Japanese Universities Gain a Competitive Edge

Twenty-two academic institutions have been chosen to enhance Japan’s ability for cutting-edge science and technology and keep Japan competitive among the world’s top universities. The recruitment of high-quality researchers from overseas, revising university management, and improvements in global visibility are the major challenges ahead for the group of 22 institutes. By Adarsh Sandhu

nitiating a nation-wide effort to boost Japan’s scientific landscape, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has launched the Program for Promoting the Enhancement of Research Universities, which exemplifies new trends in research funding in Japan. Twenty-two academic institutions have been singled out from the hundreds of Japanese universities and institutes to lead Japan's efforts to stay at the forefront of science.

These new-elite institutions were chosen via a nontraditional, top-down selection process—a rarity for these types of initiatives in Japan. The funding process is simple: set strategic research targets and priorities, conduct preliminary surveys for potential researchers and institutes most likely to achieve the goals, and provide generous funding to small numbers of top scientists for long periods of time. Representatives from the smaller and newer institutes assert that this unusual metrics-based assessment has enabled them to take on projects that would be unheard of with the traditional bottom-up, proposal-based funding procedures, which can favor larger universities.

After being awarded the prestigious status and funds, these 22 universities are now responsible for developing Japan’s scientific infrastructure and making the necessary infrastructure-related reforms to strengthen their research portfolios. This includes hiring research administration managers, recruiting top researchers from overseas, and analyzing global scientific trends in order to formulate new research strategies. The financial support to accomplish these goals ranges from US$2 million to US$4 million annually for 10 years, with a midterm assessment after five years that promises funding cuts in cases of poor performance.

The institutes selected (Table 1) include well-established former Imperial Universities (Hokkaido, Tohoku, Tokyo, Nagoya, Osaka, Kyoto, and Kyushu) as well as three smaller, newer institutes (the University of Electro-Communications, Toyohashi University of Technology, and Nara Institute of Science and Technology) and two large, research-based private universities (Keio and Waseda).

Intriguingly, despite having produced the largest number of Nobel Prize Laureates in Asia, Japan is not well represented in world university ranking tables. For example the 2013–2014 Times Higher Education World University Rankings lists only two Japanese universities in the top 100, on par with Singapore, but behind South Korea and China with three each.

This lack of visibility and representation in world rankings is a source of considerable discussion in academic circles in Japan. Many of the 22 universities have declared that part of the funding from the MEXT program will be used to pull their institutes into the top 10 of the rankings tables by the end of the 10-year program, with others aiming for a more modest goal of being within the top 100.

Some of the major challenges these universities will be faced with overcoming are: the low birth rate that has led to major decreases in the number of high school children qualified to enter university; severe constraints on research funding for universities, and the need for greater internationalization and visibility.

THE DEMOGRAPHIC LANDSCAPE

Japan's coffers are feeling the pinch. As of May 2013 there were approximately 770 universities in Japan: 86 national institutes, 83 prefecture or city-run, and 601 private. They all rely on government subsidies to run education and research programs. Financing university education and research is putting a huge burden on government resources that are also being strained by increases in medical costs due to the rapidly aging population (24.1% are over 65 years old), the costs for reconstructing the Tohoku region following the devastating earthquake and tsunami in 2011, and demands for investment in trillion-yen international “big-science” projects.

Government subsidies are crucial for the majority of universities to exist. The falling birthrate in Japan has led to excess capacity within the education system, causing an increase in bankruptcies of private universities and forcing national universities to introduce early retirement plans to reduce personnel costs.

The MEXT program sends a clear message to university administrators that MEXT cannot continue to subsidize all the universities in Japan. Future funding for research will be limited and based on objective statistics, such as citations, revenue from technology transfer, and international rankings. This funding must be used to improve university infrastructure, hire top researchers and managers, and enhance innovation to improve Japan’s global competitiveness in science.
UNIVERSITY MANAGEMENT

In 2004, the Japanese government overhauled the management of national universities by introducing a more corporate-like structure and giving presidents (elected by faculty) more autonomy to hire staff, determine salaries, and set long-term goals for education and research. Furthermore, MEXT started reducing government financial support to national universities by 1% per year. This has led to financial dilemmas for universities that are unable to fill the resulting funding gap with other sources of income.

Another common theme is revamping the role of university research administrators (URAs) to undertake a multitude of tasks including supporting researchers in procuring funding, interacting with industries to license university intellectual property, and analyzing trends in research themes to devise strategies for future, unexplored areas of research. Some universities plan to hire as many as 40 URAs as part of the program in order to take some of the administrative pressure off research faculty. More senior URAs will likely be recruited from the private sector, but many universities will tap into the postdoctoral pool, training them as part of new URA career paths. It's notable that Japan has a huge number of postdocs looking for permanent posts, particularly in the life sciences.

Table 1. Universities and research institutes selected for the MEXT Program for Promoting the Enhancement of Research Universities. (Numbers indicate annual funding in millions of Yen.)

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<thead>
<tr>
<th>Universities and Research Institutes</th>
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<td>Hiroshima University</td>
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<td>Hokkaido University</td>
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<td>Kobe University</td>
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<td>Nara Institute of Science and Technology</td>
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<td>Okayama University</td>
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<td>Osaka University</td>
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<td>Tohoku University</td>
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<td>Tokyo Institute of Technology</td>
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<td>Tokyo Medical and Dental University</td>
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<td>Toyohashi University of Technology</td>
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<td>University of Electro-Communications</td>
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<td>University of Tokyo</td>
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<td>University of Tsukuba</td>
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**Private Universities**

| Keio University                     | 200*                     |
| Waseda University                   | 300*                     |

**Other Institutes**

| High Energy Accelerator Research Organization | 300 |
| National Institute of Informatics        | 300 |
| National Institutes of Natural Sciences  | 300 |

*universities featured in this advertorial

INTERNATIONALIZATION

The projects in the MEXT program contain some common themes and goals. The universities have all made internationalization or kokusaika one of their highest priorities. Kokusaika has different meanings to different people. Here the interpretation is to increase the number of overseas researchers and students, and improve international collaboration by implementing various plans: increasing accommodation facilities for overseas researchers, introducing English language courses for students, training administration staff to produce bilingual documents, and introducing new salary scales commensurate with institutes in the United States and Europe.

So what are the challenges in hiring foreign staff? Short-term stays in Japan for young researchers can be highly rewarding and valuable for boosting their later employability, but establishing a long-term career may be more challenging due to potential family-related issues such as securing a job for a spouse and a good education for accompanying children.

The Japanese language can also be a stumbling block. Foreign researchers may feel isolated and conducting independent research can be extremely taxing; simple exercises such as ordering equipment and taking part in departmental meetings are difficult without reasonable proficiency in Japanese. Even with excellent language skills, foreign academics are unlikely to be awarded top positions such as dean and president in Japanese academia.

The emphasis on kokusaika reflects concerns about Japanese researchers becoming too inward looking. Several years ago journalists coined the term “Galapagos Syndrome” to describe the situation, exemplified by highly advanced Japanese mobile telephones that were incompatible with systems in other countries and thus globally irrelevant.

Improving global rankings and attracting top-class foreign researchers are two of the main challenges ahead as the MEXT program moves forward. Needless to say, project managers are well aware of them and have no doubt devised solutions to resolve these issues to achieve their goals. Only time will tell if the 22 institutes will each achieve their goal of becoming globally competitive. The main issue will be the degree to which Japan’s academic community is recognized for its contribution to the global creation of knowledge. Perhaps this is the true meaning of kokusaika.

Adarsh Sandhu is a freelance science writer based in Tokyo, Japan.
The University of Tsukuba
A Hub of Academic and Industrial Collaboration

The University of Tsukuba campus is located at the heart of Tsukuba Science City, about 45 minutes north of Tokyo on the Tsukuba Express train. The modern structure of the university was established in 1973 after the reorganization of its predecessor, the Tokyo University of Education, whose roots go back to 1872. The huge campus—similar in size to New York’s Central Park—is home to approximately 16,500 students and 4,100 faculty and administrative staff. The university offers a comprehensive curriculum including arts and social sciences, physical education and sports sciences, physical sciences and engineering, and medicine. Distinguished scholars affiliated with the university include Nobel Laureates Leo Esaki (Physics, 1973), Hideki Shirakawa (Chemistry, 2000), and Sin-Itiro Tomonaga (Physics, 1965).

Looking more broadly, Tsukuba is one of the world’s largest science and knowledge-based regions in the world. It has 32 research and academic institutions, approximately 20,000 researchers, and more than 7,000 foreign workers.

In recognition of the technological importance of the Tsukuba region, the Japanese Central Government and local authorities designated Tsukuba City and its peripheral regions as an “International Strategic Zone” in 2011. Managed by the Tsukuba Global Innovation Promotion Agency, the new zone was set up to act as a hub for academia-industry collaboration to foster innovative solutions to major problems facing Japan, such as the declining birth rate, an aging population, and the need for long-term energy resources.

Yasuo Miake is vice president and executive director of research affairs at the University of Tsukuba, and one of the central members of the team managing the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities. “Our strategy for running the MEXT program has three main features: introducing an international tenure-track program, headhunting top-class researchers from overseas, and increasing the number of university research administrators from the 11 we have at present to 30 within the next five years,” explains Miake. “Importantly, we want to assure our researchers that they will have more time to conduct high-quality research by reducing their time spent on administration and paperwork.” Miake also stresses the central roles of the Center for Computational Sciences, the Life Science Center of Tsukuba Advanced Research Alliance, and the Center for Cybernics Research in achieving the goals of the MEXT program (see sidebars below).

Michiyoshi Ae, executive director and vice president in charge of education affairs, who is an expert in sport biomechanics, adds that in addition to traditional research in the basic and applied sciences, the university is a powerhouse for sports and physical education, having produced scores of Olympic medalists and professional sportsmen. “We are now working with MEXT to train sports coaches, physical educators, and sport scientists in Africa and Asia.” Research at the University of Tsukuba is truly global and multidisciplinary,” concludes Ae.

Tsukuba International Strategic Zone: www.tsukuba-sogotokku.jp/en/
incorporates graphics processing units used for games in personal computers.

New initiatives based on the computing power at CCS include the High Performance Computer Infrastructure (HPCI) Strategic Program, a multi-institute collaborative project. The HPCI includes use of the 8,162 petaflops K-Computer and aims to reveal “the origins and structure of materials and the cosmos.” Notably, CCS was awarded the Gordon Bell Prize twice for work using the K-computer.

for their joint research on electronic states in semiconductor nanowires in 2011, and for their simulations of the gravitational forces acting simultaneously on one trillion astrophysical (dark matter) particles (2012).

Umemura explains that collaborative research with planetary scientists has yielded new insights into the existence of so-called left-handed amino-acids and, by extension, into the origins of life after the big bang. Other research using the simulations has helped scientists better understand interstellar turbulence and the formation of stars and planets.

“We currently have a staff of 33 full-time researchers and 14 collaborators,” says Umemura. “The funding from the MEXT program will be used to hire four young researchers as part of the university’s international tenure-track program.”

Center for Computational Sciences:
www.ccs.tsukuba.ac.jp/eng/

Life Science Center, Tsukuba Advanced Research Alliance

The Life Science Center of Tsukuba Advanced Research Alliance (LS-TARA Center) was originally launched as the Tsukuba Advanced Research Alliance (TARA) in May 1994 by the former president of the University of Tsukuba, Leo Esaki. TARA was a research platform used to conduct interdisciplinary research in cutting-edge research areas such as life science and nanomaterials, through collaborations between academia, industry, and government.

