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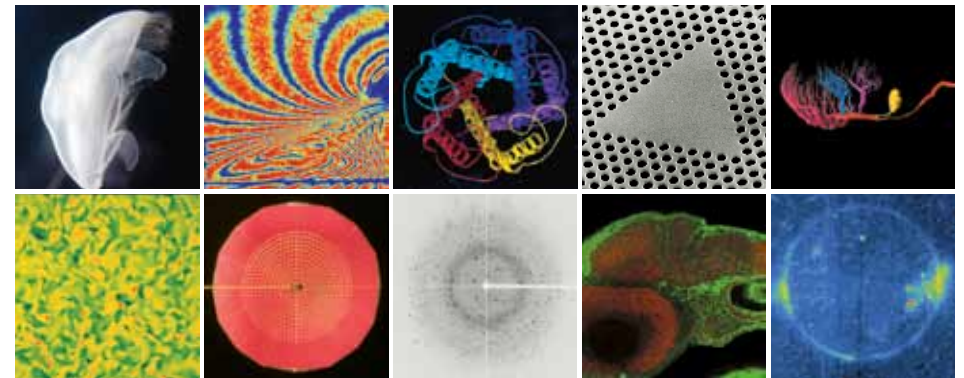
caltech an overview



The mission of the California Institute of Technology is to expand human knowledge and benefit society through research integrated with education. We investigate the most challenging, fundamental problems in science and technology in a singularly collegial, interdisciplinary atmosphere, while educating outstanding students to become creative members of society.



WELCOME TO CALTECH!



We're pleased that you want to know more about Caltech. This booklet is meant to give you a quick overview of our programs, people, and facilities. We hope you'll feel free to contact any of the departments or offices listed inside if you'd like more information.

Cover: The three newest buildings on the Caltech campus—the Cahill Center for Astronomy and Astrophysics, the Walter and Leonore Annenberg Center for Information Science and Technology, and the Warren and Katharine Schlinger Laboratory for Chemistry and Chemical Engineering.

Caltech

at a **GLANCE**

With an outstanding faculty, including five Nobel laureates, and such off-campus facilities as the Jet Propulsion Laboratory (JPL) and the W. M. Keck and Palomar observatories, the California Institute of Technology is one of the world's preeminent institutions of science and engineering. At Caltech, 967 undergraduates, 1,208 graduate students, 294 professorial faculty, and other researchers investigate the most challenging problems in science and engineering. Students enjoy virtually unlimited research opportunities and close interaction with professors. Many go on to become key figures in academia, government, and industry.

Support from friends and alumni, dedicated gifts for pioneering research from foundations and individuals, and project-specific grants and contracts from corporations and government sustain Caltech, a private, independent university.

Caltech and JPL are just seven miles apart in Pasadena, a vibrant, culturally rich city of 150,000 at the foot of the San Gabriel Mountains. Caltech's 124-acre campus is 10 miles north-east of downtown Los Angeles and 27 miles from the ocean.



Enrollment

(first term 2010)

Undergraduate students	585 men 382 women
Graduate students	857 men 351 women
Total students	2,175

2010 Freshman Class

131 men, 89 women
Middle 50% SAT scores: 2200–2330

June 2010 Degrees Awarded

192 BS,* 119 MS, 2 Eng, 179 PhD; 492 total

*Of the 192, 116 graduated with honor.

Alumni

(as of December 2010)

Living alumni	22,176
BS	11,579
MS	7,853
Engineer	360
PhD	7,126
Ex student	608
Certificate	66
Total degrees*	27,592

*Many graduates have multiple Caltech degrees.

Faculty in Residence

(as of December 2010)

Professorial faculty	294
Emeriti	100
Research faculty	74
Other faculty	57
Visiting faculty	208
Visitors	112

Postdoctoral Scholars

(as of December 2010)

Postdoctoral scholars	656
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Employees

Caltech's employees total nearly 9,000, distributed between the campus and JPL.

Campus (excluding students)	approx. 3,800
JPL (excluding contractors)	approx. 5,000

Awards and Honors

(as of December 2010)

Caltech faculty and alumni have received wide recognition for their achievements in science and engineering.

Nobel Prize: 31 recipients, 32 prizes
Crafoord Prize: 6 recipients
Kavli Prize: 4 recipients
National Medal of Science: 55 recipients
National Medal of Technology: 10 recipients
California Scientist of the Year: 15 faculty
Fellow, American Academy of Arts and Sciences: 87 faculty
Member, National Academy of Sciences: 75 faculty
Member, National Academy of Sciences, Institute of Medicine: 4 faculty
Member, National Academy of Engineering: 31 faculty

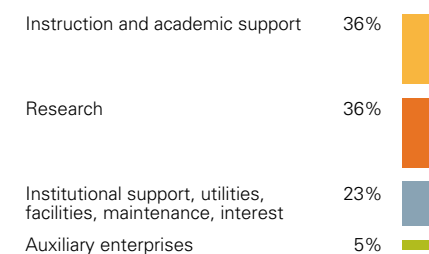
Budget

The overall expenditures of Caltech for the campus and JPL exceed \$2.3 billion.

The Jet Propulsion Laboratory receives about 90 percent of its funding from the National Aeronautics and Space Administration (NASA). In recent years, JPL's expenditures ranged between \$1.6 billion and \$1.8 billion.

Private support, success in attracting grant funding, and efficient management allow the campus to use the bulk of its resources to promote discovery and offer a world-class education to all qualified students regardless of their means.

A major component of the campus budget is supported by research grants. In fiscal year 2010, research awards and contracts totaled \$332 million. The campus budget for fiscal year 2011 is \$558 million, allocated as follows:



Administrative Officers

(as of December 2010)

Jean-Lou Chameau
President

Edward M. Stolper
Provost

Dean W. Currie
Vice President for Business and Finance

Charles Elachi
Vice President and Director, Jet Propulsion Laboratory

Peter D. Hero
*Vice President for Development and
Institute Relations*

Anneila I. Sargent
Vice President for Student Affairs

Victoria D. Stratman
General Counsel

Dennis A. Dougherty
Chair of the Faculty

Jacqueline K. Barton
Chair, Division of Chemistry and Chemical Engineering

Kenneth A. Farley
Chair, Division of Geological and Planetary Sciences

Jonathan N. Katz
Chair, Division of the Humanities and Social Sciences

Stephen L. Mayo
Chair, Division of Biology

Ares J. Rosakis
Chair, Division of Engineering and Applied Science

B. Thomas Soifer
*Chair, Division of Physics, Mathematics
and Astronomy*

Morteza Gharib
Vice Provost

Melany L. Hunt
Vice Provost

Joseph E. Shepherd
Dean of Graduate Studies

James W. Cowell Jr.
Associate Vice President for Facilities

Hall P. Daily
Director of Government Relations

Richard E. Fagen
Chief Information Officer

Julia McCallin
Associate Vice President for Human Resources

Sharon E. Patterson
Associate Vice President for Finance and Treasurer

Scott H. Richland
Chief Investment Officer

Richard P. Seligman
Associate Vice President for Research Administration

Mary L. Webster
*Executive Assistant to the President and Secretary,
Board of Trustees*

pre-1920



MILESTONES

1891

Philanthropist Amos G. Throop founds Throop University, a local school of arts and crafts offering work leading to a bachelor's degree.

1893

Throop University is renamed Throop Polytechnic Institute, reflecting its new emphasis on industrial training.

1907

Throop's elementary school, business school, teacher-training program, and high school are discontinued. Astronomer George Ellery Hale, who had come West in 1903 to establish the Mount Wilson Observatory, joins the board of trustees.

1910

Throop's administration decides to accept only male students (girls and young women had attended since 1891). The school relocates to Caltech's present site.

1913

Arthur Amos Noyes, noted chemist and former president of MIT, becomes a part-time faculty member.

1917

Eminent physicist Robert Andrews Millikan agrees to spend part of the year at Throop as director of physical research.

Above, left–right: Throop Hall; founders of the modern Caltech: Noyes, Millikan, and Hale; cooking class at Throop Polytechnic; construction of the observatory at Mount Wilson.

ALUMNI

Frank Capra, BS '18. Although he received his degree in chemical engineering, Capra's true talent turned out to be for filmmaking—as movies like *It Happened One Night* (1934) and *It's a Wonderful Life* (1946) would later prove.

