

## SPOTLIGHT ON CALIFORNIA

# California: America's industrial R&D powerhouse

The Golden State has been at the forefront of private sector innovation in the United States for many years. What factors lie behind its success?

*“California is a key marketplace for the exchange of ideas from around the globe.”*

*Darlene Solomon, Agilent Technologies*

IN 1938, Bill Hewlett and Dave Packard, two electrical engineering graduates from Stanford University, started building audio oscillators in a garage in Palo Alto, California. By 1962, their company, Hewlett-Packard (HP), was listed in *Fortune* magazine's top 500 US companies by revenue. In 1999, it spun off its measurement-instruments business into Agilent Technologies, which broke the record for the largest initial public offering in Silicon Valley history. HP is now one of the world's leading electronics manufacturers, with revenues of US\$126 billion in 2010 and more than 320,000 employees worldwide. HP's iconic story — along with those of Apple, Intel, Yahoo

and Google — has influenced nearly every fledgling Californian company hoping to repeat its success. It also highlights one of the state's defining features: its strength in industrial research and development (R&D).

According to the US National Science Foundation (NSF), California businesses invested US\$64 billion in R&D in 2007 — more than Michigan, Massachusetts and New Jersey combined. Overall, California accounts for 22 percent of all R&D in the United States. A long history of high-tech breakthroughs is just one of the factors that have made the Golden State the industrial R&D powerhouse that it is today. It has a “whole ecosystem of innovation”, says Darlene Solomon, chief technology officer at Agilent Technologies, based in Santa Clara. A January 2011 study commissioned by northern Californian life science trade association BayBio and the California Healthcare Institute (CHI) expands on this further, listing the following factors as having helped the state's biomedical industry to thrive: leading-edge science; experienced venture capital; a diverse, well-educated workforce; a group of serial entrepreneurs; a culture that appreciates risk-takers and that does not penalize failure; healthy scepticism about time-honored institutions; and freedom to ignore boundaries. In addition, California's world-class public and private universities attract billions of dollars in federal research funding and produce thousands of US postdoctoral

scientists and engineers each year. The state is also home to national laboratories such as Lawrence Berkeley and Lawrence Livermore. These elements and more apply across industries — from biotechnology to computer technology to renewable energy — and help drive job creation, even in tough economic times.

## Clusters of innovation

California boasts a diverse range of industries spread across several major regional clusters, including the San Francisco Bay Area, Sacramento, Los Angeles and San Diego. In northern California, Silicon Valley encompasses a chain of cities south of San Francisco — including Menlo Park, Palo Alto, Sunnyvale and San Jose — but the high-tech companies whose products gave the area its name are actually spread throughout the wider San Francisco Bay Area. The semiconductor research the valley is famous for is now translating into solar energy R&D, which makes use of the silicon and thin-film manufacturing technology perfected there. The city of South San Francisco, home to Genentech, is known for its concentration of biotechnology and pharmaceutical companies.

In southern California, the San Diego area hosts several institutions that have made the city a hub for biomedical research, such as the University of California, San Diego (UCSD), the Scripps Research Institute and the Salk Institute for Biological Studies. “San Diego has grown up over the last 30 years or so as one of the premier



areas for doing biotechnology,” says Paul Laikind, chief business officer of the Sanford-Burnham Medical Research Institute. Laikind, based at Sanford-Burnham’s headquarters in La Jolla, north-west San Diego, says biotechnology companies in the city are concentrated in a small area. “Because of that, it’s a very collaborative entrepreneurial environment,” he explains. A non-profit institute, Sanford-Burnham has taken advantage of San Diego’s industrial infrastructure to help commercialise its research: since 1987 it has spun off about a dozen start-up companies. Laikind himself founded four start-up companies in San Diego, all of which went public, before joining Sanford-Burnham in 2009. He says those in the region involved in biotechnology share a desire to achieve results by working together rather than competing with each other: “Our competition is whether we can make a drug that can work or not, which means a lot of collaboration between companies and institutions like ours.”