In March 2010, TARA was reorganized to create the LS-TARA Center, reflecting the university’s determination to strengthen its contribution to research in the life sciences, including fast and inexpensive genome sequencing, animal cloning, and stem cell research.

Akiyoshi Fukamizu is vice director of the LS-TARA Center and is internationally renowned for his research on a mouse model used to study high blood pressure during pregnancy. “Our findings on pregnancy-induced hypertension [PIH] in mice were a classic case of serendipity,” explains Fukamizu. “We had spent many years studying genes that encoded proteins involved in the regulation of blood pressure and the role of the renin-angiotensin system.” Breeding genetically altered mice carrying certain combinations of the renin-angiotensin system proteins led to the discovery of pregnant mice exhibiting PIH-related symptoms. The publication of these results in Science in 1996 led to worldwide discussion of their implications and the utility of having a mouse model to study PIH, which occurs in 10% of women. “These animals do not exist in nature because they die,” explains Fukamizu. “This is an important model for finding a treatment for PIH.”

Center for Cybernics Research

Robot Suit HAL (Hybrid Assistive Limb) is the creation of Yoshiyuki Sankai, director of the Center for Cybernics Research, born out of his passionate desire to help people around the world. “HAL is the world’s first cyborg-type robot that treats, supports, and expands the physical capabilities of humans. We are also developing this device to be used for medical treatment,” says Sankai. “This powered exoskeleton is already in use at over 170 medical and welfare institutions in Japan. Clinical trials with HAL are being carried out in Japan as well as at BG-University Hospital “Bergmannsheil” in Germany and the Karolinska Institute in Sweden, and HAL has been granted CED197 certification in Europe. Furthermore, a neuro-rehabilitation center in Germany is providing treatments using HAL that are now covered by national workers insurance. This is the realization of one of my childhood dreams: to build robots to help humans.”

HAL is manufactured by Cyberdyne Inc., a venture company set up by Sankai and now ISO 13485 certified. The exoskeleton is controlled by a combination of special algorithms, a Cybernic Voluntary Control (CVC) system, and a Cybernic Autonomous Control (CAC) system. The CVC system uses the wearer’s own intentions (i.e., bioelectrical signals from brain to muscle) detected by the sensors, while the CAC system operates based on a preprogrammed system determined by analysis of basic motion patterns and movement mechanisms in humans, in case the bioelectrical signals are weak. A dual systems operation mode enables support of natural physical movements in accordance with the wearer’s intentions.

Sankai explains that the success of HAL is a testament to the “flat nature of the organization” at the University of Tsukuba and its mission to “open new frontiers.” Says Sankai: “One of the unique characteristics of the university is that professors all receive the same annual university funding, irrespective of whether they are full or assistant professors. We are treated equally and given every opportunity to start new, innovative projects, as I did when I started work on robotics in my younger days here.”

Important recent developments include the electronically powered exoskeleton being the world’s first ever device of its kind to receive a global safety certificate (ISO/DIS13482). In addition, in August 2013 the potential of HAL was recognized when it was awarded the European Conformity (Conformité Européenne, CE) mark for medical devices.

Sankai is confident that HAL will help resolve many problems related to Japan’s rapidly aging society and health care in general. “This is just the beginning. We are initiating clinical tests and new experiments in areas such as testing new drugs for treating polio. We have full support from the university and the Japanese government as part of this program and other projects.”

University of Tsukuba Center for Cybernics Research:
www.first.ccr.tsukuba.ac.jp/english/
Tokyo Institute of Technology
Aiming to Become One of the World’s Top 10 Research Universities

Tokyo Institute of Technology (Tokyo Tech) is Japan’s premier science and technology research university. Established in 1881 as the Tokyo Vocational School, the institute currently has approximately 1,200 faculty, 10,000 students, and an annual revenue of 46.7 billion Yen (US$445 million). Tokyo Tech’s strengths include physics, material science, earth sciences, and computer science. Its internationally acknowledged contributions to science and technology include the early transmission of an image via a cathode ray tube by Kenjiro Takayanagi in 1926; the 1967 invention of electrically conductive plastic by Hideki Shirakawa (awarded the 2000 Nobel Prize in chemistry for this research); and deployment of Tsubame 1.0 in 2006, one of the fastest supercomputers in the world at the time.

Yoshinao Mishima, president of Tokyo Tech talks about how the mission of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities will impact Tokyo Tech: “Our immediate goal,” he explains, “is to be in the top 100 in the THE [Times Higher Education] world university rankings. My long-term goal for the university is to be one of the top ten research universities in the world by 2030. I believe that the program’s international benchmarking provides a useful measure for the quality of our research and education.”

Earth-Life Science Institute

Recent advances in astronomical instrumentation and technology have led to regular reports on the discovery of extrasolar planets, or exoplanets, that orbit stars outside of our solar system. The goal of such research is to find other habitable planets, and possibly discover other forms of life there.

Complementing the research on exoplanets, Kei Hirose and colleagues at the Earth-Life Science Institute (ELSI) at Tokyo Tech are investigating the environmental factors that enabled life to develop on Earth. “ELSI was established in 2012 to answer this very basic question,” says Hirose, director of ELSI. “Our findings will shed light on the possibility of finding life on other planets.”

“Phosphorous is essential for life on Earth, but it is a scarce element in the universe,” explains Hirose. “How was phosphorous made available to the Earth’s earliest life? Were there unique rocks on the early Earth that were enriched in phosphorous? Under what environmental conditions did DNA and RNA—molecules that have phosphate backbones—form and give rise to early life on Earth? These are some of the fundamental questions we will try to answer.”

ELSI is an international research institute where, once fully staffed, more than 30% of the researchers will be from overseas. It includes a global network of collaborators and has satellite centers at the Geodynamics Research Center, Ehime University, Japan; the Institute for Advanced Study, Princeton University; and the Origins of Life Initiative at Harvard University. It also supports partnerships with the Japan Agency for Marine-Earth Science and Technology and the Institute of Space and Astronautical Science (part of JAXA) in Japan.

The reforms will be led by new university research administration (URA) staff, hired with part of the $3 million in annual funding from the MEXT program. “The URAs will analyze and benchmark our research to quantify our strengths and weaknesses, and recommend new areas of research to pursue,” says Mishima. Three major projects being undertaken at Tokyo Tech include research at the Earth-Life Science Institute, the Materials Research Center for Element Strategy, and the Environmental Energy Innovation Building (see sidebars below).

The initial goals being addressed are increasing international collaborative research, inviting more overseas scientists to conduct research at Tokyo Tech, and improving the citation levels of papers published by Tokyo Tech researchers. “Structural reforms such as sufficient accommodation for overseas researchers must be complemented with administrative reforms, such as bilingual documentation,” stresses Mishima. While positive changes are already under way, Mishima acknowledges that “there are many challenges in the years ahead.”

Tokyo Institute of Technology: www.titech.ac.jp/english/
Materials Research Center for Element Strategy

Hideo Hosono—known for his invention of the high mobility oxide thin film transistor for flat panel displays and iron-based superconductors—is the director of the Materials Research Center for Element Strategy (MCES). The center was established at Tokyo Tech in 2012 as an independent organization to run projects at the Tokodai (Tokyo Tech) Institute for Element Strategy (TIES), also led by Hosono. Construction of a dedicated MCES building on the Suzukakaidai Campus of Tokyo Tech is scheduled to finish in March 2014.

Hosono is also the project leader of the Accelerated Innovation Research Initiative, ACCEL—a five year, approximately US$15 million project funded by the Japan Science and Technology Agency (JST). The project will look into ways of exploiting the chemical and electronic properties of electrodes (a compound in which an electron serves as an anion) and develop proof-of-concept strategies for the following three areas:

1. Development of catalysts for the realization of small, on-site, low energy production plants for ammonia, because of its importance for producing fertilizers and as an energy carrier for hydrogen
2. Realization of large-area, low-power consumption organic electroluminescent devices with efficient ways of injecting electrons into the active layers

The project builds on the success of previous work, including an Exploratory Research for Advanced Technology (ERATO) project in which a metallic oxide, mayenite \([12\text{CaO} \cdot 7\text{Al}_2\text{O}_3\text{(or C12A7)}]\), was converted into a conductor, as well as research performed under the Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST). This research led to some important discoveries, including the synthesis/decomposition of ammonia by ruthenium nanoparticles loaded on the inorganic electride, C12A7: e−.

“This research is part of a national concept called the Element Strategy Initiative [ESI],” explains Hosono. “This ESI project is being carried out by 20 researchers located at Tokyo Tech, the National Institute of Materials Science, the High Energy Accelerator Research Organization, and the University of Tokyo,” notes Hosono. “A major objective of our ACCEL project is to seek alternatives for the Haber process, the main method for producing ammonia, which was invented around a hundred years ago. Ammonia is important because it continues to be a vital component for sustaining modern society.”

Materials Research Center for Element Strategy: www.mces.titech.ac.jp/en/

Environmental Energy Innovation Building

Manabu Ihara applied his expertise in energy conversion chemistry in the construction and management of the Environmental Energy Innovation Building (EEI), Tokyo Tech’s flagship energy-conscious research facility, in cooperation with architectural specialists, Yoshiharu Tsukamoto and Toru Takeuchi.

“This building was designed to be nearly self-sufficient in producing electrical power and generate 60% less carbon dioxide compared with other Tokyo Tech research buildings with a similar research environment and size,” explains Ihara. “We have achieved both goals, and thereby produced a model for constructing energy-efficient and environmentally friendly state-of-the-art buildings in the future.”

Some of the features of EEI include: 4,570 solar cell panels set according to unique design configurations to maximize electricity generation—attached to the roof and southern and western-facing walls—that have a power generation capacity of 650 kW in total (and can be tilted to allow natural illumination of the rooms and to use natural air flow to prevent a voltage drop due to temperature increases in the solar cells); a system to supply waste heat from a 100 kW fuel-cell system to outdoor air conditioners; motion sensors in the clean rooms that efficiently control the fan filter units and automatically close the doors of unused draft chambers; and a building constructed to withstand an earthquake of magnitude 6.0.

“Over 30% of the total power used for the building was generated by solar cells,” explains Ihara. “So we were able to be nearly self-sufficient by combining natural energy with stable power from fuel cells and an efficient, energy-saving system design. And, notably, we saved approximately $300,000 in the cost of electricity, gas, and water between March 2012 and February 2013.”

Currently, Ihara is collaborating with software and data communication companies on the development of the “Ene-Swallow” smart grid to automate power management of the building. “We use the IEEE1888 international internet communication protocol to collect energy data from equipment and devices made by different manufacturers,” explains Ihara. “We have launched the Tokyo Tech ‘Green Hill Concept’ to manage the power to the facilities at our two other campuses at Tamachi and Suzukakaidai. We expect our campuses to provide a proof-of-concept model for the city of the future.”

The “Ene-Swallow” smart grid not only offers an efficient means for power management, but will also enable an uninterrupted power supply using backup batteries during natural disasters such as earthquakes—a fact of life in Japan.

The University of Electro-Communications
Leading Research in Optics, Photonics, Wireless Communications, and Fuel Cells

The University of Electro-Communications (UEC) in Tokyo is a small, luminous university at the forefront of applied sciences, engineering, and technology research. Its roots go back to the Technical Institute for Wireless Communications, which was established in 1918 by the Wireless Association to train so-called wireless engineers in maritime communications in response to the Titanic disaster in 1912. In 1949, the UEC was established as a national university by the Japanese Ministry of Education, and moved in 1957 from Meguro to its current Chofu campus in Tokyo.