Studying at CALTECH

Undergraduate Programs

Caltech offers an unparalleled undergraduate education, with a 3:1 student-faculty ratio, a wealth of hands-on research opportunities, and an unusually collegial and collaborative academic community.

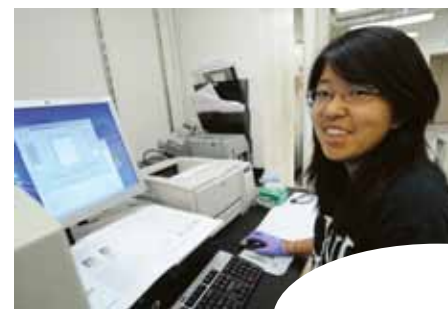
Undergraduates earn Bachelor of Science degrees, with options (majors) in applied and computational mathematics; applied physics; astrophysics; bioengineering; biology; business economics and management; chemical engineering; chemistry; computer science; economics; electrical engineering; engineering and applied science; English; geobiology; geochemistry; geology; geophysics; history; history and philosophy of science; independent studies; mathematics; mechanical

engineering; philosophy; physics; planetary science; and political science.

Required core courses across a spectrum of fields prepare students for dynamic careers.

The four academic years in the BS degree program each consist of three 10-week terms and last from September until June. Many students complete summer research projects (see SURF, page 8).

Students receive a positive, broad education in the art of living. They participate in more than 150 clubs, pursuing interests in service, international cultures, science, math, engineering, art, theater, music, business, religion, recreation, sports, cooking, gardening, and more.



“Generous financial aid and scholarship packages make Caltech extremely affordable, while the school’s immense reputation and plethora of opportunities ensure a bright future in research or academia for Caltech graduates.”

— The Princeton Review and *USA Today*,
“100 Best Value Colleges for 2010”

Undergraduate Admissions

First-year Students—Fall Only

Caltech staff, faculty, and students work together to select applicants who will thrive on challenging problems and mature into leaders who care about our world. They consider applicants’ demonstrated interest in math, science, or engineering; the quality of application materials; secondary-school records and recommendations; personal attributes, talents, and activities; and scores on the required standardized tests (the SAT or the ACT, and the SAT Mathematics Level 2 and a subject test in biology, chemistry, or physics).

Applications must be postmarked or submitted online by Nov. 1 (Early Action) or Jan. 3 (Regular Decision).

Transfer Admissions—Fall Only

Caltech welcomes applications for transfer admission. For information on preparation, exams, and application requirements, visit www.admissions.caltech.edu.

Transfer applications must be postmarked or submitted online by Feb. 11.

For applications and more information, visit www.admissions.caltech.edu or call 626/395-6341.

Costs and Aid

Four years in a row, *Kiplinger’s Personal Finance* magazine ranked Caltech as the best value among U.S. universities.

Caltech makes an outstanding education available to all students who gain admission, practicing need-blind admission for all U.S. citizens and permanent residents. Financial aid packages meet 100 percent of demonstrated need via federal, state, private, and institutional scholarships, grants, work-study student aid, and parent and student loans. The average indebtedness for the class of 2010 was \$10,760—among the lowest for a four-year education at any college or university. For more information, visit www.finaid.caltech.edu or call 626/395-6280.

Approximate costs for the academic year 2010–11 are as follows:

Tuition	\$34,989
Room and board (<i>on-campus contract</i>)	\$11,397
Student fees	\$1,293
Books and supplies	\$1,323
Miscellaneous	\$3,387

Travel expenses should be added to this budget. Costs are subject to change without notice.

SURF Program

Each year, more than 400 students design and complete research projects with scientists, engineers, and scholars of their choice—usually Caltech and JPL researchers—through Caltech’s Summer Undergraduate Research Fellowships program. Learn more at www.surf.caltech.edu or call 626/395-2885.

Premed Programs

Caltech students get outstanding clinical and research experience through joint programs with City of Hope, Huntington Memorial Hospital, Children’s Hospital LA, and the UCLA Medical Center. The Caltech–UC San Diego Medical Scholars program awards selected Caltech students early admission to the UCSD School of Medicine. Learn more at www.admissions.caltech.edu or call 626/395-6341.

Overseas Opportunities

Caltech undergraduates can participate in study-abroad programs at Cambridge University, École Polytechnique, the University of Copenhagen and the Technical University of Denmark, the University of Edinburgh, University College London, and the University of Melbourne. Learn more at www.fasa.caltech.edu or call 626/395-2150.

Athletics

More than 80 percent of Caltech undergraduates participate in an organized intramural/recreational competition each year—one of the highest participation rates in the country. Thirty percent

participate in intercollegiate athletics.

Students compete in 17 NCAA Division III varsity sports: men’s and women’s basketball, cross country, fencing, soccer, swimming and diving, tennis, track and field, and water polo, men’s baseball, and women’s volleyball. Recently, Caltech student athletes have qualified for the NCAA Championships and earned all-conference honors.

Students and other members of the Caltech community also participate in sports, martial arts, and outdoor activities through more than 25 clubs. For more information, see www.gocaltech.com.

Performing and Visual Arts

Students, faculty, alumni, and Caltech/JPL staff participate in Caltech’s arts programs and clubs. Undergraduates enroll in performing and fine arts courses for credit.

Caltech’s professionally directed choral music groups, chamber-music ensembles, concert and jazz bands, and orchestra offer musical training. Theater-arts participants produce and perform in main-stage shows. Painting, drawing, and other visual-arts classes complement the diverse humanities curriculum.

More than 20 Caltech clubs focus on music, dance, drawing, writing, literature, theater, comedy, film, or photography.

1920s

MILESTONES

During the ‘20s and early ‘30s, seismologist **Harry Wood** and astronomer **John Anderson** invent a sensitive seismograph capable of recording even very small earthquakes in Southern California, and geophysicist **Charles Richter** devises a formula (now referred to as the Richter Scale) for measuring the size of Southern California earthquakes; later, geophysicist Beno Gutenberg, together with Richter, applies it to earthquakes around the world.

1920

Throop Polytechnic is renamed the California Institute of Technology.

1921

Robert Andrews Millikan is appointed chairman of the executive council (he declines the title of president). With co-executives A. A. Noyes and G. E. Hale, he begins molding Caltech into a first-class institution for engineering and scientific research and education. He receives the Nobel

Prize in 1923, the first of 32 Nobel Prizes to be awarded to Caltech faculty or alumni over the next nine decades.

1926

A group of 100 local citizens meets at the home of Henry Huntington and agrees to contribute to the research and educational programs of Caltech. They become the Associates.

1928

Caltech’s Division of Biology is established, and eminent biologist Thomas Hunt Morgan is recruited to be its first chair. Morgan wins a Nobel Prize in 1933 for his studies of the relationship of chromosomes to heredity, work that lays the foundation for much of modern biology.

Above, left–right: Richter at home with his seismograph; Thomas Hunt Morgan; Dabney Hall, constructed in 1928; Robert Andrews Millikan.



ALUMNI

Linus Pauling, PhD ‘25, first chemist to explain the nature of the chemical bond—possibly the most important single discovery in the history of chemistry. Major advances in chemistry and molecular biology, and the creation of hundreds of synthetic products, would later have their roots in his work. (He would also become the only person ever to win two unshared Nobel Prizes, for chemistry in 1954 and for peace in 1962.)

Carl Anderson, BS ‘27, PhD ‘30, discoverer of the antielectron, or positron, the first empirical proof for the existence of antimatter. This discovery permanently reshaped scientific understanding of the universe and opened major new avenues of investigation in modern physics. Anderson was awarded the Nobel Prize in Physics in 1936, at the age of 31.

Graduate Programs

Caltech offers graduate students superb research training and a strong, flexible curriculum of course work.

Students can earn Master of Science (MS) and Doctor of Philosophy (PhD) degrees. The degree of Engineer is also granted in four areas. Caltech offers joint MD/PhD programs with UCLA and USC.

Graduate options include aerospace; applied and computational mathematics; applied mechanics; applied physics; astrophysics; behavioral and social neuroscience; biochemistry and molecular

biophysics; bioengineering; biology; chemical engineering; chemistry; civil engineering; computation and neural systems; computer science; control and dynamical systems; electrical engineering; environmental science and engineering; geological and planetary sciences; materials science; mathematics; mechanical engineering; physics; and social science.