A further geographical advantage of California is the state’s west coast location, which makes it a natural crossroads for international scientists and engineers. “California is a key



Biotechnology company Genentech, based in South San Francisco, anticipates continued job growth in the next decade.

marketplace for the exchange of ideas from around the globe,” says Agilent’s Solomon. “Especially as Asia has taken off, I think California has been positioned [in

the market] very well as a point of access and a good cultural fit in terms of that emerging growth.”

### Money magnet

Although California’s domination in industrial R&D has been achieved largely through the efforts of the private sector, the state does provide generous incentives for businesses to do science. Companies that increase their R&D investment from the previous year get a tax credit equivalent to 15 percent of the difference, says Andrea Jackson, director of state and government affairs for Genentech. “[The California government is] always incentivizing companies to do more R&D,” she says. According to the California Budget Project, which carries out independent fiscal and policy analysis, 2,483 corporations claimed US\$1.2 billion in R&D credits in 2008.

In return, companies in California are generous about reinvesting their earnings in R&D. Agilent dedicates around 10 percent of its roughly US\$6.5 billion annual revenue to R&D

globally, a proportion that Solomon says is above average among its peers. “In some of our businesses, where we’re focusing on future growth, we’re investing far more than that 10 percent,” she adds.

California also attracts far and away the most venture capital (VC) in the United States — US\$11.6 billion in 2010, nearly five times as much as the second ranked state, Massachusetts. Furthermore, California ranks first in the country in number of jobs and revenues for venture-backed companies, according to a 2011 study by global business analysts IHS for the US National Venture Capital Association, with 60 percent of the VC investments in California going to the software, energy, and biotechnology sectors.

### Academic prowess

Industrial innovation in California is well supported by its academic institutions. Stanford University, a private institution, is based at the heart of Silicon Valley and

### Top science companies in California

Pharmaceutical manufacturing and scientific R&D companies in California with more than 1,000 employees

Company	City
Aerospace Corp	El Segundo
Affymetrix Inc	Santa Clara
Allergan Inc	Irvine
Amgen Inc (>5,000)	Thousand Oaks
Bayer Corp	Berkeley
EDAW Inc	San Diego
Genentech Inc	South San Francisco
Gilead Sciences Inc	Foster City
Life Technologies Corp	Carlsbad
NBTY Inc	Carson
Northrop Grumman Electronic Systems	Azusa
Novartis Vaccines & Diagnostics (>5,000)	Emeryville
Roche Palo Alto LLC	Palo Alto
SRI Consulting (now part of IHS)	Menlo Park
Watson Pharmaceuticals Inc	Corona

Source: State of California Employment Development Department/Infogroup; codes used were Scientific Research & Development (5417) and Pharmaceutical Preparation & Manufacturing (3254); data correct as of April 2011; public and non-profit organizations, and universities, excluded



Sanford-Burnham Medical Research Institute, a non-profit institute, has spun off around a dozen companies since 1987.

fosters strong relationships with companies — many of which are based at the Stanford Research Park, founded in 1951 when the university leased some of its land to emerging technology firms. The research park offers several incentives to encourage industry-university interactions: businesses are able to sponsor joint research projects with Stanford faculty and students, invite faculty to join their boards or act as consultants, offer internships to students and use the university's libraries.

SRI International, a non-profit contract research institute, split off from Stanford University in 1970 and now employs more than 2,100 people. The institute has conducted research for over 90 private and non-profit businesses, and also licenses and commercializes the technology it develops with federal funds. Norman Winarsky, SRI's vice president of ventures, says its four spin-off companies that have gone public are now worth US\$20 billion.

The University of California (UC) has also forged enduring partnerships and collaborations with industry. The UC system, spread across 10 campuses, is the

state's flagship higher education institute and is a powerful engine for job creation, says Steve Kay, dean of the division of biological sciences at UCSD. The university has "generated the pipeline of trained scientists and technologists that has really fed into the high-tech, the biotech, and now, more recently, the clean-tech explosions," he says. A UCSD study published in February 2011 revealed that the 156 active UCSD-related companies are directly responsible for 18,140 jobs.

The UC system also hosts four Gray Davis Institutes for Science and Innovation, each a collaboration between several campuses, that are purposed with accelerating technology transfer and increasing interactions between the state, UC and industry. They are the Center for Information Technology Research in the Interest of Society (CITRIS), the California Institute for Quantitative Biosciences (QB3), the California NanoSystems Institute (CNSI) and the California Institute for Telecommunications and Information Technology (Calit2).