“Until a few years ago we taught courses on Morse code and radio navigation,” explains Wataru Mitsuhashi, member of the board of directors responsible for research strategy at UEC. “The equipment we used for these courses is now on display in our Museum of Communications!” With approximately 4,000 students and 350 faculty, UEC is regarded as a small university, but with particular expertise in wireless communications, laser science, robotics, informatics, and material science, to name just a few.

The UEC was selected for the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities as a result of its strengths in three main areas: “optics and photonics research, where we are number one for the number of joint publications with foreign researchers; wireless communications, which reflects our roots; and materials-based research, particularly on fuel cells,” explains Mitsuhashi.

UEC’s main research reforms include the introduction of a new personnel salary system enabling the appointment of staff with a diverse range of experience; enhancement of its international standing by introducing an improved system to hire top-class researchers from all over the world; creation of an international photonics hub for laser and optics research; and training of university research administrators (URAs).

The University of Electro-Communications:
www.uec.ac.jp/eng

Institute for Laser Science

The Institute for Laser Science (ILS) is one of the most active research groups based in optics and photonics in Japan, with 50 UEC faculty members conducting research at the institute. “Our international approach to research has enabled us to make tremendous advances since the institute was established in 1978,” says Hitoki Yoneda, director of ILS. “We have published the largest number of multi-institute international joint papers in Japan, which underscores the international nature of this institute. What is remarkable is that ILS has only eight full-time core research staff.”

Major milestones since 1978 can be divided into six areas: development of a laser driver for inertial confinement fusion; atom optics, Bose-Einstein condensates, and cold atoms; ultrashort pulsed lasers and high-energy density science; highly charged ions; high-frequency stabilized lasers and gravitational wave antennas; and quantum solids.

Findings from research conducted at ILS have often found further scientific application. One example is the high-quality optics and ultrahigh stability lasers that are being used for the construction of Japan’s Kamioka Gravitational Wave Detector (KAGRA) to detect the gravitational waves predicted by Einstein’s theory of general relativity. The project involves building two 3 km long laser interferometric gravitational wave detectors in a coal mine in Kamioka, Japan. Other “big-science” applications are highly stable lasers for precise frequency references for the X-ray free-electron laser, SCALA at the SPring-8 synchrotron in Japan, and the Atacama Large Millimeter/submillimeter Array (ALMA) telescope in Chile.

In 2000, ILS researchers reported the development of ceramic solid-state lasers, constructed from composite materials based on Cr2+-doped crystals (Yb:YAG/Cr2+-YAG) and capable of increased power output up to four orders of magnitude greater than current systems.

Progress has also been made in the application of highly charged ions (HCl) to fundamental science. In particular, ILS developed a greatly improved version of the electron beam ion trap for astrophysics, nuclear fusion, and ultrashort wavelength lithography. Notably, ILS researchers have demonstrated the use of HCI for forming a “hollow atom” in silicon and titanium oxide surfaces.

The research at ILS forms the basis for training and educating the next generation of scientists and engineers in this field. “We demonstrate unique experiments to students,” says Yoneda. “For example, the management of sudden explosions and equipment failure are two daring experiments in our educational program. We also collaborate with partners overseas to organize regular courses on topics such as high-power lasers and their applications, and warm dense matter.”

The outlook of postdoctoral fellows at ILS is truly global, with collaborations formed between ILS and the University of Southampton and the University of Edinburgh in the United Kingdom, Nanyang Technical
Advanced Wireless Communication Research Center

The Advanced Wireless Communication Research Center (AWCC) was established in April 2005 as a global research center for wireless communications and advanced wireless technology education based on both theory and practice. Although UEC was founded to lead Japan’s wireless technology efforts following the Titanic accident, much has changed since then. “Our research reflects our commitment to an innovative and integrated approach for developing wireless technologies for the future,” says Yasushi Yamao, director of AWCC.

AWCC also aims to transfer the fruits of its laboratory research to society via industry-focused technology transfer. “Currently, 36 of the 350 faculty members at the university are conducting research at AWCC,” explains Yamao. “These include three full-time faculty, four concurrent professors, 20 research collaborators, and nine visiting professors. All have extensive links to industry in order to facilitate technology transfer.”

With the mission of realizing ubiquitous and “cognitive” wireless communications, AWCC is pursuing the following projects:

- Wireless engineering for a secure and safe society
- Emerging hardware technologies
- Green information communications technology
- Creation of advanced wireless systems

Recent research findings include the development of a massive, wireless rewritable commercial price tag system incorporating 30,000 terminals. “This is an example of an industrial collaboration on ubiquitous wireless communications technology,” says Yamao. “Our innovative protocol enables the connection of many devices as part of a low-power consumption, long-life, battery-operated system for use in large shops and supermarkets.”

In response to demands for methods to monitor radiation levels in the wake of the Fukushima accident, AWCC has constructed an ad hoc wireless network of sensors to measure radiation levels. The system enables the measurement of temporal changes in radiation, including seasonal changes.

Innovation Research Center for Fuel Cells

Recent reports of cars powered by hydrogen fuel cells have captured the world’s imagination with the hope of a clean energy source to mitigate environmental issues. The advent of commercial fuel cell automobiles is the result of intense basic research at many academic institutions. Yasuhiro Iwasawa, director of the Innovation Research Center for Fuel Cells, is one of the center’s leading scientists and has made major contributions to unraveling the mysteries of the fundamental mechanisms underlying the generation of electricity from fuel cells. Iwasawa is the head of an approximately US$26 million project to use X-ray absorption fine structure (XAFS) spectroscopy to probe the atomic structure of catalysts in fuel cells, in situ and in real time. “Fuel cell catalysts are a black box right now,” explains Iwasawa. “The atomic structure, reaction mechanisms, and degradation mechanism are still unclear. So we have built an 80 m beamline at the SPring-8 synchrotron facility in order to use XAFS to clarify these issues. This is the only XAFS beamline in the world capable of performing high-level in situ XAFS, real-time XAFS, and spatially resolved XAFS.”

Specifically, Iwasawa and his colleagues are focusing on the XAFS analysis of the cathode catalyst inside the membrane electrode assembly during power generation. Fuel cell reactions are such swift, dynamic processes that high-spatial-resolution analysis is critical. “Our approach has several unique features,” explains Iwasawa. “Being in situ and temporal, we can monitor chemical and structural changes down to a time scale of 100 µs at 100 nm spatial resolution, and at 1 µm 3-D resolution under the operating conditions used in our experiments.”

Results from these unprecedented analyses at SPring-8 have yielded intriguing insights into how catalysts behave. Notable findings include elucidation of the structural changes in the Au(core)-Pt(shell)/C catalyst during the on-off process of fuel cells, and the discovery that the reaction rate of the Pt/C catalyst is faster than Pt/C, and in particular, that the reformation of the Pt-Pt bonds and the dissociation of the Pt-O bonds are fast reactions. These results are expected to enable the design of highly efficient and robust fuel cells for the automobile industry.

Innovation Research Center for Fuel Cells: www.icfc.uec.ac.jp
Nagoya University was established in 1871 and is internationally recognized for its contributions to basic research including discoveries by its four Nobel Laureates: Ryoji Noyori (2001, chemistry), Osamu Shimomura (2008, chemistry), and Toshihide Maskawa and Makoto Kobayashi (who shared the 2008 prize in physics). Nagoya University is also the birthplace of the gallium nitride blue light-emitting diode, invented by Isamu Akasaki.

"From Na-go-ya Dai-gaku to Nagoya University" is our adage, which captures the essence of our plans to globalize education and research," says Michinari Hamaguchi, president of Nagoya University, as he sets out his plans to create an environment for young scientists to conduct cutting-edge research that contributes to the global society. "Here Dai-gaku is Japanese for university, and this dictum refers to our commitment to improve the global visibility of Nagoya University. The funding from the MEXT [Ministry of Education, Culture, Sports, Science and Technology] Program for Promoting the Enhancement of Research Universities will be used to initiate reforms to enhance research programs, such as projects at the new Nagoya University Institute of Transformative bio-Molecules [ITbM, see sidebar], which is one of nine World Premier Initiative [WPI] projects chosen by MEXT."

Nagoya University’s research strategy is an integral part of a plan launched by President Hamaguchi in 2009, which includes improvements in internationalization and research through initiatives such as the G-30 Program and Super Global University Strategy as well as a program to specifically attract international students from Asia to study medicine and agriculture.

The G-30 Program offers English language courses and scholarships for approximately 50 international students annually. There are six courses and 11 programs for undergraduates and seven courses and 17 programs at the graduate school, all taught in English, in subjects ranging from engineering to economics. “We want to increase the number of international students from the current 2,200 [15% of the total number of students] to 3,000 [20%] by 2020,” says Hideyo Kunieda, trustee and vice president for research and student support. “We also want to increase the number of Japanese students going overseas, from what is currently around 600, to 1,000—out of a total of approximately 2,200 students in one grade studying at Nagoya University—by 2020.”

It is hoped that the Super Global University Strategy will support the establishment of classes at centers set up by Nagoya University in other countries. One example is the Center for Asian Legal Exchange (CALE), an umbrella organization managing the university’s Education and Research Centers for Japanese Law. The five centers, offering courses in Japanese law and language, are located in Uzbekistan, Mongolia, Vietnam, Cambodia, and Myanmar, with plans to open new centers in Indonesia and Laos.

“We want to nurture people to devise laws applicable throughout Asia, similar to the laws governing the European Union,” explains Hamaguchi. “Graduates from the courses given at CALE go on to influential positions in government and academia. They are also an important part of the Nagoya University’s international network.” Other similar centers have already been established in Germany, China, and the United States.

The university also invites international students from Asia to courses at its Nagoya campus in subjects related to medicine and agriculture. An example is the Young Leaders Program in Healthcare Administration, a one-year Master’s course that engages students from 14 countries in Asia and Eastern Europe. Other facilities for education include the Endoscope Training Center located in hospitals in Vietnam, and overseas centers such as the Technology Partnership of Nagoya University, Inc. (NU Tech) in North Carolina in the United States, and the “Europe Center” located in Freiburg, Germany.

One of the more recently established programs is the Women’s Leaders Program to Promote Well-Being in Asia, which was granted support in 2013 by the MEXT/JSPS (Japan Society for the Promotion of Science) under the Program for Leading Graduate Schools.

Students at Nagoya University can also take courses offered by the joint degree program in medical sciences...
with the University of Adelaide in Australia, the joint educational program with University of Freiburg and University of Strasbourg, and the Japan-U.S. Advanced Collaborative Education Program (JUACEP) with the University of Michigan and the University of California, Los Angeles.

**STRATEGIES AND GOALS**

“We have introduced a new incentive system to encourage our young researchers, taking them from a position of being a source of ‘labor’ to one of ‘leaders,’” explains Hamaguchi. “For instance, we will increase the salaries of researchers who acquire funding from competitive grants such as the WPI project.” Another important set of reforms are related to assignment of tenured faculty positions. Hamaguchi stresses the need for transparency and accountability in the process of appointing faculty positions. “All assistant professor positions will be part of our tenure-track system with evaluation within five years, after which tenured lecturer posts will be offered to those who meet our requirements,” explains Hamaguchi.

“It is essential to create an environment for young scientists to conduct interdisciplinary research that contributes to global sustainability,” adds Hamaguchi. “One of the most important aspects of the reforms is changing the mind-set of staff—both faculty and administration—to recognize the importance of the changes in the creation of an internationally competitive university.”