Students work closely with Caltech's renowned faculty to complete innovative research at the forefront of each of these fields. They investigate the most difficult, fundamental questions in science and engineering and address major issues that our society and the world are facing.

The diverse graduate student community takes part in a wide range of cultural, social, and recreational activities at Caltech and nearby, and participates in over 150 campus clubs and organizations.

More than 500 single or married graduate students live in Caltech apartments and residences. Caltech rents about 50 apartments and houses to students with families and lists nearby private rentals.

Caltech headlined *U.S. News & World Report's* 2010 graduate-school science ratings, ranking #1 in chemistry, earth sciences, and physics.

Almost all graduate students who are admitted to Caltech receive fellowships and/or research or teaching assistantships that cover tuition and provide a stipend for personal and living expenses.

For more information or an application for admission, visit www.gradoffice.caltech.edu or call 626/395-6346.

1930s

MILESTONES

Theodore von Kármán, head of Caltech's Graduate Aeronautical Laboratory, and his colleagues develop the principles of modern aviation and jet flight, launching a new industry and turning Southern California into the aircraft capital of the world. Off-campus experiments by von Kármán's students eventually lead to the founding of the Jet Propulsion Laboratory.

1931
Albert Einstein visits campus for the first time. (The opening of the Athenaeum, Caltech's faculty club, is timed to coincide with his visit.) He returns in 1932 and 1933 to consult with Caltech scientists about his general theory of relativity.

1935
Arnold Beckman, PhD '28, develops the pH meter to measure the acidity of lemon juice for a citrus-processing plant. The device proves an essential tool for analytical chemists in many fields. To market the pH meter, Beckman founds Beckman Instruments, Inc., which becomes one of the world's largest manufacturers of scientific and medical instruments. He will later become the first alumnus elected to Caltech's Board of Trustees.



Above, left–right: Einstein at Caltech; Arnold Beckman with pH meter; detail of Robinson Laboratory of Astrophysics, constructed 1932; Theodore von Kármán.

ALUMNI

Charles Townes, PhD '39, inventor of the maser and laser. Townes's investigations into radio and infrared astronomy led to the discovery of complex molecules like ammonia and water in the interstellar medium, and of evidence of a gigantic black hole in the center of our galaxy. He shared the 1964 Nobel Prize in Physics.

William Pickering, BS '32, MS '33, PhD '36, director of the Jet Propulsion Laboratory from 1954 to 1976. During Pickering's tenure, JPL reached one spaceflight milestone after another, among them Mariner 2's flyby of Venus (1962); Mariner 4's first close-up photos of Mars (1965); and Surveyor 1's soft landing on the moon (1966).

Chester Carlson, BS '30, physicist, inventor, and patent attorney. He invented the process of instant copying, which he called electrophotography, and which was subsequently named xerography and commercialized by the Haloid Corporation (Xerox).

THE EVOLVING CAMPUS



The Walter and Leonore Annenberg Center for Information Science and Technology

The Walter and Leonore Annenberg Center for Information Science and Technology (IST)—a three-story, 50,000-square-foot facility—serves as a base for the multidisciplinary IST initiative. IST researchers are helping reshape 21st-century science and engineering in the context of information. It is the first program in the country to combine research and teaching ranging from the fundamental theoretical understanding of information to the science and engineering of novel information substrates, biological circuits, and complex social systems.

The Annenberg Center reflects the creativity and energy of IST in its light and open design. Sustainability defines the center, with landscaping featuring mini-plazas accented by native plants. Spray and drip irrigation promote low water use, and sensors save on energy for lighting, heating, and air-conditioning. The Annenberg Center officially opened in October 2009. Generous funding in excess of \$50 million from the Annenberg Foundation, the Gordon and Betty Moore Foundation, Stephen D. Bechtel Jr., and others has made this remarkable campus initiative possible.

Linde + Robinson Laboratory for Global Environmental Science

Caltech is transforming the Robinson Laboratory of Astrophysics, built in the 1930s, into a state-of-the-art facility that will house the Ronald and Maxine Linde Center for Global Environmental Science.

The Linde Center was founded in 2008 with generous support from trustee Ronald Linde (MS '62, PhD '64) and his wife, Maxine. It provides rigorous science to inform public policy, investigates fundamental questions about how Earth's climate works, and helps society address global climate change. The Linde Center takes a multidisciplinary approach, drawing on Caltech's strengths in geophysics, geology, geochemistry, fluid mechanics, supercomputing, and more. Linde Center and JPL researchers collaborate closely.

The pioneering green renovation, funded in part by Foster and Coco Stanback, is expected to make Linde + Robinson the nation's most energy-efficient science lab and the first LEED Platinum-rated lab in a historic building. It will restore the building while also providing well-equipped laboratories for geochemistry, microbiology, and atmospheric and oceanic science. The project will be completed in 2011.

Warren and Katharine Schlinger Laboratory for Chemistry and Chemical Engineering

The four-story, 60,000-square-foot Warren and Katharine Schlinger Laboratory for Chemistry and Chemical Engineering is the new home of several of Caltech's chemists and chemical engineers.

The laboratory's classrooms, seven research labs, and three conference rooms support cross-divisional collaboration among chemical scientists and chemical engineers, who explore molecular medicine and nanoengineer biomedical materials, develop alternative energy technologies, synthesize pharmaceuticals and advanced materials, conduct fundamental research, and improve understanding of Earth's atmosphere and climate. One exciting initiative, led by Nobel laureate Robert Grubbs, the Atkins Professor of Chemistry, is a center for catalysis and chemical synthesis that may lead to better and faster experimentation by speeding the invention of new catalytic reactions.

The Schlinger Laboratory was dedicated in March 2010. Its construction was made possible by longstanding friends Warren Schlinger (BS '44, MS '46, PhD '48) and his wife, Katharine, along with other major supporters.

Research and FACILITIES

Academic Divisions

The Institute has six academic divisions:

- > Biology
- > Chemistry and Chemical Engineering
- > Engineering and Applied Science
- > Geological and Planetary Sciences
- > Humanities and Social Sciences
- > Physics, Mathematics and Astronomy

Beneath this apparently simple organization lie some 35 areas of research, many of which cross traditional disciplinary boundaries. Caltech has encouraged interdisciplinary approaches to research since its inception.

The next page outlines some of the research that Caltech faculty and students do.

The Universe— from Quarks to the Cosmos

- > Learn how the universe, galaxies, stars, and solar systems formed and evolved
- > Investigate the constituents of the universe—from Standard Model particles to dark matter and dark energy
- > Develop mathematics and physics that describe the quantum world, and invent tools to observe quantum behavior
- > Study space-time and gravitational waves
- > Design spacecraft, telescopes, optics, and microelectronics
- > Discover planets around other stars
- > Study planets' geophysics, compositions, hydrology, and atmospheres

Earth and the Changing Environment

- > Investigate the coevolution of life with Earth's atmosphere, climate, and geology
- > Examine climate change on all timescales
- > Identify sources, sinks, and effects of greenhouse gases, aerosols, and pollutants
- > Model the interplay of atmospheric circulation, ocean currents, and the cryosphere
- > Study tectonics and solid-Earth geophysics
- > Observe and model seismic activity and its effects on buildings and infrastructure
- > Develop earthquake early-warning systems

Sustainable Energy

- > Develop transformational technologies to harvest, generate, and store energy
- > Engineer novel materials and low-cost catalysts for fuel cells, photovoltaics, and other technologies
- > Invent bioinspired energy technologies
- > Design distributed energy markets and smart-grid technologies

Information and Computer Science

- > Invent next-generation chips, circuitry, lasers, detectors, and other hardware
- > Link information science with advanced theory in mathematics and physics
- > Design models, algorithms, and simulations
- > Find meaningful results in massive datasets
- > Invent self-assembling materials such as DNA circuits
- > Develop global communication networks that break speed and data-transfer records
- > Engineer machines with sensory capabilities
- > Develop quantum computing and information technology

Novel Materials and the Properties of Solids and Fluids

- > Create high-performance polymers, elastics, adhesives, metallic glasses, and more
- > Study stress, failure, and fracture
- > Study turbulence in areas from atmospheric circulation to hypersonic propulsion
- > Advance aerospace engineering
- > Build theory in chemistry and engineering to advance future science and technology