California industry also

provides the most support for local academic R&D in the United States. During the 2009 fiscal year, industry-financed R&D expenditures at Californian universities and colleges totalled US\$506 million, according to the NSF.

### Staying ahead

Funding for higher education, however, has been harder to come by in the wake of the recent economic downturn. The UC system is facing financial challenges as a result of the state budget deficit. For the 2010 fiscal year, UC had a budget shortfall of US\$1 billion, which it has tried to make up with faculty furloughs, tuition increases and programme cuts. On a more positive note, certain research avenues are just starting to grow. In 2004, voters in California passed Proposition 71, a US\$3 billion bond issue to fund stem-cell research in the state. The California Institute for Regenerative Medicine, a regulatory agency, allocates the funds. In 2010, as a result of those grants, five new stem-cell research facilities were dedicated at UC Davis, UC Los Angeles (UCLA), UC Irvine, Stanford University,

and the University of Southern California in Los Angeles. A sixth centre, the Sanford Consortium for Regenerative Medicine, is under construction in San Diego and due to open in 2011 for collaborative stem-cell research between the Salk Institute, Scripps Institute, UCSD and Sanford-Burnham. The hope is that the research will eventually provide new opportunities to spin out companies focused on stem-cell therapies.

California has also been hit hard with unemployment, which now exceeds 12 percent. The biomedical research industry, though, has not shed as many jobs as other high-tech sectors, according to the BayBio/CHI study. The biofuels industry is also one of the fastest growing in terms of job creation, says Gail Maderis, president and chief executive of BayBio.

Agilent's Solomon says there are jobs available, but workers need to be flexible. For new recruits, the company looks for 'T-shaped' people — researchers who are highly skilled in one area but who can also communicate horizontally across fields. Winarsky of SRI adds that scientists working on innovative research have good job prospects: "They are high-premium people."

A question on many people's minds is how the state, strapped for funds, will deal with its budget crisis. Genentech's Jackson says she does not anticipate the corporate R&D tax credit being trimmed back. "So far the legislature has felt a compelling interest to keep those tax credits in place to continue to grow the industry," she says. Pharmaceutical companies like Genentech take comfort in the fact that their products remain necessary, even in lean times. "We're in a flat growth spell right now, but the industry's pipeline is healthy," Jackson says. "We anticipate continued job growth in the next decade." California's history of innovation, from HP's inception to today's efforts in stem-cell research and solar technology, will provide a strong foundation for future growth. ■

*Nature editorial staff have no responsibility for content*

# Life Inspired.



Sergio, Patient

## Passionate About Our Science and Our People

We're passionate and rigorous about our science. For more than 30 years, Genentech has been at the forefront of the biotechnology industry, using innovative science to develop breakthrough medicines that improve the lives of people with serious or life-threatening diseases. We're also passionate about our people, our most important asset. That's why we offer Genentech employees:

- The chance to make a difference in the lives of patients
- Extraordinary colleagues
- An inclusive environment that encourages diversity
- Highly competitive benefits

We have the following opportunities in Genentech Research and Early Development (gRED) in our South San Francisco, CA, headquarters:

### Associate Director/Director, Antibody Engineering – Req. #377081

The successful candidate will lead a group of 15-30 researchers in developing innovative antibody technologies and therapeutics as well as running their own lab. The ideal candidate will have a PhD and 10+ years of experience in engineering antibodies for human therapy, including publications, patents, and generation of investigational drugs. Candidates with strong leadership skills are particularly encouraged to apply.

### Associate Director, Immune Cell Signaling – Req. #376671

This position will lead research efforts focused on discovering and pursuing new drug targets and will be jointly appointed within the departments of Discovery Immunology and Biochemical Pharmacology. The ideal candidate has a PhD or equivalent in biological sciences with extensive research as well as small molecule drug discovery experience in immunology. Eight or more years' experience as an independent scientist in a biopharmaceutical and/or academic environment is required.