To achieve these goals Nagoya University has integrated previous resources such as the Office for Initiatives for Industry, Academia and Government Cooperation (which includes the Technology Licensing Office) and the University Research Administration (URA) Office to form the Science and Industry, Academia and Government Cooperation Center, led by the university’s Vice President Hideyo Kunieda. “Strengthening the gathering, analysis, and dissemination of information, enhancing the ability to initiate new projects, and having a single, unified system for interacting with external organizations are the central functions of the new research management system,” explains Kunieda. To support this, the number of URAs will increase from the present 34 to 44.

Hamaguchi notes that the program will also be an important means for increasing the number of tenured faculty members under the age of 35. “Japanese national universities all share this problem,” explains Hamaguchi. “Young scientists are often employed on short-term postdoctoral contracts, a situation that does not enable them to conduct the independent research necessary for tenured positions. The program aims to alleviate this situation.”

**Nagoya University:**

[en.nagoya-u.ac.jp](http://en.nagoya-u.ac.jp)

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**Institute of Transformative bio-Molecules**

Kenichiro Itami, director of the Nagoya University Institute of Transformative bio-Molecules (ITbM), wants to change the world. “At ITbM, we want to design molecules to solve global problems related to the environment, food production, and medicine,” he explains. “Our international teams of chemists and biologists are creating unique bioactive molecules with highly specific and targeted functions with the goal of addressing the most daunting problems facing society.”

ITbM is a 10-year project with annual funding of US$5 million. It was launched in April 2013 after being selected by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) as one of the projects in WPI. Researchers at ITbM are undertaking three major projects: control of biological systems, visualization of biological systems, and synthesis of novel biofunctional molecules.

“Approximately 55% of our research staff are from overseas,” says Itami. “We have excellent bilingual research support staff, including our ‘WPI-Mother’ who plays a central role in looking after the daily needs of our overseas researchers both inside and outside the lab.”

The “mixed-labs” concept is an important feature of the research infrastructure of ITbM, where chemists, biologists, and theoreticians share the same laboratory space. “This under-one-roof approach is the driving force for our research,” says Itami.

The ITbM has 10 principle investigators—seven based at Nagoya University and three overseas at ETH-Zurich in Switzerland, Queen’s University in Canada, and the University of Washington in the United States. Researchers at ITbM also collaborate with the National Science Foundation’s Center for Selective C-H Functionalization and RIKEN’s Center for Sustainable Resource Science. In addition to international collaboration, ITbM has also established three important centers at Nagoya University that are uniquely geared toward research. These are the Molecular Structure Center, the Chemical Library Center, and the Live-Imaging Center.

“We are mixing synthetic chemistry with systems biology to create new synthetic paradigms,” says Itami. “We plan to create our designer molecules both in beakers and in living organisms.”

**Institute of Transformative bio-Molecules:**

[www.itbm.nagoya-u.ac.jp](http://www.itbm.nagoya-u.ac.jp)
Our research and education has been recognized through the receipt of three major project awards this year,” explains Yoshiyuki Sakaki, president of Toyohashi University of Technology (Toyohashi Tech). Sakaki is a molecular biologist who was chosen as a Person of Cultural Merit in 2013 by the Japanese government. The three projects are: the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities; the Program for Leading Graduate Schools on Brain Information Architects; and a joint project to establish an overseas campus in Penang, Malaysia.

Toyohashi Tech was established approximately 38 years ago. With about 2,000 students and 200 faculty members, it is one of the smallest national universities in Japan. “A little giant, comparable in size to Caltech in the USA,” says Sakaki. “Being selected for the MEXT program is like a shot of adrenaline for our researchers; we’re very excited about it!”

Sakaki notes that the selection procedure for the program was top-down and based on independent objective metrics, such as citations, royalties from patents, and research funding grants received. “Toyohashi Tech was selected as one of 22 outstanding research universities and research institutes,” continues Sakaki. “This acknowledges our research to date, and the contributions of the Electronics-Inspired Interdisciplinary Research Institute [EIIRIS], the engine driving research at Toyohashi Tech” (see sidebar below).

OBJECTIVES OF THE PROGRAM

“In our projects we will devise methods for creating positive value from nominally negative assets,” explains Makoto Ishida, vice president of Toyohashi Tech and the person in charge of research. “For example, using waste to create valuable assets, such as biofuels, and extending the functions of our imaging devices to universal self-diagnosis health care biosensors. We refer to this as Value Creation Engineering.”

The Value Creation Engineering project will be managed by the Research Administration Center—set up in December 2013—which includes the University Research Administration Office.

The creation of new industries is one of the major objectives of the Toyohashi Value Creation Engineering project. “Our university has an excellent record in technology transfer,” explains Ishida. “We want to build on this by linking up with global partners to generate ideas for new innovative industries.” Toyohashi Tech will use its expertise in interdisciplinary research, together with research talent at EIIRIS, to achieve these goals. The project will entail collaboration with research institutes and companies worldwide, hiring research staff and students from overseas, and reforms in the personnel system.

Toyohashi University of Technology: www.tut.ac.jp/english

The Electronics-Inspired Interdisciplinary Research Institute

EIIRIS is the flagship research hub of Toyohashi University of Technology. It was established in October 2010 to build on Toyohashi Tech’s expertise in microelectronics and act as a platform for the creation of new research paradigms combining electronics with the life sciences. The institute aims to solve problems in diverse areas including environment, energy, food production, and population. For outreach, EIIRIS organizes international conferences, such as The Ibaro Conference Series, and advertises its activities through regular press releases and a quarterly Toyohashi Tech e-newsletter.

Research covered at EIIRIS includes advanced medical technology, brain-related technology, and green technology. EIIRIS has 11 researchers, two technical assistants, two research support staff employed directly with EIIRIS funding, and 10 tenure-track researchers.

EIIRIS has a range of high-quality research facilities. On the first floor of EIIRIS-1 there is a 1,500 m² clean facility, completed in 2010. It houses lithography process rooms, Raman spectroscopy and scanning electron microscopes, and optics areas with advanced fluorescent microscopes and systems for measuring minute electrical signals used in neuroscience research. EIIRIS-2 is a huge 2,300 m² clean facility connected to EIIRIS-1 via a bridge on the third floor. It contains design and fabrication equipment for large-scale integrated circuits and micro-electro-mechanical systems (MEMS). Finally, EIIRIS-3 is a life sciences experimental facility for full-scale experiments using animals—an unusual research facility for an engineering university.

One highlight of research at EIIRIS is
Treatment of diseases such as Alzheimer’s. Concentration of ACh may yield clues for the line (ACh). Knowledge of the variations of the body in response to monitor and control chemical reactions in the such as a chemical-human machine interface connected to external circuits for applications

Sawada has used the ion imaging sensor for 2-D imaging of the pH outside cells. “The initial device was used for 2-D imaging of the pH outside cells,” says Sawada. “We have recently extended the applications of the sensor for monitoring neurotransmitters in cells. This signal can be connected to external circuits for applications such as a chemical-human machine interface to monitor and control chemical reactions in the body in real time via an implanted device.”

Sawada has been investigating the relationship between the subjective quality and pictorial features of a pearl, as seen by a pearl appraiser and a novice. “I am developing an optical system to capture how an expert sees features,” says Nakauchi. “This research is ultimately aimed at elucidating neuromechanisms of congenital ability and memory.”

Hiroyuki Daimon is studying the efficient utilization of biomass, carbon dioxide (CO2), and heat as part of a major project on creating sustainable, recyclable energy to counter the adverse effects of climate change. “We have constructed a prototype within the Toyogawa sewage treatment plant,” says Daimon. “We collect biomass, ferment it to produce methane, and use the methane gas to generate electricity. The residue is used to produce fertilizer.”

Notably, Daimon and his research group leave nothing to waste. Any CO2 produced during the fermentation is introduced into a marine plant farm for seaweed production, and the CO2 and heat generated during the generation of electricity is delivered into a greenhouse for growing tomatoes. “These are early demonstration experiments with which we have begun the Toyogawa Biomass Park,” says Daimon. “We invite visitors to join us and even taste our delicious tomatoes and vegetables!”

Other exciting research, in this case in the field of functional materials, is being done by EIRIS scientist Tran Viet Thu and colleagues who have synthesized graphene and composites by bacteria-mediated reduction, and silver-reduced graphene oxide nanohybrids for the development of highly efficient catalysts.

Shigeki Nakauchi studies visual perception and cognition to answer questions such as: Why are humans able to recognize objects the instant they see them but machines cannot? His research covers three main areas: understanding visual systems, measuring brain activity by electroencephalography, and visualizing otherwise invisible information using infrared-spectrum imaging. A particularly intriguing set of experiments involves studying the differences in the perceptual processing abilities of experts and novices. As an example, Nakauchi
Kyoto University was established in 1897 as Japan’s second Imperial University, responding to calls from Kyoto residents for the creation of educational and research facilities in the city (which was the capital of Japan from 794 to 1868).

“The people of Kyoto have tremendous respect for scholars and scholarship,” explains Hiroshi Matsumoto, president of Kyoto University. “The unique combination of the rich culture and history of Kyoto and the university’s commitment to globally minded academic freedom and an integrated, multidisciplinary approach to research has spawned discoveries by Kyoto University researchers that have changed the world. Their work exemplifies our motto, ‘self reliance and self respect.’”

Kyoto University’s prowess as a research powerhouse is evidenced by the major scientific breakthroughs made by the eight Nobel Laureates affiliated with the university. The most recent Nobel winner is Shinya Yamanaka, director of the Center for iPS Cell Research and Application (CiRA), who shared the 2012 prize for physiology or medicine for his work on reprogramming mature cells to become stem cells. Furthermore, in the field of mathematics, two of the three Japanese recipients of the Fields Medal—formally known as the International Medal for Outstanding Discoveries in Mathematics and widely referred to as the “Nobel Prize for mathematics”—are Kyoto University alumni. Kyoto University plans to reform its research activities by creating an environment where knowledge can extend beyond existing boundaries. This borderless pool of knowledge will be implemented by promoting internationalization, employing staff with diverse expertise and experience, investigating unexplored disciplines and topics on the fringes of what is currently accepted as science, spurring invention and innovation to connect academic curiosity with the needs of society, and creating a sustainable management system to overcome organizational and institutional barriers.

“Our research plans include two unique ideas reflecting the university’s commitment to nurturing innovative solutions to tackle global issues such as climate change,” says Matsumoto. “The first is known as mikagaku in Japanese, which literally translated means ‘proto-science.’ Here we are exploring the unexplored and in some cases, the unimagined. These are ideas and concepts that are yet to be recognized as scientific disciplines. An example of mikagaku is research on induced pluripotent stem cells—the notion of reprogramming adult cells was unimaginable until the pioneering work by Shinya Yamanaka.”

The other Kyoto-style approach to research is embodied in the Hakubi Project, launched in 2009. “Each year we select 20 young scientists and give them five years to pursue research on a topic of their choice, at any location in the world,” explains Matsumoto. “They receive excellent funding and administrative support, with only the bare minimum of oversight. It’s a very popular project. This year we have had 644 applications—including 236 from overseas—for the 20 posts. This project is an example of our multidisciplinary and international approach to addressing multifaceted global issues.”

One of the ongoing Hakubi Projects involves scientists developing a system for giving health checks to the elderly in the Kingdom of Bhutan and the development of a microscope that can image a DNA double helix in water.

Kyoto University will launch many projects as part of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities. One such project is the Supporting Program for Interaction-Based Initiative Team Studies (SPIRITS), where the university will support the launch of 100 new projects over 10 years, irrespective of discipline.