Biomedicine

- > Nanoengineer molecular medicines and drug-delivery devices to fight cancer, Alzheimer's, and other diseases
- > Invent technologies that build on immune-system defenses
- > Combat global epidemics with diagnostic labs-on-chips, bioengineering, and new drugs and vaccines
- > Synthesize proteins, cells, and tissues for biomedical applications
- > Develop new imaging methods for biological and biomedical research

Genetics and Development

- > Use next-generation sequencing to learn how complex organisms develop
- > Discover mechanisms of biological signaling and intracellular communication
- > Use computation and real-time imaging to create fully predictive models of complex biological systems

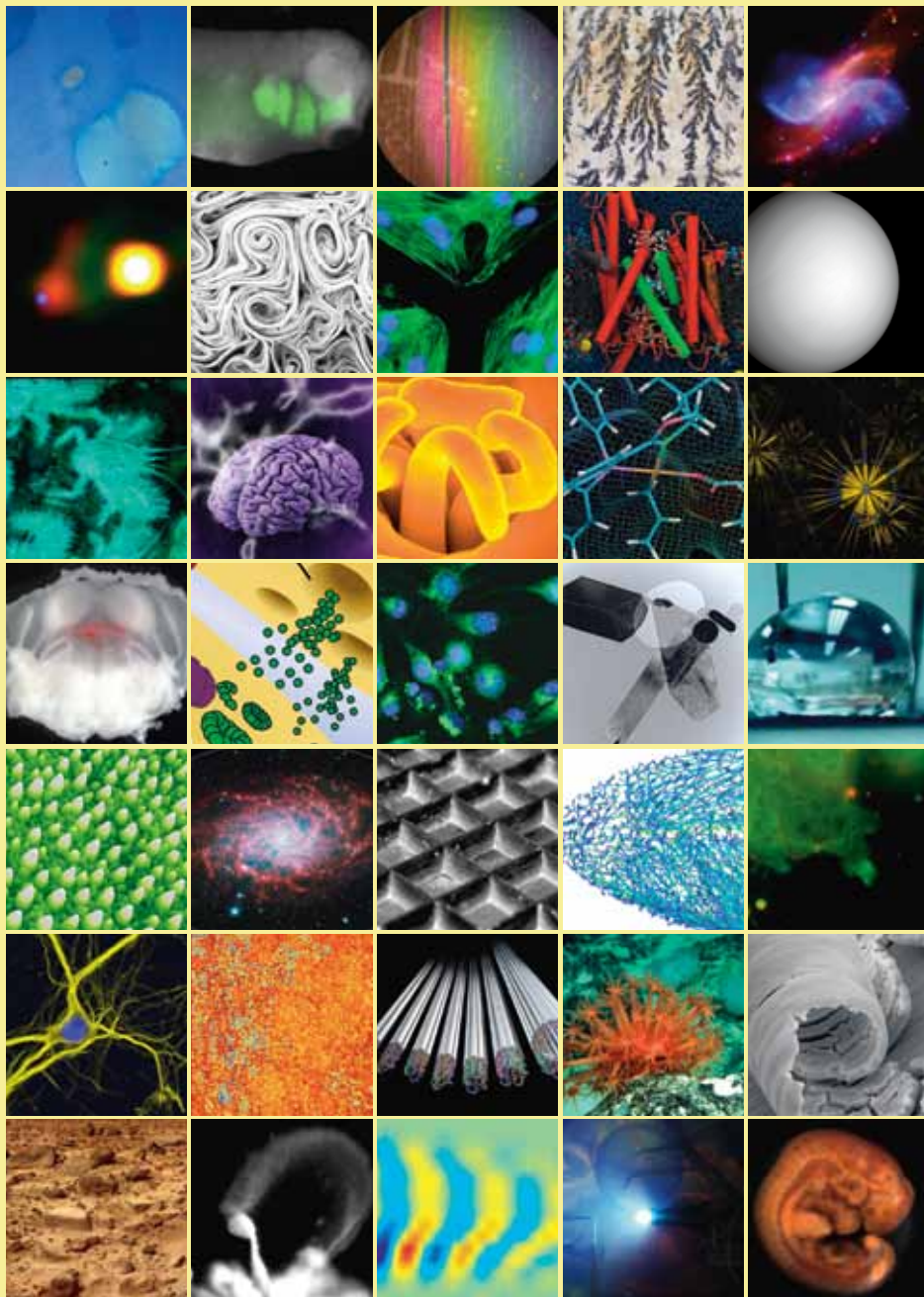
Neuroscience

- > Learn about consciousness and behavior
- > Map neurological diseases, addiction, learning, memory, and emotion in the brain
- > Build prostheses that respond to intention
- > Use brain imaging and other techniques to study economic and social behavior

Societies, Economies, and Governments

- > Refine economic theory by including the effects of emotions and perceptions
- > Develop models to help optimize political representation and fairness
- > Analyze experimental and real markets, auctions, and elections
- > Learn how societies and markets recover
- > Study history and literature to gain insight into past social and economic conditions
- > Trace the history of science and technology





Many of these images are excerpted from entries in Caltech's annual Art of Science competition.

RESEARCH HIGHLIGHTS Academic Year 2009–10

September 2009

- > Biologists get a detailed glimpse of chemo-receptor architecture in bacterial cells

October

- > Geobiologists reveal unexpected sources of nitrogen fixation
- > Physicists create a robot that can simulate the "visual" experience of a blind person who has been implanted with a visual prosthesis
- > The Annenberg Center for Information Science and Technology is dedicated

November

- > Scientists develop DNA origami nanoscale breadboards for carbon nanotube circuits
- > Biologists find emotion-like behaviors, regulated by dopamine, in fruit flies

December

- > High-energy physicists set a new record for network data transfer
- > Caltech and UCLA launch joint center for translational medicine

January 2010

- > Astronomers find second-smallest exoplanet

February

- > Neuroscientists discover brain area responsible for fear of losing money
- > Researchers develop nanoscale structures with superior mechanical properties
- > Researchers create highly absorbing, flexible solar cells with silicon wire arrays

March

- > The new Warren and Katharine Schlinger Laboratory for Chemistry and Chemical Engineering opens
- > Caltech and UCSD scientists establish the leech as a model for the study of reproductive behavior

- > Caltech-led team provides proof in humans of RNA interference using targeted nanoparticles

April

- > African American babies and boys least likely to be adopted, study shows
- > Researchers create "sound bullets"
- > Biologists link gut microbial equilibrium to inflammatory bowel disease

May

- > Spiders at the nanoscale: Molecules that behave like robots
- > Schooling fish offer new ideas for wind farming
- > Caltech-led team first to directly measure body temperatures of extinct vertebrates

June

- > Biologists provide molecular explanation for the evolution of Tamiflu resistance
- > Geologist investigates canyon carved in just three days in Texas flood
- > Researchers show how active immune tolerance makes pregnancy possible

July

- > Scientists measure changing lake depths on Titan
- > Researchers discover that gut bacteria affect multiple sclerosis
- > Caltech-led team gets up to \$122 million for Energy Innovation Hub

August

- > Gain and loss in optimistic versus pessimistic brains
- > Fruit flies use horizontal landmarks for altitude control, says Caltech research team
- > New view of tectonic plates

Seismological Laboratory

The Seismo Lab is one of the world's centers for geophysical research. Lab faculty and students explore Earth's structure and dynamics from the core to the ice caps. They use high-performance parallel-computing clusters, one of the world's major seismic networks, and Earth-observing satellites. They work to reduce the toll earthquakes take on humanity, conducting research, modeling earthquakes and the shaking of buildings, and developing seismic networks and detectors. With the USGS, the lab operates the Southern California Seismic Network, recording and analyzing data from more than 400 seismic stations. For information or to register for a tour, call 626/395-3298 or visit www.seismolab.caltech.edu.

Beckman Institute

This institute facilitates the invention of methods, materials, and technologies for research in biology and chemistry. A hub for biological imaging, biomolecular design, spectroscopy, electron microscopy, molecular materials, biological network modeling, computational regulatory genomics, and proteome exploration, it also has facilities for protein expression, cell sorting, crystallography, and more.

Resnick Sustainability Institute

In this new institute, top faculty and students in engineering, applied physics, chemistry, biology, and materials science will complete fundamental research in energy science. They aim to drive game-changing advances in energy generation and storage, producing technological innovations with terawatt-scale impact. See resnick.caltech.edu.