- **Scientist/Senior Scientist, Antibody Engineering B-Cell Cloning**  
Req. #376466
- **Senior Scientist, X-ray Crystallography**  
Req. #377162

### Associate Director, Bioinformatics – Req. #380051

As an Associate Director within the Bioinformatics department, this position will focus on novel variant discovery, biomarker discovery, and data integration. The ideal candidate should have well developed research plans that will take advantage of newer technologies such as DNA-seq, ChIP-seq, RNA-seq, proteomics and metabolomics. A PhD in life sciences, computer sciences, mathematics or other relevant field is required.

### Associate Director, Drug Metabolism and Pharmacokinetics (DMPK) – Req. #379896

The Associate Director will lead a team of more than 15 talented ADME Scientists and work closely with colleagues in other departments on advancing projects ranging from early to late stage discovery and in the clinic up to approval. A PhD degree in pharmacokinetics, drug metabolism or other relevant fields such as pharmaceutical, biological or chemical sciences and at least 10 years' industrial experience is required.

- **Senior Scientist, Antibody Drug Conjugates**  
Req. #380053
- **Scientist, Vascular and Lymph System Biology**  
Req. #379942

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The **Earth Sciences Division** at Berkeley Lab is looking for individuals to fulfill **strategic scientist and manager positions** as well as **postdoctoral positions** in research programs that crosscut many areas of the geosciences disciplines. These include **climate, carbon sequestration, ecology, geothermal energy, hydrogeology**, and more. Individuals whose experience matches qualifications in **computational modeling** (specifically of **coupled processes, reactive transport, and multi-phase flow**), **geotechnical engineering**, and **laboratory and field-work applications** should apply.

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**Berkeley Lab** has over **150 openings** in both science and operations. Visit our career web site for a complete listing ([jobs.lbl.gov](http://jobs.lbl.gov)). Berkeley Lab is an affirmative action/equal opportunity employer committed to the development of a diverse workforce.

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#### Graduate Program in Hearing & Communication Neuroscience (HCN) at the University of Southern California and the House Research Institute.

HCN is an inter-disciplinary program jointly sponsored by the Neuroscience Graduate Program at USC and the House Research Institute (HRI), one of the foremost hearing research centers in the world. The program spans 18 labs from several departments at USC and HRI. Our goal is to bring together scientists working in diverse areas to provide outstanding training opportunities in Hearing & Communication for Ph.D. graduate students, postdoctoral scholars, and physician scientists.

HCN integrates a broad range of approaches from cell & molecular neurobiology, genetics, development, linguistics, and systems & cognitive neuroscience. In addition, because of the strong ties to patient-oriented studies at HRI, the program offers opportunities for facilitating interactions between basic scientific research and its potential applications.

Interested applicants to the Joint USC/HRI Hearing and Communication Neuroscience Training Program should contact Liz Moseley <[lmoseley@hei.org](mailto:lmoseley@hei.org)> or through our Website <http://hcn.usc.edu/>



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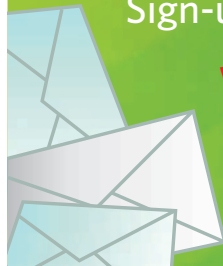
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# THE UNIVERSITY OF CALIFORNIA AT BERKELEY

## Department of Molecular and Cell Biology, and Center for Computational Biology

The Department of Molecular and Cell Biology (MCB), and the Center for Computational Biology (CCB) are seeking applications for four faculty positions in the areas listed below. We seek candidates with Ph. D. and/or M.D. degrees who have a strong interest in undergraduate and graduate teaching and demonstrated excellence, originality and productivity in research.

### **Systems Biology (MCB)**

We seek candidates interested in the study of the complex networks that function at different levels of organization. This will be a broad based search and applicants are encouraged to apply who are employing a combination of laboratory and theoretical approaches provided by biochemistry, genetics, and developmental or evolutionary logic. Areas of research could include (but are not limited to), the architecture and function of genetic networks, the regulation of metabolism and energy homeostasis, information processing by signaling pathways, and spatial organization and temporal control at the cellular, tissue or organ level. This position is open at the Assistant Professor level (tenure-track).