There will also be a new and renewed John Mung Program to support international development for university members. The program provides assistance for faculty members to conduct their research abroad, for administration staff to gain experience in international affairs, for university research administrators (URAs) to develop their research promotion skills, and for students to study overseas. (The title of this program is the English name of the Japanese sailor, Nakahama Manjiro, who, after being rescued from a shipwreck by an American whaler, spent a number of years studying abroad and later returned to become a leading interpreter of Western culture during the Meiji era.)
Another major project, called Hyakkasōmei, creates a platform for scholars from different countries and disciplines to gather and freely discuss issues that may lead to new, as yet unrecognized scientific disciplines encompassed in the concept of mikagaku. “Kyoto University is famous for its open-minded research culture,” says Kiyoshi Yoshikawa, executive vice president for research.

The university will also establish an exploratory initiative institute as a platform to test new reforms, such as rewarding the performance of outstanding researchers with increases in salary. If the reforms prove to be successful, they will be applied throughout the university.

“Resources from the MEXT program will be used to hire more URAs to further facilitate creative research by reducing the administrative workload of principal investigators,” adds Yoshikawa. The university will hire 20 new URAs in addition to the current 30 URAs to manage the new initiatives. It will also launch the Kyoto University Skill Development Program as a career development path for URAs.

“The URAs will fulfill many roles, including working with the directors of the university to analyze research trends and project them into the future, and to propose new areas of research to pursue,” says Koji Tanaka, director of the Kyoto University Research Administration Office.

INTERNATIONAL OUTREACH AND DEVELOPMENT

Kyoto University maintains an extensive global network to pursue its education and research via collaborative programs, joint international symposia, and exchange agreements. Notably, in the 2011–2012 academic year, approximately 3,000 international researchers worked at Kyoto University while approximately 8,100 Kyoto researchers worked overseas for differing periods of time during the year.

Collaboration in Asia includes the Kyoto University Bhutan Friendship Program and the Japan International Cooperation Agency on supporting engineering in Myanmar. The university maintains many similar activities around the world. “The 1st Bristol-Kyoto Symposium held in Bristol in January 2013 is an example of the university’s commitment to fostering strong international relationships,” says Yoshikawa. “Approximately 90 people from Kyoto traveled to Bristol for face-to-face discussions on enhancing existing research collaborations and initiating new ones.” The 2nd Bristol-Kyoto Symposium was held a year later in Kyoto in January 2014. Other such meetings were held with three institutions in Switzerland in November 2013, and with National Taiwan University in December 2013.

The 2x by 2020 (Double by Twenty-Twenty) Initiative, formulated under the leadership of Michiaki Mishima, executive vice-president for international affairs and hospital administration, is the roadmap for Kyoto University’s international research strategy until the year 2020. The plan includes bold and ambitious targets such as more than doubling the number of international researchers and faculty members from 3,190 to 6,500 and the number of international students from 2,082 to 4,300.

Even more, Kyoto University has set a goal to become one of the top 10 universities in the world, as ranked by the Times Higher Education World University Ranking, by 2020.

Kyoto University: www.kyoto-u.ac.jp/en

Researcher Spotlight

Aya Yanagawa is an assistant professor in the Laboratory of Innovative Humano-Habitability in the Institute of Sustainable Humanosphere, Kyoto University. “I decided to pursue a career in research because I am fascinated by the hidden beauty and strategies for survival in all living things,” she says, speaking from CNRS, Laboratoire Évolution, Génomes et Spéciation, in Paris, where she is completing a nine-month sabbatical sponsored by Kyoto University.

Yanagawa is currently studying the grooming behavior in insects for removing pathogens and microbes from the surfaces of their bodies. “I am investigating insect-pathogen relationships in termites and fruit flies, that is, the links that may exist between behavior and disease defense mechanisms.”

Specifically, Yanagawa is looking for links between insect pathology, microbial control, and the behavioral resistance of insects against microbial infection. “Generous funding by Kyoto University has enabled me to study the insect hygiene behavior of termites in Japan and to travel to France to look at flies,” she explains. “The university provides an excellent environment for young researchers.”

In the long term, her research could lead to the development of ecologically friendly, biological pest controls as alternatives to chemical insecticides. “The world is facing a plethora of daunting problems, such as pollution, energy shortages, and agricultural issues such as food security,” says Yanagawa.

“I believe that the future of agriculture will be brightened by employing integrated pest management techniques. As a researcher in agriculture, I hope that my study will contribute to a more harmonious co-existence between natural systems and human activity.”

Yanagawa adds that her wishes may now be one step closer to becoming reality, as recent research has revealed that behavioral resistance is one of the most effective means of fighting pathogenic infection in insects. Her project should yield clues for finding effective ways of using pathogens in biological control. Furthermore, investigating the behavior of the fruit fly, Drosophila melanogaster, could lead to the discovery of new genetic information about disease transmission by flies, which will be important in medical entomology, hygiene, and sanitation.

Laboratory of Innovative Humano-Habitability, Institute of Sustainable Humanosphere: www.rish.kyoto-u.ac.jp/English/members-en.html
Okayama University is a comprehensive institution with approximately 1,300 faculty and 14,000 students. It offers courses in subjects ranging from medicine and pharmacy to humanities and physical sciences and is situated approximately three hours west of Tokyo by high-speed rail. The roots of the university go back to the Medical Training Place set up in 1870 with the support of the lord of Okayama.

“An independent report compiled by the National Institute of Science and Technology Policy shows our research strengths in physics and basic life sciences,” says Shin-ichi Yamamoto, executive director and vice president for research. “As part of the Ministry of Education, Culture, Sports, Science and Technology [MEXT] Program for Promoting the Enhancement of Research Universities, we have established the provisionally named Organization for Global Advanced Interdisciplinary Sciences, which will implement reforms that build on our strengths to create a globally competitive, research-based university.”

The main pillars of the Okayama University’s overall research strategy are the Center of Innovation project, enhancing translational clinical research at Okayama University Hospital (a hospital that was selected as one of the 15 core hospitals for clinical research in Japan), and the abovementioned MEXT program.

“The Organization for Global Advanced Interdisciplinary Science will coordinate our research strategy by collaborating with other institutes located near Okayama, such as RIKEN’s SPring-8 synchrotron, the X-ray free electron laser (SACLA) in Harima, and the K-supercomputer in Kobe,” explains Yamamoto.

Toru Numaguchi was appointed senior research administrator in 2012. “Some of the major challenges in the implementation of research reforms will be defining new areas of research over the next, say, 10 years, as well as initiating productive and high-quality international research, and estimating funding requirements over that 10-year span,” says Numaguchi.

The directors of research at Okayama University have used and will continue to use powerful databases to conduct bibliometric studies in order to benchmark research, find partners for research and technology transfer, and develop future strategies.

“Data analysis and surveys will become increasingly important for devising research strategies at universities in Japan,” says Yamamoto. “Data from this type of benchmarking may play a greater role in decisions for funding major projects, as in the case of the MEXT program, which was a top-down decision based on independent performance data.”

Some of the centers at the university benefiting from the MEXT program are highlighted in the sidebars below.

Okayama University: www.okayama-u.ac.jp/index_e.html

Creating New Materials for a Green Future

Organic solar cell alternatives to the conventional photovoltaic devices, fabricated using inorganic materials such as amorphous silicon and other such semiconductors

- Development of novel solar cells based on new dielectric materials
- Development of low-energy consumption processes to manufacture high-performance organic field-effect transistors
- Synthesis of new nanomaterials for storing hydrogen and methane
- Development of new superconducting organic materials
- Development of high-temperature superconductors using new design approaches
- Conversion of optical energy to electrical energy using processes based on biological systems.

“We are global in our approach to pursuing our goals,” explains Kubozono. “One of our colleagues from Okayama University is on a long-term stay at the University of Durham in the United Kingdom, where he is investigating new carbon-based superconductors.” Funding
from the MEXT program will be used to strengthen the university’s global presence by inviting scientists from overseas to conduct research at the center.

Okayama University scientists are strongly encouraged to share their findings with the broader scientific community. “We regularly publish our findings in high impact journals, reflecting the high quality of our research,” says Kubozono. “Notably, we have published a paper in the journal Nature each year since the launch of the center.”

Kubozono was recently in the spotlight following the generation of potassium-doped picene, a semiconducting solid hydrocarbon. The material exhibits superconductivity properties at relatively high temperatures (up to 18 Kelvin, or -255.2°C). “Superconductivity in carbon materials may be a new way to produce superconducting circuits for ultra-low power electronics,” says Kubozono. “This is an excellent example of our focus on interdisciplinary science, with chemists contributing to physics.”

Kubozono Laboratory: interfa.ris.okayama-u.ac.jp/index.html


“Success may yield a means of extracting clean energy from the sun.”


Photosynthesis Research Center

The Photosynthesis Research Center was launched in April 2013. “Our goals are to clarify the biochemical mechanisms of photosynthesis, in particular reactions related to light-induced water-splitting,” explains Jian-Ren Shen, director of the center. “Our findings may enable the synthesis of catalysts for artificial photosynthesis—for a potentially unlimited source of clean energy.”

The importance of Shen’s research into the mechanisms of light-induced water-splitting led to its selection as one of the 10 Breakthroughs of the Year in 2011 published by Science. It was also awarded the prestigious 2012 Asahi Prize for outstanding accomplishments in the fields of academics and arts.

“The results are described in a 2011 Nature paper and are the culmination of 21 years of my research on photosynthesis resulting in the synthesis of ultra-pure, single-crystals of the so-called Photosystem II membrane protein complex, or PS II,” explains Shen.

Ultrahigh resolution X-ray diffraction experiments on the PS II crystals conducted at the SPring-8 facility showed that it has a cubic-core of four manganese atoms, five oxygen atoms, and a calcium atom. This cluster of Mn₄CaO₇ catalyzes the light-induced splitting of water. “The distorted chair-like structure of the cluster proved to be difficult to synthesize artificially,” says Shen. “But there is considerable industrial interest in doing so.”

Research Core for the Extreme Quantum World

“Photons are the most abundant particles in the universe at about 410 particles per cubic centimeter, while the second most abundant are neutrinos (330 particles per cm³). The physics of photons (light) is well established, but quantitative information about neutrinos, such as their absolute mass, is lacking despite their importance for explaining the structure and origins of the universe.”

The physical properties of neutrinos are not well understood in large part because they are extremely difficult to detect. Current state-of-the-art research on neutrinos is expensive, time-consuming, and requires the use of massive particle accelerators and/or detectors buried deep in the Earth.

Now, Noboru Sasao and colleagues at the Okayama University Research Core for the Extreme Quantum World are proposing to conduct research in ordinary, inexpensive university labs in an attempt to demystify the world of neutrinos and the origins of the universe through the Spectroscopy with the Atomic Neutrino (SPAN) project.

“In SPAN, we are investigating the properties of neutrinos by analyzing the response of target atoms to incident laser light,” says Sasao, leader of the SPAN project. “Our approach offers a relatively inexpensive and systematic method for obtaining preliminary data about neutrinos that could be used as the basis for more advanced and quantitative research on the origins of matter in the universe.”

In these experiments, the researchers excite atoms or molecules coherently with laser light and detect and measure the energies of photons emitted due to the de-excitation, a process called radiative emission of a neutrino pair (RENP). Neutrinos are impossible to detect directly but information about their absolute mass can be ascertained by analysis of the photon spectra. However, the rate of emission of light in the RENP process is extremely small, which in turn limits the probability of finding information about neutrinos in the emission spectra. “We intend to overcome this problem by using lasers to amplify the optical signal from samples,” explains Sasao. “We refer to this amplification mechanism as macro-coherent amplification, and it manifests itself as two photons being emitted in the de-excitation process, which we have called paired super-radiance.” Initial proof-of-principle experiments using a solid sample of parahydrogen are promising, showing a coherence time of longer than 20 ns. This is very long for solid materials, which typically have coherence times of less than 1 ns.

