an AED to an unconscious, pulse-less person (represented by a mannekin). A former COSMOS student (and current MD/PhD student at UC Davis Med School) gave an interactive lecture about her PhD research on bone/tissue engineering using specially designed polymers. Students also practiced analyzing the clinical “bedside manner” skills of a medical student by evaluating them using the same guidelines used by the faculty doctors. Finally, we wrapped up our trip by hearing from a panel of current medical students and a current doctor on what it takes to get into medical school. Later that day, our fantastic veterinarian TAs gave a talk on the human cardiovascular system. On Wednesday, Cluster 7 got a chance to show what they learned from the cardiovascular system lecture by participating in a cardiovascular system water balloon relay. They carried water-filled balloon “molecules” to various stations where they had to correctly answer questions or else had to return to the start, all the while being pelted by water balloon “free radicals.” It was a great way to beat the heat and demonstrate knowledge! Students also learned how bacteriophage viruses are used in some parts of the world to fight bacterial infections rather than antibiotics.

On Thursday, students learned how the immune system operates and what can happen when it becomes compromised. Later, the veterinary TAs took our students on a tour of the necropsy floor at the vet school, where they saw veterinary students working on finding the cause of death of a cow and a dog. The TAs also held interactive discussions on various body systems, where students analyzed gross specimens as well as radiographs.

We wrapped up the week with Cluster 7 working on their research papers, cameo lectures, and body projects. They can’t wait to showcase their hard work at the closing ceremony!

Cluster 8

We had a busy third week with much of our time either away from Davis or in the computer lab working on projects. We continued converting newspaper to ethanol, we analyzed the glucose samples we produced using thin layer chromatography and we synthesized a form of benzodiazepine which is a drug used for anxiety disorders and convulsions.

We went to the Tahoe Environmental Research Center and here is a report from Aileen Cheng: *We all woke up early and met at 6:45 AM to eat breakfast together. After that, we took a 2 and a half hour bus ride to Tahoe. There, we all participated in a lab. We first split into two groups, and in those two groups, we split between the standards group and the samples group. The samples group measured the*



FAMILY NEWSLETTER

The Newsletter for Families of COSMOS Participants – Monday, July 26, 2010

absorbancy of a specific wavelength of a solution of known concentration after several steps. Then, the standards group plotted a graph of our data. The sample group took the samples of different substances like deionized water, water from Lake Tahoe, water from SRC, clam juice, and fertilizer, in which the concentration was unknown. They then performed the same steps as the standards group and got the absorbancies of the different samples. They then took the sample group's graph and used it to find the corresponding concentrations of the samples. After everyone finished the lab, we compared our data and talked about how the high levels of phosphorus, which we were finding the concentration of in the lab, was of concern in Lake Tahoe, as algae need phosphorus to survive, so the more phosphorus there is, the less clear Lake Tahoe will be. Then we decided to hold a mock trial and someone in our group volunteered to be the one to speak for our data. By doing this we learned about how to prove the credibility of our research.

We toured the facility and learned about the environmental problem in Lake Tahoe which mainly has to do with invasive species and human-related activities. We also got to see some of the things required of the residents to do in order to prevent runoff from their homes into the lake. After that fun and informative day, we headed back to Davis.

Wednesday morning was filled with lectures on membrane proteins and their function. Professor Allen shared amazing computer models of these complex molecules that control many important cellular functions. I think it helped many of the students who are studying proteins for their project and the others were able understand the structure and function of the protein to chemical properties they learned earlier. In the afternoon they listened to an interesting guest speaker from the math department. Here is what Karen Sugano had to say about it:

Dr. Motohico Mulase, a UC Davis Senate Award winner for distinguished undergraduate teaching, gave us a lecture on the complex relationships of mathematical theories and formulas. Although his lecture was very esoteric and difficult to understand, I found his last words very interesting. He stated that the joy of mathematics is to discover two things that are completely different to be actually the same. Like how Riemann's rule is same as Euler's, and how Mulase theorizes that mirror symmetry is the same as the Laplace Theorem, mathematics have connections that intertwine together. Finding that connection is the true joy of mathematics, and I agree with him. In my Pre-Calculus class in sophomore year, I had an incredibly hard teacher who gave tests that looked terrifying at first glance. However, as we simplify the integral, we conclude to a final answer of a simple number such as 0 or 1. It always amazes me that such a complicated, impossible looking problem is equal to a number like 0 or 1. Although I may be in a different realm as Dr. Mulase, I feel like I share the same satisfaction when two completely different looking things just click together.