### **Biology of Cancer (MCB)**

We seek candidates interested in the mechanisms of cancer and treatment of this disease with a primary focus on human cancer or mammalian models. Thus areas of interest could include (but are not limited to) the genetics and epigenetics of human cancer, tumor-host interactions, tumor metastasis, tumor immunology, and the use of mouse models to dissect mechanisms of tumor initiation and progression. This position is open at any level (tenured or tenure track).

### **Human Genome Variation (MCB / CCB)**

We seek candidates whose research focuses on an understanding of genome and epigenome variation of humans as it relates to phenotype, particularly disease predisposition, using both computational and laboratory approaches. This position is open at the Assistant Professor level (tenure-track).

### **Stem Cell Biology (MCB)**

We seek candidates whose research focuses on any aspect of stem cell biology, including (but not limited to) the use of stem cells to develop models of human biology or disease, molecular mechanisms of transcriptional regulation in pluripotent and differentiating stem cells, the regulation of stem cell renewal and differentiation during development, and the biology of cancer stem cells. This position is open at any level (tenured or tenure-track).

Applications and letters of reference should be submitted online through <http://mcb.berkeley.edu>. Applications should include a *curriculum vitae*; a list of publications; copies of three significant publications; a brief description of research accomplishments; and a statement of research objectives and teaching interests. In addition, applicants applying for a non-tenured position should arrange to have three letters of reference submitted online. Potential reviewers should be referred to the Statement of Confidentiality found at: <http://apo.chance.berkeley.edu/evalltr.html>. The deadline for applications is November 15, 2011.

We are interested in candidates who will contribute to diversity and equal opportunity in higher education through their teaching, research, and service. We are also committed to addressing the family needs of faculty.

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# STANFORD

SCHOOL OF MEDICINE

Stanford University Medical Center

## FACULTY POSITION

Department of Biochemistry  
Stanford University School of Medicine

Applications or nominations are invited for an Assistant Professor position in the Department of Biochemistry. We are seeking individuals with an extraordinary record of scientific accomplishment and creativity working in any area of biochemistry, biophysics or molecular biology research, broadly defined. As a basic science department within the School of Medicine, we encourage applications focused on the molecular basis of human health and disease as well as those focused on fundamental mechanisms of life. The principal criterion for appointment in the University Tenure Line is a major commitment to research and teaching. Candidates should submit in one complete PDF document: a curriculum vitae including a list of publications, a description of research accomplishments and future plans, and contact information for three references to Biochemistry\_Recruitment@stanford.edu.

Applications should be received by December 1, 2011. Reference letters should be sent to the above email address or to the Search Committee Chair, Department of Biochemistry, Stanford University School of Medicine, 279 Campus Drive, Room B400, Stanford, CA 94305-5307.

Stanford University is an Equal Opportunity Employer and is committed to increasing the diversity of its faculty. It welcomes nominations of and applications from women and members of minority groups, as well as others who would bring additional dimensions to the University's research, teaching and clinical missions.

NW216857R



University of California Irvine  
School of Medicine

Department of Biological Chemistry

## Assistant or Associate Professor

The Department of Biological Chemistry in the School of Medicine invites applications for one state-funded, tenure-track/tenured position at Assistant or Associate Professor level.

We are seeking outstanding individuals in the fields of Protein Biochemistry, Chemical Biology, Cancer Biology, Epigenetics, Cell Biology, and Molecular Medicine. The individual is expected to lead a vigorous research program of high caliber and participate in the training of graduate and medical students. The position is open until filled.

Applicants should complete an online application profile and upload the following application materials electronically to be considered for the position:

**Application Procedure** - Applicants should upload a description of their research plans, a short statement regarding teaching interests, reprints of relevant publications, a curriculum vitae, and the names and addresses of three references to:  
<https://recruit.ap.uci.edu/apply/>.