Research Core for the Extreme Quantum World: www.xqw.okayama-u.ac.jp/index.php
Nara Institute of Science and Technology (NAIST) is one of Japan's youngest research-based institutes. Located in the Kansai Science City at the border of Nara, Osaka, and Kyoto, NAIST consists of three graduate schools: Information Science, Biological Sciences, and Materials Science. The faculty members are young—around 40% are under 39 years old—and the students international, with 30% of doctoral students from outside Japan.

“NAIST only offers graduate school courses,” explains President Naotake Ogasawara. “We had our first intake of students 21 years ago and currently have approximately 200 faculty and 1,000 students, of whom 300 are pursuing doctoral degrees. NAIST researchers publish an average of 340 papers per year of which more than 40 are in the top 10% in their field according to international benchmarking data.”

NAIST was established in 1991 with the intention of removing departmental barriers and promoting interdisciplinary research. This openness and flexibility have led to important discoveries by prominent scientists who have conducted research at NAIST. Examples include Shinya Yamanaka, who was awarded the 2012 Nobel Prize in physiology or medicine for his seminal work on re-programming mature cells to restore pluripotency, work he began during his time at NAIST as a young researcher. Another high-profile NAIST researcher is Ko Shimamoto, who is internationally recognized for his pioneering work as a researcher on the hormone florigen and its role in the flowering of plants. “To further develop and extend these powerful research activities to the next generation, we always make efforts to discover and encourage the growth of young faculty members,” says Ogasawara.

As part of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities, NAIST will launch the following initiatives: an international tenure-track program that will employ six university research administrators [URAs] to manage this project based upon the findings of their ongoing institutional research,” says Naokazu Yokoya, executive director and vice president. “They will act as a bridge between the researchers and executive directors of the university, introducing and promoting research from both academia and industry around the globe.”

Kenji Kohno is the director of the Center for Frontier Science and Technology and one of the NAIST faculty members responsible for implementing the MEXT program. “The fact that we do not have an undergraduate school means that we do not show up in international university ranking data,” says Kohno. “The current methods used for assessing universities do not accurately cover small, graduate schools like NAIST—so while we produce world-class research and researchers that are active in various fields around the globe, these are not clearly represented by this ranking methodology.” New research currently attracting attention includes work on optical media interfaces headed by Yasuhiro Mukaiyawa, investigations into the principles of plant development headed by Keiji Nakajima, and Masakazu Nakamura’s research on organic compounds used to produce environment-friendly, low-energy electronic devices. Research highlights of these three young faculty members, underscoring the open and flexible environment at NAIST, are outlined on the following page.

Nara Institute of Science and Technology: www.naist.jp/en/
Making the Invisible, Visible

Rays of light contain valuable information about the texture and shape of objects ranging from a bowl of fruit on a kitchen table to human skin or solutions of colloids. The nature of light rays is changed by reflection and scattering by objects before the light enters our eyes or is captured by a camera. Furthermore, in translucent materials it is not possible to directly measure the behavior of light as it is scattered within the material. A deep understanding of how light behaves and is propagated in scattering media is important in many areas of research including image rendering, medical imaging, and materials characterization.

“My research activities are focused on optical media interfaces,” says Yasuhiro Mukaigawa, professor in the Graduate School of Information Science. “We use a wide variety of special cameras and image capture technologies to take photographs of objects, mathematically analyze the images, and reproduce complementary images of the same scene, which show features that are not visible to the human eye prior to analysis.”

An example of Mukaigawa’s research is the Parallel High-Frequency Illumination (PHFI) technique that removes all scattered light emanating from an object, yielding clear and sharp images of objects inside cloudy liquids. “Objects inside a turbid solution are clearly delineated by this apparatus,” says Mukaigawa. “It makes the otherwise invisible, visible.”

Mukaigawa Laboratory: omilab.naist.jp

Demystifying Plant Development and Cellular Signaling

Examination of the cross-sections of plant leaves and roots under a microscope reveals beautiful patterns of intricately interweaving cells of myriad sizes and shapes, all arising from a single zygote. “The question arises as to how these complex plant structures are derived from a single cell,” says Keiji Nakajima, associate professor in the Graduate School of Biological Sciences. “Our research aims to identify the basic principles of plant development using model plant species.”

Specific targets include studying the intracellular signal transduction pathways underlying the pattern formation of roots and embryos, and cell reprogramming triggered by embryogenesis. In this vein, the laboratory also studies mechanisms enabling microRNAs to move from cell to cell and the evolution of such pathways.

Another fascinating research area focuses on understanding cell reprogramming and pattern formation during embryogenesis, that is, the process of initiation and development of a plant embryo from a zygote. “We have discovered a key reprogramming factor in Arabidopsis—a small flowering plant we use as a model. We are currently working on its mechanism of action,” explains Nakajima. “And we are developing methods that utilize this reprogramming factor to propagate useful plant lines.”

Nakajima Laboratory: bsw3.naist.jp/nakajima/English/

Organic Materials for Printable Devices

Masakazu Nakamura was hired by the Graduate School of Materials Science as a tenure-track professor, part of a program designed to promote young NAIST faculty members. He uses organic compounds to fabricate field-effect transistors, energy harvesting devices, and terahertz sensors. The aim is to produce low-energy, environmentally friendly electronics devices that can be printed on flexible surfaces such as plastics and clothes.

“We have developed unique characterization techniques such as atomic-force microscope potentiometry to explore fundamental mechanisms governing carrier transport and band structure of organic materials. The discovery of unexpected small fluctuations of the electronic band in the organic compound pentacene led us to initiate new research on so-called terahertz wave imaging sensors for applications that include security checks at airports,” says Nakamura.

Another area where flexible devices could play an important role is in energy harvesting. A recent highlight is the design of flexible thermoelectric conversion materials and devices. Nakamura and colleagues have also discovered that high-purity thin films of fullerenes and some other materials exhibit a large thermopower (as defined by the Seebeck coefficient) of 100 mV/K, which is a hundred to a thousand times larger than normal values and could be used in high-efficiency thermoelectric devices to convert heat into electricity.

“Energy conversion and harvesting is important for powering flexible electronic devices on any surface,” explains Nakamura. “Recently we produced composite materials consisting of protein molecules bridging carbon nanotubes that could drastically improve thermoelectric conversion efficiency. The figure of merit, ZT—on which thermoelectric efficiency depends—is 2,200 times higher than conventional nanotubes.”

Nakamura Laboratory: mswebs.naist.jp/LABS/greendevice/index_e.html
Kumamoto University is located at the center of the island of Kyushu in southwestern Japan, approximately two hours by air from Tokyo. The university is one of Japan's most highly acclaimed higher education institutions, originating as one of the five institutions established during the Meiji era (in the nineteenth century) that united in 1949 to form the current university. It is renowned for its high academic standards and its research on AIDS, magnesium alloys, pulse power, and advanced life sciences. Its picturesque location is at the heart of Kumamoto City, famous for its rich culture, stunning mountain vistas, and the spring water from Mount Aso, an active volcano.

In October 2013, Kumamoto University was one of 22 institutes chosen by Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) for the prestigious and highly competitive Program for Promoting the Enhancement of Research Universities.

“Of the 22 universities and institutes selected for this program, Kumamoto University is farthest from Tokyo,” says Trustee and Vice President Shinji Harada, who is in charge of research and social cooperation. “The two major goals of the MEXT program at Kumamoto University are training university research administrators [URAs] and enhancing research at its internationally renowned institutes” (see sidebars, below).

Kumamoto University
Catalyzing the Next Generation of Multidisciplinary Researchers

Center for AIDS Research

The Center for AIDS Research (CAIDS) was established in 1997 as the first academic center in Japan devoted to studying HIV and acquired immunodeficiency syndrome (AIDS). With its broad and extensive expertise in the fields of immunology and drug development, CAIDS has been contributing to the development of vaccines and new drugs, including the protease inhibitor drug, Darunavir. Recently, it served as the core for a Global Centers of Excellence program, which promoted international research and provided world-class training opportunities. It focuses on immunology and strives for the development of new immune-based treatments, vaccines, and new drugs.

Director: Masafumi Takiguchi
www.caids.kumamoto-u.ac.jp/aidsnew/englishpage/

Kumamoto Castle

Magnuminium Research Center

The Magnesium Research Center (MRC), established in December 2011, is focused on further enhancing the unique properties of magnesium (a light-weight metal) by developing magnesium alloys for applications such as aircraft construction. Highlights of MRC's recent research efforts include the realization of KUMADAI Heat Resistant Magnesium Alloy in 2003 and KUMADAI Non-flammable Magnesium Alloy in 2012.

Director: Yoshihito Kawamura
www.mrc.kumamoto-u.ac.jp (in Japanese)

Kumamoto Castle

Institute of Pulsed Power Science

The Institute of Pulsed Power Science conducts interdisciplinary basic and applied research on pulsed power—the temporally controlled, instantaneous release of energy (electrostatic, magnetic, mechanical, or chemical). Research areas being pursued at the institute include medical and environmental applications using the biological effects of pulsed power (bioelectrics), and extreme material science using explosives and super-gravity facilities.

Director: Hidenori Akiyama
www.ipps.kumamoto-u.ac.jp/English/

Institute of Molecular Embryology and Genetics

Established in 1992, research at the Institute of Molecular Embryology and Genetics is focused on cutting-edge life and medical science from the point of view of developmental biology and human diseases. The institute comprises 30 primary faculty members in the three main divisions of Developmental Regulation, Stem Cell Research, and Organogenesis, as well as the Center for Organ Regeneration Research and Regenerative Medicine.

Director: Mitsuyoshi Nakao

Taniguchi. “Ours is an ‘all-university’ initiative,” explains Harada. “We have contributions from researchers in the life sciences, natural sciences, humanities, and social sciences. We expect the fruits of this program to benefit our undergraduates’ education as well.”

The history of research at Kumamoto University shows the truly open policy of securing a world-class research staff. “Approximately two-thirds of the faculty members at the university's medical school were recruited from other institutes in Japan,” explains Harada. “This policy of head hunting is rare in Japan and is a trademark of Kumamoto University. We welcome active, highly motivated researchers from all over the world to join us as part of this program.”

Kumamoto University:
www.kumamoto-u.ac.jp

Mitsuyoshi Nakao
Keio University
Inspiring Multidisciplinary Environmental Research

Keio University is committed to the “protection of the global environment and the development of a sustainable, zero-waste society,” according to their 2012 Environmental Policy Statement, which informs the university’s research and teaching focus. Founded in 1858, it is one of the oldest and most prestigious private universities in Japan, offering courses in the arts, social sciences, physical sciences, engineering, and medicine. This large and influential academic institution has 10 undergraduate schools, 14 graduate schools, approximately 1,400 tenured faculty, and 33,000 students. The challenging research and education programs at the university reflect the spirit of “independence and self-respect” espoused by the university’s founder, Yukichi Fukuzawa.

Global Environmental System Leaders Program

“Our faculty, administration staff, and students are aware of their individual responsibility to contribute to a sustainable global ecosystem,” says Yasushi Kiyoki from the Graduate School of Media and Governance, and leader of the Global Environmental System Leaders (GESL) program. “Education and research at Keio University are intrinsically linked with environmental issues. The GESL program is an excellent example of our multidisciplinary approach to environment-related research.”

With full backing from the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities, the GESL program aims to nurture global leaders with a deep understanding of social and technological issues, with the ultimate goal of spearheading global efforts to preserve the Earth’s ecosystem.