Observatories

Caltech faculty and students are involved in many **NASA missions** (see JPL, page 20). They helped develop the **Large Hadron Collider** and do research

there. They use Caltech-owned or jointly run observatories, including the **W. M. Keck Observatory**; the **Laser Interferometer Gravitational Wave Observatory**, an international effort to directly detect ripples in space-time; the **Caltech Submillimeter Observatory**; the **Owens Valley Radio Observatory**; the **Combined Array for Research in Millimeter-wave Astronomy**; **BICEP II**; and the **Palomar Observatory**, with the 200-inch Hale Telescope. Future telescopes include **CCAT**, which may see the first galaxies, and the **Thirty Meter Telescope**, which will yield the clearest, deepest picture of the universe to date.

1940s



MILESTONES

Max Delbrück introduces the rigorous techniques of physics to the study of biology and makes fundamental discoveries concerning the nature of viruses and viral disease. He will receive the 1969 Nobel Prize for this work.

Biologist **Henry Borsook**'s research throughout the '30s and '40s leads the federal government to establish recommended daily adult requirements for vitamins A, B, C, and D.

1944

The Jet Propulsion Laboratory is established. Over the years, JPL evolves from a developer of missiles for the Army into a NASA flagship dedicated to the robotic exploration of the moon, the planets, and interplanetary space.

1946

Lee DuBridg is inaugurated as Caltech's president, succeeding Millikan, who retired in 1945. DuBridg will be dubbed "the senior statesman of science" by *Time* magazine in 1955.

1948

The 200-inch Hale Telescope becomes operational. Located on Palomar Mountain, north of San Diego, California, the Hale is the largest and most powerful telescope of its time.

Above, left-right: first rocket test at Arroyo Seco, future home of JPL; Max Delbrück and the phage group; Hale Telescope at Palomar Observatory; members of Caltech's Navy V-12 program.

ALUMNI

Eugene Shoemaker, BS '47, MS '48, astrogeology pioneer and comet hunter. Shoemaker mapped the geology of the moon's surface and later served as principal investigator for field geology for the Apollo program, helping to prepare astronauts to do field work on the moon. In 1993 his astronomical observation team discovered comet Shoemaker-Levy 9, which crashed spectacularly into Jupiter in July 1994.

Edward Lewis, PhD '42, Caltech biologist whose studies of genetic mutations in *Drosophila* fruit flies won him the 1995 Nobel Prize. Particularly important are his discoveries about homeotic genes, which tell the undifferentiated cells of an embryo where and how to form the body's various tissues and organs and are remarkably similar in all creatures—from fruit flies to humans.

Jet Propulsion Laboratory

When a few Caltech graduate students and researchers started test-firing rocket motors in an arroyo seven miles from campus in 1936, they set off a chain of events that would make that canyon home to the nation's leading center for planetary exploration. A few years later, led by their mentor, Caltech professor Theodore von Kármán, these first rocket scientists founded JPL.

JPL built America's first satellite, Explorer 1, and, in partnership with NASA and the campus, sent robotic spacecraft to every planet in the solar system.

JPL's remote-sensing satellites provide vital data about Earth and its systems. JPL builds telescopes that see deep into the cosmos and manages communications among distant spacecraft. Managed for NASA by Caltech, the Lab currently operates 20 spacecraft and nine instruments. Some 5,000 people work at the 177-acre site.

The Lab and the campus have a history of mutual success. Faculty and students have played a major role in many JPL missions for NASA. The

campus and Lab's combined intellectual and experimental assets continue to attract top scientists, engineers, and students.

In 2010, JPL and Caltech had **more than 100 funded collaborations and 80 joint appointments of faculty, lecturers, and visitors**. Many Caltech students complete research at JPL. Lab staff teach several Caltech courses, and faculty share cutting-edge research in a JPL-wide seminar series.

Caltech students and faculty are particularly involved with the renowned **Spitzer Space Telescope**; the **Galaxy Evolution Explorer**; the cosmos-mapping **Wide-field Infrared Survey Explorer**; **NuStar**, a high-energy X-ray mission that will study black holes, stellar explosions, and extremely active galaxies; and the European Space Agency's **Herschel** and **Planck** missions, which use Caltech/JPL technology to study star and galaxy formation and the origin of the universe, respectively. The **five**

1950s



Above, left-right: Richard Feynman; along the Olive Walk, 1950; Owens Valley Radio Observatory, operational since 1958; George Beadle and Linus Pauling.

MILESTONES

Already renowned for his revolutionary work in quantum electrodynamics (for which he will receive the 1965 Nobel Prize), theoretical physicist **Richard Feynman** joins the Caltech faculty in 1950. Over the next three decades, he expands on that work, at the same time completely revising the teaching of undergraduate physics, writing a best-selling memoir, and demonstrating his talents as a drummer, actor, and artist. Feynman becomes even more widely known in 1986, when he is appointed to the presidential commission investigating the explosion of the space shuttle *Challenger*.

1953 Geochemist Clair Patterson first determines, through studies of the decay rate of lead isotopes in the earth's oldest rocks, that our planet has existed for 4.6 billion years. When his research focus later shifts from rocks to the oceans and atmosphere, he discovers that lead pollution from automobile exhaust has reached dangerously high levels. Patterson's determined crusade against lead pollution strongly influences

the federal government's decision to establish pollution controls within the auto industry.

1954 Linus Pauling, chairman of the Division of Chemistry, and George Beadle, chairman of the Division of Biology, launch a major research program in chemical biology.

1958 JPL launches Explorer I, America's first Earth-orbiting satellite.

alumni

Gordon Moore, PhD '54, semiconductor industry pioneer. As cofounder, and later chairman, of Intel Corporation, he oversaw the development of the silicon-chip microprocessor, the device that made personal computers possible. Moore is also a chairman emeritus of Caltech's Board of Trustees.

Harrison Schmitt, BS '57, geologist; astronaut; senator; businessman; educator. Schmitt is the only Caltech graduate, the only scientist, and the last of only 12 humans to have walked on the moon. After his 1972 Apollo 17 mission, Schmitt served in the U.S. Senate and on a number of presidential commissions. He is currently a consultant and a university instructor.

Moshe Arens, MS '53, engineer; professor; statesman. As an executive in the Israeli aircraft industry, Arens directed the development of Israel's military and civil aircraft programs. He has served Israel as a member of the Knesset, ambassador to the U.S., defense minister, minister of minority affairs, and foreign minister.

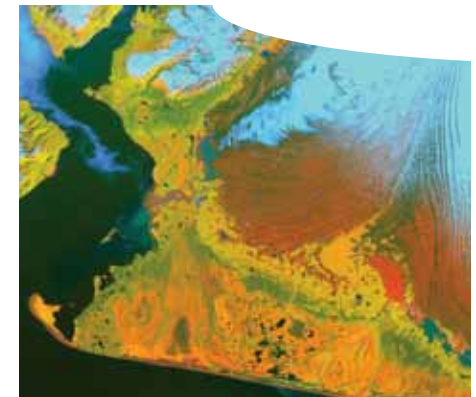
NASA facilities on campus include the Infrared Processing and Analysis Center, the Exoplanet Science Institute, and the Spitzer, Herschel, and Galaxy Evolution Explorer science centers. Campus and Lab researchers also work closely on technologies for future space exploration, including **microelectronics** and **advanced computing**.

JPL manages the **Cassini** mission and the **Mars program**: the Mars rovers, the Mars Reconnaissance Orbiter, the

Mars Odyssey, and the **Mars Science Laboratory**, a next-generation rover.

The Lab and campus have built on their leadership in planetary science to provide data about Earth, designing remote-sensing satellites that collect information on climate, sea level, polar ice, topography, and more. JPL will soon rebuild the **Orbiting Carbon Observatory**, lost during launch. A few other current missions are **CloudSat**, the **Ocean Surface Topography Mission**, and the **Gravity Recovery and Climate Experiment**.

The pace of discovery continues to accelerate. Caltech's new **Keck Institute for Space Studies** brings together the best talent from JPL, the campus, and the wider community to explore grand challenges in science and develop related prototypes. Collaborations like this will shape the course of space exploration and Earth remote sensing for decades to come. See www.jpl.nasa.gov and www.kiss.caltech.edu.



1960s



MILESTONES

Caltech paleoecologist **Heinz Lowenstam** startles biologists and geologists alike with the discovery that many animals do what conventional science has considered impossible: they generate such substances as the iron-containing mineral magnetite within their bodies. Lowenstam's work leads to later findings that many migratory animals, including birds, bees, and whales, manufacture magnetite, and may owe their uncanny homing instincts to the presence of internal compasses that allow them to navigate by means of Earth's magnetic field.