*The University of California, Irvine has an active career partner program and an NSF ADVANCE Program for Faculty Equity and Diversity and is an equal opportunity employer committed to excellence through diversity.*

NW216834R



University of California  
San Francisco

## UCSF Faculty Position in Physiology

The department of Physiology and the Program in Biological Sciences at the University of California San Francisco (UCSF) seek an assistant professor (tenure track) or associate professor taking cellular, molecular, genetic or other novel experimental approaches to problems in physiology. The successful applicant will occupy laboratory space at the new Mission Bay campus of UCSF and will be expected to establish an exciting research program and participate in graduate and postdoctoral training. Complete applications should be received by December 1, 2011, to ensure full consideration. Please send curriculum vitae, reprints of one or two key publications, a two-page summary of past research and future goals, electronically (PDF format), and three letters of recommendation sent to email address to: [facultysearch@ucsf.edu](mailto:facultysearch@ucsf.edu).

UCSF seeks candidates whose experience, teaching, research, or community service has prepared them to contribute to our commitment to diversity and excellence.

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# UC San Diego

## Divisions of Biological and Physical Sciences

The University of California San Diego invites applications from outstanding candidates for multiple tenure-track or tenured faculty positions as part of a multi-year, campus-wide initiative to establish a preeminent program in the area of Quantitative Biology (qBio), emphasizing quantitative experimentation and theoretical analysis to study living systems. The qBio initiative builds on the interdisciplinary infrastructure provided by the NSF Center for Theoretical and Biological Physics, the NIH Center of Excellence in Systems Biology, the BioCircuits Institute, existing divisional strengths and various interdepartmental graduate programs. The following positions are part of a multi-year faculty hiring program at junior and senior levels.

Candidates are encouraged to apply to specific job descriptions that fit their interests; successful candidates may be affiliated with multiple academic units and will complement and participate in the development of quantitative biology across campus. All candidates must have earned a Ph.D., or equivalent degree, and a commitment to teaching at the undergraduate and graduate levels. Preference will be given to scholars with demonstrated excellence and creativity in research, scholarship, and commitment to equity and inclusion in higher education.

**Quantitative Biology (10-315):** The Section of Molecular Biology, Division of Biological Sciences, seeks scholars at the Assistant Professor level with a particular focus on quantitative approaches that combine mathematical modeling and molecular biology to study gene regulation and cellular signaling at the single cell level.

**Quantitative Biology and Cellular Biophysics (10-318):** The Department of Chemistry and Biochemistry, Division of Physical Sciences, seeks scholars at the Assistant Professor level in the broad area of cellular biophysics, ranging from molecular signaling or gene regulatory networks to biophysical properties of molecules within cells. Approaches might include, but are not limited to, innovative molecular imaging, molecular kinetics, network modeling, or theory.

**Quantitative Biology (10-321):** The Department of Physics, Division of Physical Sciences, seeks scholars at the Assistant Professor level in qBio, defined as the iterated dialogue of quantitative experimentation and theoretical reasoning to study living biological systems. Successful candidates will have broad interests in biological physics to complement existing strengths of the department and will have an exemplary research record in an area ranging from gene signaling to cellular mechanics.

**Systems/Quantitative Developmental Biology (10-312):** The Section of Cell and Developmental Biology, Division of Biological Sciences, seeks scholars at the Associate Professor level pursuing innovative research using systems, quantitative or dynamical research approaches to solve problems in Developmental Biology. Outstanding applicants at the Assistant Professor level will also be considered. Interesting areas include, but are not limited to, the generation, regeneration, or maintenance of some cell type, body system, or organ.

**Evolutionary Systems Biology (10-294):** The Section of Ecology, Behavior and Evolution, Division of Biological Sciences, seeks scholars at the Full Professor level pursuing innovative research in the area of evolution of multi-component interactions in biological systems. Outstanding applicants at other levels will also be considered. Preference will be given to conceptually oriented individuals who use theory and/or emerging technologies to quantify experimentally the mechanistic and causal connections between genes, function, fitness, and evolution.

Review of applications will commence by November 1, 2011 until all the positions are filled. Interested applicants must submit a cover letter, curriculum vitae, statement of research, statement of teaching, a statement describing their past experience and leadership in equity and diversity and/or their potential to make future contributions, and contact information for 3-5 references. Applications must be submitted through the University of California San Diego's Academic Personnel RECRUIT System at <https://apol-recruit.ucsd.edu/>.

*UCSD is an equal opportunity / affirmative action employer with a strong institutional commitment to excellence and diversity (<http://diversity.ucsd.edu/>).*