Students in the GESL program take a five year course—two years for their Master’s and three additional years for their Doctoral training—choosing major and minor specialties from four courses taught at the Graduate School of Media and Governance and Graduate School of Science and Technology. Notably, GESL students spend up to six months doing fieldwork at one of the partner institutes, which include Princeton University in the United States, the University of Cambridge in the United Kingdom, Tampere University of Technology in Finland, and the United Nations Environment Program (Asia Pacific Adaptation Network).

Kiyoki’s research on a Mathematical Model of Meaning (MMM) is central to the running of the GESL program. “MMM links the cyberworld with the physical world,” explains Kiyoki. “It enables context-dependent web searching for environment-related media data, such as video and photographs.” GESL students share this highly intercorrelated information with researchers at other institutes in real time, to analyze and monitor natural disasters. “We expect 30%–40% of the GESL graduates to join international institutes, such as the United Nations,” says Kiyoki. “This is Keio University’s contribution to environmental research and policy making.”

Global Environmental System Leaders Program: gesl.sfc.keio.ac.jp

Challenges in Cross-Border Recycling in Asia

Eiji Hosoda is an economist who studies waste management, specifically the cross-border movement of recyclable products. “The mid-1980s saw major increases in exports of so-called end-of-life products from economically mature countries to nations such as China that had a strong demand for raw materials,” he explains.

The early, uncontrolled cross-border movement of recyclable products had two major effects in Asia. In Japan, strict extended producer responsibility (EPR) laws were enacted in 1997 to recycle packages, home appliances, and end-of-life vehicles. Yet despite these laws, the outflow of recyclable goods to developing countries severely limited the reuse of valuable resources within Japan itself. This led to recycling businesses going bankrupt. The second issue was that end-of-life goods transported to other Asian countries were potential sources of pollution, such as “e-waste” from electrical goods.

“I realized that incinerators and other such technology alone would not be enough to prevent potential environmental problems,” says Hosoda. “We needed to develop an internationally viable system to deal with the whole process of cross-border recycling and waste management.”

In 2006, Hosoda and colleagues in Kitakyushu City, Japan, and Tianjin, China, joined in a three-year pilot project for recycling mixed plastics. The results were published in a 2009 report entitled, “A Guideline on Cross-Border Trading for Recycling; Kitakyushu-Tianjin Method.” The combination of using electronic tags for tracking the movement of plastics, establishing an institute to certify private companies, and the participation of representatives from the cities of Kitakyushu and Tianjin, have been key to the success of the project. “This model for waste recycling and management is globally transferable across national borders,” says Hosoda.

Hosoda Laboratory: web.econ.keio.ac.jp/staff/hosoda/
Waseda University

With approximately 43,974 undergraduates, 9,357 graduate students, 4,362 international students, and 1,679 tenured teaching staff, Waseda University is one of Japan’s largest research-based private academic institutions. The university is a member of the Research University 11, a consortium of 11 Japanese research-based universities established in 2009.

“The landmarks given in the Waseda Vision 150 define our road map until 2032, which is the 150th anniversary of our founding,” says Vice President Shuji Hashimoto. “The funding from the Ministry of Education, Culture, Sports, Science and Technology [MEXT] Program for Promoting the Enhancement of Research Universities will be integrated into existing projects and infrastructure to realize the goals of our roadmap. The Waseda Vision 150 is our commitment as one of the leading universities in Asia to contribute to cutting-edge research and inspire education on a global scale.”

The major targets of Waseda Vision 150 include increasing the number of international students from approximately 4,300 to 10,000, increasing the number of lectures in foreign languages from approximately 7% to 50%, and increasing the number of tenured teaching posts to 2,000. The university is well situated for overseas researchers, with plenty of international schools and accommodations available in the area, and an English-speaking community that has already taken root.

As part of the MEXT program, Waseda University will hire eight university research administrators (URAs). The responsibilities of the newly appointed URAs will include planning and executing research projects based on objective analysis of international research trends, establishing research centers, supporting young researchers, distributing press releases, and dealing with the media. In addition to URAs, the Waseda University project will make use of the Waseda Research Institute (WRI) Corporation, a company set up by the university to comprehensively support research activities, supporting the promotion of cooperation with industry, academia, government, and the community by the university’s research teams.

“All the new URA staff will be employed as members of faculty as part of the Center for Research Strategy,” says Yoshiaki Fukazawa, senior executive director for the promotion of research and information technology. “URA career paths are still being established in Japan. We expect our URAs to be able to interface with researchers, administrators, and society. Their contracts are for five years initially, but we are considering the possibility of converting these positions into tenured posts.”

**Waseda University:**
www.waseda.jp/top/index-e.html
www.waseda.jp/rps/kenkyu/index-e.html

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**Hitoshi Kurumizaka**

A faculty member at the Graduate School of Advanced Science and Engineering, joined Waseda University in 2003 following a postdoctoral fellowship at the National Institutes of Health (NIH) in the United States and a five-year stint as a research scientist at RIKEN in Saitama, Japan.

“I am currently studying how DNA is packaged into the tiny, microscopic space of the eukaryotic nucleus by histone proteins,” says Kurumizaka. “More specifically, we want to clarify the crystal structure of specific histones associated with packing nucleosomes—the fundamental unit of DNA packing in eukaryotes. Histones hold the key to how we humans have a total of around 100 billion kilometers of DNA wound up in the nuclei of our cells.”

To ensure specific functions, a precise chromatin architecture of DNA-protein complexes is required for centromeres—the attachment point for the chromosome to the mitotic spindle during cell division—to be generated on chromatin. A centromere-specific chromatin is produced by the assembly of nucleosomes containing the centromere-specific histone H3 variant, CENP-A, a protein whose structure is not well understood.

In a 2011 *Nature* paper, Kurumizaka and colleagues successfully reconstituted the centromere-specific nucleosome with human CENP-A and determined its crystal structure.

“In this ground-breaking study, we revealed the specific and common structural properties of the CENP-A nucleosome, compared with the canonical nucleosome,” says Kurumizaka.

This is the first report describing the centromeric nucleosome structure at an atomic resolution. The results have important implications for understanding the molecular mechanisms underlying chromosome segregation, epigenetic inheritance of the chromatin domains, and functional chromatin formation—processes so important that their destruction can cause serious diseases, including cancer.

Kurumizaka Laboratory:
www.hrc.sci.waseda.ac.jp/eng/member/kurumizaka/

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**International Students at Waseda**

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**Shuji Hashimoto (left) and Yoshiaki Fukazawa**

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A New Breed of Cancer Researcher

As our understanding of cancer has gone from simplistic to complex, so too has research on treatment and detection. In a field once dominated by scientists with biomedical backgrounds, cancer research today includes engineers, chemists, and physicists. To land a job in any emerging area of cancer research, interdisciplinary training is becoming increasingly important. Luckily for job seekers, educational institutions are rising to meet the need. By Gunjan Sinha

W hen Martin Pule landed a Fulbright scholarship 14 years ago to study at the Center for Cell and Gene Therapy in Baylor College of Medicine, he never anticipated that he would be working in one of the hottest fields of cancer research today: immunotherapy. At Baylor, Pule began training in Malcolm Brenner’s laboratory—one of the pioneers of engineered T-cell treatments. In 2008, Brenner’s team published one of the first studies demonstrating that T cells could be taken from a patient with neuroblastoma, engineered to express tumor-specific receptors, and then administered back to the patient as a treatment. At the time most cancer researchers considered T-cell therapy a “fantastical and unrealistic thing to do,” Pule recalls. It was “cumbersome and seemed a lot less feasible than treating patients with cancer-fighting antibodies.” Fast-forward to 2014 and immunotherapy is one of the most promising, novel ways to treat cancer to emerge in over a decade.

Pule’s career path is typical of many scientists working at the crossroads of immunology, gene therapy, and cancer. Trained in medicine, his research focus came from a coalescing of chance decisions with the march of scientific progress. While Pule largely acquired his varied expertise along the way, interdisciplinary training is the catch phrase for scientists entering emerging fields of cancer research today.

“There’s a strong perceived need among cancer research funding bodies that new modes of education and skill sets are necessary,” says Bennett Goldberg, director of Boston University’s (BU) Center for Nanoscience and Nanobiotechnology, an interdisciplinary center that brings together academic and industrial scientists and engineers to develop nanotechnology applications in biomedicine.

“There’s been a huge push over the past five years to apply more physical science and engineering to biomedicine in general.”

—Bennet Goldberg

**IMMUNOTHERAPY**

Scientists have tried for decades to coax the body’s immune system to stamp out cancer cells but have had little clinical success. After years of setbacks, promising results finally began flowing out of clinical trials a few years ago with a therapy that uses chimeric antigen receptors (CAR)—receptors engineered to recognize specific targets on cancer cells.

CARs typically contain a portion of a monoclonal antibody, which recognizes a specific tumor antigen, and are linked to signaling molecules inside the T cell. To use these receptors as a therapy, T cells must first be isolated from a patient’s blood and engineered ex vivo using gene-therapy vectors. Once returned to the patient, the T cells recognize and bind to target antigens on cancer cells, stimulating the signaling molecules that in turn instruct the T cell to activate, divide, and attack cancer cells.

Recently, stunning clinical trial results showing that CAR therapy could help dramatically shrink tumors in patients who had failed to respond to conventional treatments led to cancer immunotherapy being dubbed Science’s “Breakthrough of the Year” in December 2013 (news.sciencemag.org/breakthrough-of-the-year-2013).

The excitement isn’t restricted to the scientific community; industry continues>
is also on board. In December, The Fred Hutchinson Cancer Research Center, MSKCC, along with pediatric partner Seattle Children’s Research Institute teamed up to form Juno Therapeutics, a Seattle-based biotechnology company aiming to develop novel cancer immunotherapies. Juno was launched with an initial investment of $120 million—one of the largest pots of seed funding for a biotech startup in history. Juno’s incarnation followed Novartis’ 2012 exclusive global collaboration agreement with the University of Pennsylvania to research, develop, and commercialize targeted CAR immunotherapies to treat different types of cancer.

“T-cell engineering has gone from being something of a cottage industry with a small group of investigators tinkering along to a field that has completely exploded,” says Pule.

After Baylor, Pule returned to Europe to finish his clinical training and to set up his own lab at University College London (UCL), where he is now a clinician scientist in the UCL Cancer Institute’s Department of Hematology. Pule’s lab is coordinating the Advanced T-cell Engineered for Cancer Therapy (ATECT) consortium—a €6 million ($8.13 million) five-year research collaboration funded by the European Commission that is aimed at improving CAR therapy.

Most T-cell engineering approaches are designed to simply introduce genes into cells using viral vectors, Pule explains. But ATECT scientists have combined viral vector technology with a proprietary genome-engineering tool developed by Paris, France-based Cellectis, an ATECT partner, called transcription activator-like effector nuclease (TALENs), enabling them to also disrupt or delete genes. Using this gene editing technology, researchers have the potential to disrupt the genes that cause a patient’s body to attack or reject donated T cells.

Currently, to avoid immune system rejection, CART cells are made for each patient individually using their own cells. An “off the shelf” T-cell cancer therapy, however, would eliminate the need to personalize each treatment. It would also enable CAR therapy to be mass-produced and would greatly facilitate access to what remains a highly complex experimental therapy. Cellectis is currently developing several off-the-shelf CART-T cell products.

For job seekers, the immunotherapy’s success means opportunities. “The easiest way to get into this field now would be to land a position in one of centers that are doing this kind of work,” says Pule. “A wide range of people are needed.” Among them are molecular biologists and protein engineers who make the receptors, immunologists who do the in vitro and preclinical research, virologists who make the viral vectors, and skilled specialists who can manufacture vectors and cells according to Good Manufacturing Practice guidelines. That said, “a lot of know-how and skills are just learned on the job,” he adds.