1962
In a ceremony at the White House, President Kennedy presents Theodore von Kármán with the first National Medal of Science. Fifty-two more Caltech faculty and alumni will receive this award over the next five decades.

1964
Astronomer Maarten Schmidt determines that quasars—a puzzling class of cosmic objects—are the most powerful and distant

objects in the universe. Since quasar light has been traveling for billions of years to reach Earth, Schmidt's discovery gives astronomers an unprecedented look at how the universe appeared at a much younger age, billions of years before the birth of the sun and its planets.

1969
Harold Brown succeeds Lee DuBridge as Caltech's president.

1969
Physicist Murray Gell-Mann receives the Nobel Prize for his work on the theory of elementary particles.

Above, left–right: von Kármán receiving National Medal of Science; Harold Brown and students; Maarten Schmidt; construction of Beckman Auditorium.

ALUMNI

Douglas Osheroff, BS '67, physicist. Osheroff, a leader in the study of superfluidity and of the properties of thin superconducting films, shared the 1996 Nobel Prize in Physics for the discovery of superfluidity in helium-3. A member of the National Academy of Sciences, he was also among the first group of MacArthur Foundation "genius" fellowship recipients in 1981. He has been a professor at Stanford University since 1987.

York Liao, BS '67, cofounder of Varitronix Ltd. Applied physicist/entrepreneur Liao turned his scientific curiosity about the electro-optical properties of liquid crystals into one of the leading LCD manufacturing companies in the world. Initially a producer of LCDs for wristwatches, Varitronix now concentrates on manufacturing LCDs tailor-made to such specific applications as airport and railway-station departure boards, navigation instruments, and missile controls. Liao is also a Caltech trustee.

ECONOMIC IMPACT



Patents, Start-ups, and Direct Economic Contribution

Although Caltech is small in numbers of students and faculty, there is nothing small about its research and its impact on the economy.

Caltech has obtained more than 2,000 U.S. patents since 1980. It receives more invention disclosures per faculty member than any other U.S. university. Technologies regularly get commercialized: 40 to 50 inventions are licensed each year.

Caltech's faculty, staff, and students have created more than 120 start-up companies via the Office of Technology Transfer (www.ott.caltech.edu) since 1995, half of them in Southern California.

Graduates take leadership positions in industry, government, and academia throughout the U.S. and the world, contributing to innovation and economic health around the globe. Each year, over 130 companies come to campus to recruit employees and interns. (For information, call 626/395-6361 or visit www.career.caltech.edu.)

Caltech also contributes directly to the economic vigor of greater Los Angeles. The campus employs approximately 3,800 nonstudents, and JPL, which Caltech manages for NASA, employs approximately 5,000. In fiscal year 2009, JPL spent more than \$341 million—over and above payroll—in Southern California.

Educational OUTREACH

Events and Bus-ins

Caltech's events centered on science and engineering reach tens of thousands of adults and youth annually. Caltech researchers share their latest work with 4,000 people each year through the **Watson Lecture Series**, one of several free lecture series on campus. The **Jr. Watson Program** gives talented high-school students a chance to tour each speaker's lab and dine with a member of the lab group before the lecture. More than 500 youth, family members, and adults enjoy each **Science Saturday** event. More than 600 schoolchildren bus in for each **REEL Science** event. These two programs combine high-definition science and nature films with discussions

led by graduate students and postdoctoral scholars. See www.events.caltech.edu for a calendar and information.

The Loh Down on Science

Caltech teams up with Southern California Public Radio and TIAA-CREF to bring listeners *The Loh Down on Science*, hosted by alumna Sandra Tsing Loh. More at lohdown.caltech.edu.

Caltech on iTunesU

Free video and audio downloads are available through Caltech on iTunesU. The collection includes interviews with researchers, public lectures, updates from major research programs, and coverage of events like commencement, TEDxCaltech, and student performances. See www.itunes.caltech.edu.



Classroom Outreach

The campus and JPL work closely with teachers and students near and far to enrich science and engineering education.

The lab encourages learning by providing **JPL/NASA** classroom activities, homework help, student competitions, programs for underserved populations, teacher training, classroom visits, JPL tours, internships, and career guidance (www.jpl.nasa.gov/education).

The **Caltech Precollege Science Initiative** supports research on science education and develops teacher-training programs and K–12 science curricula.

It has provided inquiry-based science modules to all of Pasadena's public elementary schools and more than 12 other school districts (www.capsi.caltech.edu).

The **Caltech Classroom Connection** pairs Caltech volunteers with local K–12 teachers. Teams create weekly activities (www.classroomconnection.caltech.edu).

School groups often tour Caltech's **Tectonics Observatory** (www.tectonics.caltech.edu) and the **Seismo Lab** (www.seismolab.caltech.edu/tours.html). Observatory scientists visit classes, provide

teaching materials, participate in teacher training, and lead geology field trips.

Underrepresented students (such as African American, Hispanic, and Native American students, women in male-dominated fields, and first-generation college students) come to Caltech for **MURF** (www.murf.caltech.edu), a summer of college-level research, and **YESS** (www.yess.caltech.edu), three weeks of lab tours, lectures, field trips, and courses at the high-school level.

Caltech students tutor Pasadena public school students through the Caltech Y's **RISE program** (www.caltechy.org),

offer **private tutoring** advertised at www.career.caltech.edu, and volunteer in science, math, and reading programs.

K–14 students all over the world participate in Caltech/JPL research. For just one example, over 40 colleges and high schools have enlisted in professor Harry Gray's "solar army." They test possible catalysts for splitting water into hydrogen fuel and oxygen with the aid of sunlight. Chilean students remotely operate a JPL telescope. Hawaiian students attend programs and intern at Caltech observatories.

1970s



MILESTONES

Leroy Hood and his research group develop a prototype DNA-synthesis machine that becomes an essential tool in genetic engineering and biotechnology.

Roger Sperry, continuing work begun in the late '60s, discovers that the left and right hemispheres of the brain are specialized for different capacities: the left for verbal thinking and language, and the right for spatial-visual thought. This research helps define the emerging discipline of neuroscience and earns him the 1981 Nobel Prize.

1970

Female undergraduates enter in the fall class. It is the first time since 1909 that women have been admitted to the undergraduate program.

1975

Virologist Renato Dulbecco wins the Nobel Prize for his discoveries concerning the interaction between tumor viruses and the genetic material of the cell.

1978

Marvin ("Murph") Goldberger becomes president of Caltech, succeeding Harold Brown, who has accepted the position of Secretary of Defense in the Carter administration.

Above, left–right: Roger Sperry; Baxter Hall of the Humanities and Social Sciences, constructed in 1971; first undergraduate women, 1971; Murph Goldberger, teaching freshman physics.

ALUMNI

David Ho, BS '74, virologist, physician. Ho currently serves as director of the Aaron Diamond AIDS Research Center, an affiliate of the Rockefeller University. He was named *Time* magazine's Man of the Year in 1996 in recognition of how, in the magazine's words, his "pioneering experiments with protease inhibitors helped clarify how the virus ultimately overwhelms the immune system." As a result of the new methods of treatment he has developed, many AIDS sufferers are living longer, and there is new hope that the virus may someday be eliminated.

Sharon Long, BS '73, geneticist, molecular biologist. Long is a pioneer in the study of how *Rhizobium* bacteria infect legume plants and establish a nitrogen-fixing symbiosis in root nodules. Because they reduce the need for expensive fertilizer, nitrogen-fixing bacteria are of considerable agricultural interest. A member of the first undergraduate class that included women, Long received a MacArthur Foundation fellowship in 1992 and was elected to the National Academy of Sciences in 1993. She is currently a professor and former academic dean at Stanford University.

How to Be INVOLVED

It doesn't matter if you're on campus or a continent away—you can get involved in Caltech research, programs, and activities.

Keep Up with Caltech Research

You can do this without lifting a finger—Caltech people and research make the news often. In 2009 alone, Caltech and its research came up in more than 120 features in magazines like *Newsweek*, *Time*, and the *New Yorker* and hundreds

of TV, radio, and Web interviews. Popular science and technology magazines regularly featured and quoted faculty and students. In 2010, Caltech people and research appeared in more than 40 *New York Times* stories, as well as in articles in the *Daily Mail*, *Der Spiegel*, *La Stampa*, *El País*, *India Journal*, *Shanghai Daily*,



the *Hong Kong Herald*, and the *Sydney Morning Herald*.