Thursday we travelled out of town again, this time to Foster City to a biotech firm called Gilead and in the afternoon to the UCSF research facility in San Francisco. Both were amazing opportunities to talk to scientist on the cutting edge of drug design at Gilead and see labs of many different researchers at UCSF. Here is what Minna Xiao Wrote about Gilead: *Today we visited Gilead, a large biopharmaceutical company that discovers, develops, and manufactures therapies for viral diseases, infectious diseases and cancer. At the beginning of our tour, a medicinal chemist and a biochemist gave*



FAMILY NEWSLETTER

The Newsletter for Families of COSMOS Participants – Monday, July 26, 2010

us an overview of the many steps that go into developing a new drug. Our tour guide is currently involved in the development of drugs to counter HIV, and his last project was developing a counter to Hepatitis C. The medicinal chemist demonstrated how one known chemical compound may be altered to form a new compound that can potentially fight known diseases, and the biochemist explained the many procedures that are involved in testing the effectiveness and bioavailability of the new drugs. We were then given an insightful tour of the various research labs and computational labs at Gilead.

Jason Won wrote this summary of UCSF: *Later, we went to UCSF for a tour of their facilities. There are a lot of different things they do. First, we went into a lab where a research group is trying to develop microscopes down to a protein-scale resolution (around 5nm). They have succeeded using new technology down to a 20nm scale, which is really cool. Apparently, when they start getting down to that level, the fact that they are up on the 5th floor becomes a big issues. Another place we went to was the CAT lab, the center for advanced technology. As the scientist giving us the tour said, it's the place where "people get to play with expensive toys." They have a plethora of awesome equipment there, including a laser cutter, a CNC, a 3D printer, and other non-machining equipment such as a genome sequencer and too many terabytes of hard drive space. Finally, we went down to see the computational biology group's computer clusters, perhaps several hundred pizza-box shaped cases stacked in columns of maybe 25. After this, we were able to talk with a researcher over video chat giving us a brief overview of nanotechnology and nanostructures.*

Friday ended the week with a bang! After a lecture on entropy, one of the driving forces of reactions, Professor Allen demonstrated three reactions where the disorder increases. The first was a decomposition of sucrose using sulfuric acid. The second reaction was the decomposition of hydrogen peroxide using potassium iodide as a catalyst. The last was the biggest and had to be done outside. In this experiment he poured two gallons of boiling water into two gallons of liquid nitrogen and produce a huge cloud that shot all the way to the top of the building and cooled us all off. Look for the video soon on YouTube.

Cluster 9

Cluster 9 had stimulating week learning about astrophysics. In the mornings Dr. Margoniner taught us about cosmology – the formation and age of the universe. We learned Olbers Paradox and Hubble's Law, and did a neat activity on the expansion of the universe. After cosmology, Dr. David Wittman stretched our minds with demonstrations and problems concerning general relativity. We learned about the loss of simultaneity, time dilation and length contraction, and tried to figure out how a twelve meter pole can fit in a ten meter barn.

In the afternoon we worked on our projects, analyzing data and writing our papers. The last of the groups collected data from the roof of the Physics Building using Dr. Feldstein's telescope and data collecting and processing equipment.

The highlight of the week, though, was our field trip to the Lick Observatory on top of Mt. Hamilton just east of San Jose. Lick is owned and operated by the University of California, and we were given a tour of the facilities by UC staff astronomer Dr. Elinor Gates. Dr. Gates took us inside the Shane Telescope, a



FAMILY NEWSLETTER

The Newsletter for Families of COSMOS Participants – Monday, July 26, 2010

120-inch reflector which was once the world's second largest telescope. Dr. Gates told us about her work with Adaptive Optics systems, which use a deformable mirror which changes shape hundreds of times a second in response to fluctuations in atmospheric turbulence. The AO system employs a powerful laser to create an artificial "star," and Dr. Gates has to check with the FAA and the Air Force before using the equipment. We got to "ride the dome" around the Shane while Dr. Gates told us about the manufacture and maintenance of the telescope and the various instruments used on it. We also got to tour the control room and meet some astronomers visiting from other countries. Dr. Gates showed us some of the other telescopes at Lick, including the Katzman Automatic Imaging Telescope and the Automatic Planet Finder. We returned to the main building and Dr. Gates told us some of the history of the observatory and the Lick Telescope, an enormous antique refracting telescope built in 1889. The Lick was the largest telescope in the world in 1889, and is still the world's second largest refractor. Dr. Gates took us into the dome and we were able to observe the moon, globular cluster M13, and a few other deep space objects with the huge antique telescope. It was beautiful, amazing, wonderful evening.



As always, if you have questions or concerns, you are welcome to contact us at the COSMOS Office at cosmos@ucdavis.edu or by calling (530) 754-7326.