But you don't have to be everywhere at once to keep up. To be the first to know about breakthroughs and happenings at Caltech, you can subscribe to **Caltech Today** by email or RSS—or

just visit today.caltech.edu. You can get updates from the **Facebook** pages of the California Institute of Technology, Caltech Public Events, and the Caltech Alumni Association, or follow them on **Twitter**.

For highly readable, in-depth stories about Caltech research, subscribe to Caltech's quarterly magazine, *Engineering & Science* (www.eands.caltech.edu). If you'd like to watch researchers discuss their own work, you can find complete, **professionally recorded lectures** at today.caltech.edu/theater and at www.itunes.caltech.edu.

1980s

MILESTONES

1983

Physicist Willy Fowler, PhD '36, wins the Nobel Prize for "studies of the nuclear reactions of importance in the formation of the chemical elements of the universe." His research shows that we are, as Carl Sagan liked to say, "starstuff": nearly all the elements

in the universe and in our bodies were originally cooked up inside stars.

1986

Chemist/biologist John Hopfield and computer scientist Carver Mead establish Caltech's graduate program in Computation and Neural Systems. The first of its kind in the nation, the program combines studies in neurobiology, computation, information theory, very-large-scale integration technology, and materials science.

Its aims: to develop computers patterned on neural networks like the brain, and to better understand the computational aspects of biological brains.

1987

Thomas Everhart becomes Caltech's sixth chief executive.

1989

The Beckman Institute opens. This center for cross-disciplinary research in the chemical and biological sciences houses investigators in such fields as biomolecular design, laser and mass spectroscopy, and genome research.

Above, left-right: Willy Fowler; Carver Mead; Tom Everhart at Frosh Camp; Beckman Institute.



ALUMNI

Sandra Tsing Loh, BS '83, humorist, author, and social commentator. The daughter and sister of Caltech grads, Loh is proud of her degree in physics (she describes it as having been "a character-building experience"), even though she later felt inspired to embark on a performing career. She is the author of several books, including *Mother on Fire* (2008). She has presented her own show in New York and L.A. theaters, and her commentaries can be heard on local and national public-radio stations (see page 25).

Philip Neches, BS '73, MS '77, PhD '83, one of America's leading technologists and a Caltech trustee. Neches founded Teradata Corp., which developed hardware and software products to implement the world's largest relational databases. Chief scientist and vice president there until 1988, he then joined NCR Corporation, where he led a repositioning of that company's line of computer products in advance of a merger with AT&T. As vice president and chief technical officer of AT&T's multimedia products and services group, he participated in the formation of what became AT&T's Internet service. Neches is now an independent consultant.

Join a Club or Friends Group

More than a thousand people who've never studied at Caltech participate actively in friends groups, including the Associates, the Friends of Beckman, and the Friends of the Caltech Libraries.

Caltech's small, famously hard-working student body sustains more than 150 clubs. Other members of the Caltech/JPL community join many of these clubs, too.

Groups come together to pursue an array of interests, to volunteer, to express faiths, and to celebrate culture. More than 25 groups meet to play sports and enjoy the outdoors. Over 20 focus on the arts.

When students graduate, they're invited to join the Caltech Alumni Association, which also welcomes post-doctoral scholars.

The Caltech Y

Founded by students in 1916, the independent, nonprofit Caltech Y sponsors a packed calendar of social and cultural events, service projects, forums, and wilderness outings.

A small sampling: Alternative Spring Break, Make-a-Difference Day, International Week, the Social Activism Speaker Series, the Y hike in the Sierras, and the Washington, D.C., science-policy trip. The Y also helps students put together events, meetings, and initiatives. It aims to enrich students' lives and help each one grow into a responsible citizen of the world. For information, call 626/395-6163 or visit www.caltechy.org.

Caltech Alumni Association

The Alumni Association provides a lifelong link with Caltech. In addition to lunches, lectures, field trips, behind-the-scenes tours, and travel programs to help alumni connect with each other and with Caltech, CAA offers career counseling and other professional development services. Newsletters, online resources and social networks, and subscriptions to *Engineering & Science* help members develop their careers and continue learning. Each spring, CAA hosts reunions and Seminar Day, when Caltech faculty present cutting-edge research to alumni, Associates, and guests. Each fall, Alumni College provides a full weekend of learning.

CAA also provides volunteer opportunities such as planning events and talking about Caltech with prospective and new students. For information, call 626/395-6592 or visit www.alumni.caltech.edu.

The Associates

Legendary Caltech leader Robert Millikan believed that the first meeting of the Associates, in 1926, was the most important moment in Caltech's history. Associates vigorously support Caltech research and education. More than 2,300 individuals participate in the organization—an international cross section of entrepreneurs, community leaders, philanthropists, and others. About

1990s

MILESTONES

The two sites for the **Laser Interferometer Gravitational-Wave Observatory (LIGO)** are selected. The two observatories—one in Livingston, Louisiana, and the other in Hanford, Washington—are attempting to confirm experimentally the existence of the gravitational waves posited by Einstein's general relativity theory.

Chemical physicist **Ahmed Zewail** wins the 1999 Nobel Prize in Chemistry. He is recognized for his efforts in a field he pioneered known as femtochemistry, which uses ultrafast lasers to probe chemical reactions as they occur in real time.

1990

The T5 hypervelocity shock tunnel is installed on the roof of Caltech's Guggenheim Laboratory. This unique facility produces extreme velocities and pressures, allowing aeronautics investigators to simulate the airflow conditions that aircraft encounter during, for example, entry into a planetary atmosphere.

1991

Caltech celebrates its centennial with a float in the Rose Parade and a year of special events.

1993

Keck I, the first of two 10-meter telescopes planned for the W. M. Keck Observatory on Mauna Kea, Hawaii, becomes operational. Its twin, Keck II, is completed in 1996. The two instruments are being used in tandem to view objects too distant to be seen with any other optical telescope.

1997

The Mars Pathfinder spacecraft—developed and managed by JPL for NASA—lands on the red planet on Independence Day.

1998

David Baltimore is inaugurated on March 9 as Caltech's seventh president.

Above, left-right: W. M. Keck Observatory; Nobel Laureates Rudy Marcus and Ed Lewis; Moore Laboratory of Engineering, dedicated 1996; Nobel Laureate Ahmed Zewail.



ALUMNI

Ari Kaplan, BS '92, baseball statistician. Observing that baseball statistics didn't always tell the whole story about a pitcher's effectiveness, Kaplan set about devising a better statistic. For a SURF project, he developed the Reliever's Effectiveness Ratio, which reflects a relief pitcher's performance better than the traditional Earned Run Average. His new system so impressed the Baltimore Orioles' managers that they hired him to redesign their computerized statistical tracking. He has now consulted for 12 Major League Baseball teams and is currently CEO of the Independent Oracle Users Group.

Andrea Ghez, MS '89, PhD '92, astronomer. Ghez, a professor at UCLA and a MacArthur Fellow, is changing the way astronomers think about star birth. While still a grad student, she found that stars are probably born in pairs, rather than singly, as had long been thought, and she obtained the best evidence yet that a massive black hole sits at the center of the Milky Way.

a third are alumni. Associates gather for lectures and events in Pasadena, West L.A., the Bay Area, and New York, and travel with renowned Caltech faculty. The group provides opportunities for people who are intellectually curious about the world to meet, network, and socialize. Associates may use campus libraries and join Caltech's gyms and its faculty club, the Athenaeum.

This group has substantially advanced science and engineering: members have endowed more than 50 professorships and many fellowships and scholarships, helped pay for dozens of campus buildings, and provided vital unrestricted support.

For information, call 626/395-3919 or visit www.associates.caltech.edu.

Support Research and Education

Tens of thousands of people and hundreds of organizations have made a difference by investing in Caltech research and educational programs.

Some have worked with Caltech staff to design a single gift that advances one area of research or a particular program for students. Some have contributed unrestricted funds every year for decades.

Creative, thoughtful, and consistent support from private donors underlies every Caltech innovation and discovery. It gives researchers time and freedom to develop new ideas into proven concepts that can attract grant support. It allows them to seize time-sensitive opportunities

and do the high-risk, high-reward science and engineering that set Caltech apart.

Call 877/CALTECH (877/225-8324) or see www.giving.caltech.edu to learn more.

Come to an Event

About 75,000 people come to campus each year for talks, tours, performances, and student events. In the flagship Earnest C. Watson Lecture Series, faculty members report on topics of current interest. Families enjoy Science Saturdays—matinees followed by discussions with students and postdoctoral scholars.

Caltech's many music, theater, and dance groups perform often. The cam-

pus also hosts the venerable Coleman chamber concerts and performances by renowned musicians and dance groups.

Visitors can take advantage of a terrific lineup of international programming—one way Caltech celebrates its diversity and prepares students for careers in the international communities of science and engineering.

For information, including details for persons with disabilities, call 626/395-4652 or visit www.events.caltech.edu.

JPL also hosts events—like its spring open house and the popular Von Kármán lecture series—welcoming 55,000 visitors each year (www.jpl.nasa.gov/events).

2000s

MILESTONES

Astronomer **Mike Brown** and his colleagues find Eris, the first solar-system object larger than Pluto. The International Astronomical Union then votes to demote Pluto to dwarf-planet status, leaving the solar system with eight planets. Now Eris is the largest dwarf planet, currently visible in the constellation Cetus to anyone with a top-quality telescope.

In 2009, the board of directors of the TMT Observatory Corporation select Mauna Kea, Hawaii, as the preferred site for the Thirty Meter Telescope, which is intended to become the most advanced and powerful optical telescope on Earth.

2001

Gordon and Betty Moore and their family foundation announce that they will make a combined gift to Caltech of \$600 million. It is by far the largest donation ever made to any academic institution.

2004

Physicist David Politzer wins the Nobel Prize for work he began as a graduate student on how the elementary particles known as quarks are bound together to form the protons and neutrons of atomic nuclei.

2005

Organic chemist Robert Grubbs wins the Nobel Prize "for the development of the metathesis method in organic synthesis." Metathesis allows scientists to build new molecules with specialized properties.

2006

Jean-Lou Chameau becomes Caltech's eighth president.

2008

Caltech successfully completes a five-year, \$1.4 billion fund-raising campaign.



Above, left-right: Nobel Laureate Robert Grubbs; Broad Center for the Biological Sciences; President Jean-Lou Chameau; scene from documentary Quantum Hoops.

alumni

Adrian Ponce, PhD '00, chemist. In the aftermath of 9/11, his basic research into spore chemistry opened the way to the development of a prototype device that could detect airborne bacterial spores, including anthrax spores. Caltech patented the device, a company licensed the technology so that it could manufacture anthrax detectors, and Ponce suddenly found a new purpose for his work. "Doing something useful always feels good," he says.

John Dabiri, MS '03, PhD '05, Caltech engineer, named one of the Brilliant 10 (the brightest researchers of 2008) by *Popular Science*, selected for a Presidential Early Career Award for Scientists and Engineers (PECASE) in 2009, and named a MacArthur Fellow in 2010. Dabiri examines the mechanics and dynamics of biological propulsion. Potential applications include aquatic locomotion, fluid dynamic energy conversion, and cardiac flows. Jellyfish are the current focus. The findings of Dabiri's group are already inspiring design improvements in data-collecting buoys, military submarines, and onshore windmills.

Maps and TOURS

Getting to Campus

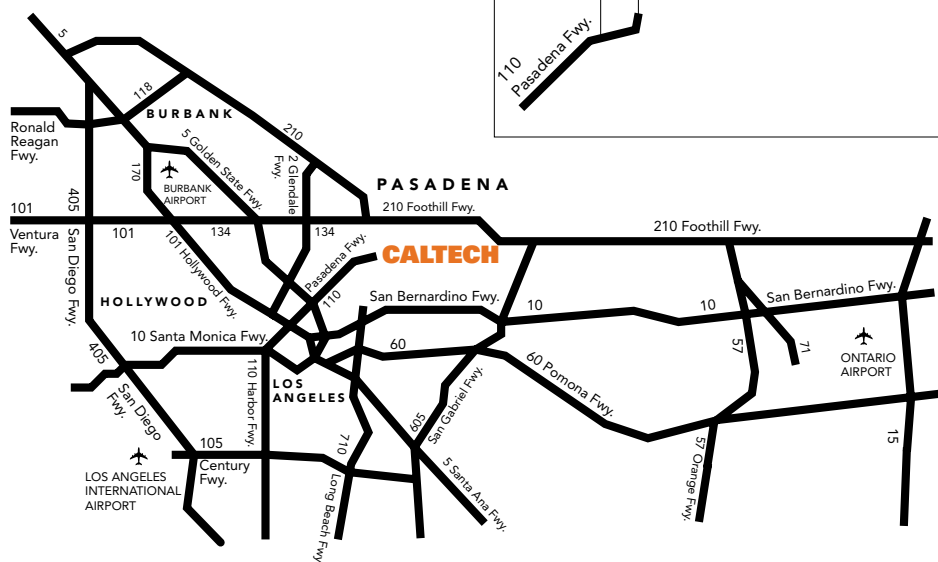
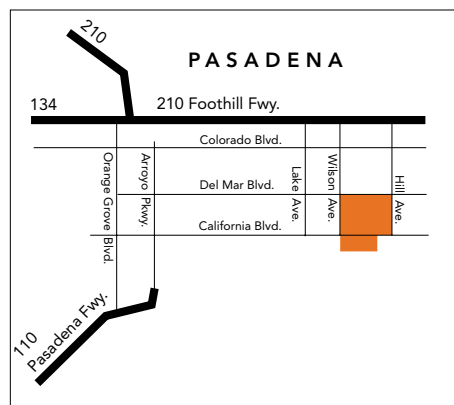
From Los Angeles International Airport (LAX)

Drive south on Sepulveda Blvd. to the Century Freeway (105). Proceed east on the 105 to the Harbor/Pasadena Freeway (110). Go north on the 110 until it ends on Arroyo Parkway in Pasadena. Continue north on Arroyo Parkway to California Blvd. Turn right onto California Blvd. and proceed to Caltech.

Several van shuttles also offer door-to-door service from the airport.

From Burbank-Glendale-Pasadena Airport

Leaving the airport, follow the signs to the Golden State Freeway (5). Drive south on the 5 to the Ventura Freeway (134). Go east on the 134 to the Foothill Freeway (210). Continue east on the 210 to Hill Avenue. Travel south (right) on Hill Avenue until you reach campus. Several van shuttles also offer door-to-door service.



From Downtown Los Angeles

Drive north on the Harbor/Pasadena Freeway (110) until it ends on Arroyo Parkway in Pasadena. Continue north on Arroyo Parkway to California Blvd. Turn right onto California Blvd. and proceed to Caltech.

From West Los Angeles

Travel east on the Santa Monica Freeway (10) to the Harbor/Pasadena Freeway (110). Go north on the 110 until it ends on Arroyo Parkway in Pasadena. Continue north on Arroyo Parkway to California Blvd. Turn right onto California Blvd. and proceed to Caltech.

From Orange County or the San Gabriel Valley

Drive north on the San Gabriel River Freeway (605) to the Foothill Freeway (210). Go west on the 210 to the Hill Avenue exit. Turn left onto Hill Avenue and follow it to campus.

Useful Campus Telephone Numbers

(all are area code 626):

Switchboard	395-6811
Undergraduate Admissions	395-6341
Graduate Office	395-6346
Campus Programs	395-4652
Alumni Association	395-6592
Development	395-3225
Media Relations	395-3227
Earthquake Information	395-3003

Address mail to the appropriate individual or department at Caltech, Pasadena, CA 91125.

Visit the Caltech website at www.caltech.edu.



Tour Information

Caltech welcomes visitors at all times of the year. Student-led tours of the campus and information sessions led by admissions counselors are available every weekday, except on Institute holidays, some national holidays, and during winter break.

Tours depart from Caltech's Office of Undergraduate Admissions (383 S. Hill Ave., 626/395-6341). Register for a tour at www.admissions.caltech.edu.

Architectural tours of the campus are conducted on the fourth Thursday of each month except December, July, and August (in November, tours are held on the third Thursday). Tours leave at 11:00 a.m. from the front hall of the Athenaeum, 551 S. Hill Ave. For reservations, call 626/395-6328.

Visitor parking is available in the Holliston parking structure; obtain permits from the automated pay station inside the structure.



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