Seth A. Ettenberg, head of biology for oncology at Novartis Institutes for Biomedical Research in Cambridge, Massachusetts, agrees. Ettenberg is in the process of assembling a team of scientists to interface with researchers at the University of Pennsylvania with whom the company is co-developing CAR immunotherapies. “The main question that we ask job applicants is: ‘Do you have a story to tell?’” In hiring early career scientists, Novartis looks for candidates who

have demonstrated that they ask big picture questions and do rigorous hypothesis-driven research, he says. Ideally, job candidates will also have published in a top journal, he adds, although this criterion generally extends across all areas of the company. A more unique skill required for the cancer immunotherapy group is the ability for intense teamwork. Because cell-based therapies are still experimental, Novartis has immunologists and cell manufacturing specialists working side-by-side. This differs from their development process for small molecules and antibody-based drugs, where manufacturing practices are well understood, says Ettenberg. Therefore, a candidate’s communication skills are of the utmost importance.

Novartis’ hiring managers typically speak to candidates several times over the phone before inviting them to give a presentation. The presentation can make or break a person’s prospects, Ettenberg adds. “We really look at how well thought out the presentation is and how they handle questions. Are they dismissive, aloof, do they say ‘I don’t know’ when they really don’t know?” If it goes well, candidates are then invited for a full day of interviews. For senior scientists, interdisciplinary training is important for the tasks they will be required to do. For creative and excited scientists just starting out, however, there are many skills one can learn on the job, Ettenberg says.

**NANOTECHNOLOGY**

Engineered T cells aren’t the only emerging technology promising to transform cancer treatment. Nanotechnology—the science of manipulating matter at the nanoscale to create devices with novel chemical, physical, and biological properties—also has the potential to radically change how cancer is diagnosed and treated. From new imaging agents to new modes of drug delivery, “cancer nanomedicine” is another exploding field of cancer research.

NCI recognized the potential of nanotechnology to improve cancer treatment and detection as early as 2004 when it formed the NCI Alliance for Nanotechnology in Cancer. In addition to several other nanotechnology projects, NCI Alliance currently supports nine centers of cancer nanotechnology excellence, six cancer nanotechnology training programs, and 12 cancer nanotechnology platform research partnerships aimed at addressing major barriers and fundamental questions in cancer.

At the Koch Institute for Integrative Cancer Research, a recipient of NCI Alliance grant money, Angela Belcher, works on improving nano-based imaging of cancerous tissue. Current practices employ computed tomography, magnetic resonance imaging, or ultrasound to image soft tissues. Belcher’s lab is trying to develop a less expensive method that will enable smaller tumors to be imaged at greater tissue depths than is currently possible with these technologies. Her approach uses genetically modified bacteriophages that bind specific cancer cell receptors and that carry a single carbon nanotube which fluoresces when exposed to near-infrared light. Her team has already demonstrated that the technique enables imaging of tissues as deep as 3 cm in animals, but should be able to image up to 10 cm, she says.

“Angie is a very good example of the type of people we like to have working here,” says Tyler Jacks, director of the Koch Institute. “She has a deep background in materials science but is working at the convergence of life science and engineering.”

Belcher, who has a joint appointment at the MIT Department of Materials Science and Biological Engineering, is a materials chemist by training. She accepted the joint appointment two and a half years ago after she collaborated on a cancer-related project with MIT biomedical engineer Bob Langer. At the Koch Institute, her task is to use engineering to solve challenges facing cancer researchers. The interdisciplinary environment at Koch is a good fit for her, says Belcher since she has had interdisciplinary training from early on—she designed her own major as an undergraduate at the University of California, Santa Barbara. “I’ve always asked the question: What are different disciplines are helpful for addressing the problem you want to solve?” she explains.
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- Management and coordination of strategic collaborations with either academic or industry partners

**Your qualifications**
- University degree in biology, biochemistry, or pharmacy with a PhD in the area of oncology or pharmacology
- Professional experience in oncology or a related discipline, ideally with a focus on cancer immunotherapy
- Expertise in translational research and drug discovery, experience in an industrial environment would be an advantage
- Excellent proficiency in spoken and written English, basic knowledge of German language is helpful

**Research Scientists Oncogenic Signaling, Tumor Metabolism and Tumor Immunotherapy (m/f)**

Reference Code: 0000085163

**Job description**
- Characterize novel drug candidates as potential treatment option for oncology patients
- Establish state of the art in vitro assays to characterize the mode of action of drug candidates and use them in the characterization, optimization and selection processes
- Establish innovative animal models for the detailed evaluation of lead and development candidates
- Scientific planning, evaluation, interpretation and presentation of experimental studies, collaboration in interdisciplinary project groups and with external partners

**Your qualifications**
- MD or a university degree in biology, biochemistry, pharmacy or veterinary medicine with a PhD in the field of oncology, veterinary sciences or pharmacology
- Very good knowledge, and strong hands-on experience, in the field of in vitro pharmacology and the performance of tumor experiments in vivo
- Several years of professional experience in the field of oncology or related discipline, preferably in an industrial setting
- Knowledge and expertise especially in the areas of oncogenic signal transduction, tumor metabolism or tumor immunotherapy would be an advantage
- Excellent proficiency in spoken and written English, basic knowledge of German language is helpful

**Your application**

We offer a competitive salary in an international environment as well as excellent opportunities for professional and personal development. If your background and personal experience fits this profile, please send us your complete application at www.career.bayer.de, submitting a cover letter, your CV and references.

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Daniel Heller, on the other hand, came to cancer nanomedicine with a background almost exclusively steeped in physical science. Heller came to the Molecular Pharmacology and Chemistry Program at MSKCC after finishing his Ph.D. in chemistry at the University of Illinois at Urbana-Champaign. Except for a brief stint as a postdoc in Bob Langer’s lab at MIT, he had never worked in biomedicine.

Heller landed at MSKCC almost by accident. While at MIT, he met his future MSKCC head, who suggested that he apply for a job, at a meeting. “I had no idea that Sloan Kettering was even an option,” recalls Heller, who had had been applying exclusively to universities. In retrospect, “not only is it the best place for me, but it is probably the best place for a lot of people who don’t even know it,” he says.

The reason: need. In most engineering departments “there are a lot of people making hammers, but there aren’t a lot of nails nearby,” explains Heller. “Now, I’m in a place where there are a lot of nails, and I’m one of a few hammers. That’s an exceptional position to be in.”

At MSKCC, Heller focuses on developing nanoscale molecular sensors and targeted therapeutics. For example, his team is currently making optical sensors from carbon nanotubes in order to quantify metabolite levels in living cells—a tool that has no existing counterpart. Indeed most of the projects in his lab involve creating tools that enable scientists to study what had not been previously possible because the technology was nonexistent. In coming up with project ideas, Heller has found that the ability to have on-going dialogues with cancer clinicians who also work on site makes it easier for him to understand the problems he is tasked with solving.

Heller’s lab consists of a hodge-podge of expertise, including physicists, chemists, and biologists. This type of interdisciplinary team often poses language barriers at first, but these can break down over time through working together. Teamwork is key, he says. “You can’t be too introverted.” For scientists working in any discipline and looking for a job in cancer research, there are opportunities in areas and places that are not obvious. “Talk to people and look at alternative places to work that are far outside of your field,” advises Heller.

**EPIGENETICS**

Interventions that alter the epigenome of cancer cells present yet another novel cancer treatment approach. A cell’s epigenome is a secondary level of genetic modification that does not affect the integrity of genes, but impacts when and where they will be expressed. As with the mutations that change the genetic code, epigenetic abnormalities can also drive cancer. However, unlike genetic mutations, epigenetic changes are reversible, and as such, potentially correctable with therapeutics. There are already four U.S. Food and Drug Administration (FDA)-approved drugs that alter the epigenetic profile of cells to treat cancer and at least 30 more investigational drugs in ongoing cancer clinical trials, according to current data available on clinicaltrials.gov.

At the Gurdon Institute at the University of Cambridge in England, Tony Kouzarides works with two different pharmaceutical companies developing epigenetic drugs to treat cancer. His partnerships with industry came about after a successful collaboration with pharmaceutical giant GlaxoSmithKline (GSK) a few years ago during which he showed that an epigenetic drug the company was developing to treat inflammation was actually active against leukemia cells, specifically mixed-lineage leukemia, the most common form of leukemia in babies. The drug mimics an epigenetic tag in bone marrow cells that prevents leukemia-causing genes from being activated and is now in clinical trials. “We helped [GSK] understand the drug’s mechanism of action,” says Kouzarides, “when the company didn’t have the expertise in this area.”

Kouzarides is a biologist by training, having earned a Ph.D. studying viruses in the Department of Pathology at the University of Cambridge. Over the years, however, he became specialized in cancer genetics. Today his laboratory focuses on the epigenetics of histone proteins, which package DNA, and how epigenetic mechanisms regulate gene expression in cancer cells. The work done in his group today requires a very broad range of skills, he says. For example, if one of his researchers identifies an important cancer-related signaling pathway, they would benefit from a knowledge of chemistry so they can communicate their needs to companies that have libraries of molecules that might target their pathway of interest, explains Kouzarides. They might also have to interact with cancer clinicians as well as generate models of the disease to better understand the pathway.

Kouzarides isn’t suggesting that people interested in working in the field of cancer epigenetics become a “jack of all trades.” In fact, quite the opposite: “everyone has a type of science that they do, and no one can do everything,” he explains. “Certainly having one or two major skills is important, but the rest you can pick up from collaborations.”

BLU’s Goldberg concurs: “You have to have depth in one area to develop scientific acumen,” he says, “since there’s a confidence that comes with depth in one field.” Only then can one go on to develop breadth across several areas, he explains, which is something nanotechnology training programs help to provide.

While epigenetics, cancer nanomedicine, and immunotherapy are important new directions for cancer research, they certainly are not the only ones. The Koch Institute, for example, received NCI funds to establish interdisciplinary training programs in cancer systems biology and a physical sciences oncology center in which network theory and mathematical and computational modeling are being brought to bear on cancer research. To work at the crossroads of any of these areas, “having a very broad perspective is becoming increasingly attractive,” says Jacks.

For Ph.D. graduates in any of the sciences who are interested in cancer research, there are many ways to gain that broad perspective including interdisciplinary fellowships that require students to choose mentors from different disciplines, postdoctoral training programs outside of one’s field, and institutional training programs. According to Jacks, any type of interdisciplinary training is “a good way to position yourself for something that is growing in importance.”

Gunnar Sinha is a freelance writer living in Berlin, Germany.

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The Stephenson Cancer Center at the University of Oklahoma Health Sciences Center invites applications for faculty positions. Rank and tenure eligibility to be commensurate with qualifications and experience. Interested applicants should have a demonstrated record of sustained, peer-reviewed funding and publications, with preference given to active NCI funding.

The Stephenson is Oklahoma’s only academic cancer center. With a well-developed and supportive infrastructure and over 150 members from the University of Oklahoma (OUHSC, OU Norman, OU Tulsa), the Oklahoma Medical Research Foundation and Oklahoma State University, the Stephenson places a high priority on promoting translational research that moves research ideas into clinical applications. Position applicants should have demonstrated research aligned with one of the following four Stephenson research programs (and research foci):

- Basic Cancer Biology (epigenetics / chromatin regulation; tumor microenvironment, tumor-stromal cell interactions; tumor immunology; angiogenesis; metastasis; tumor initiating cells / cancer stem cells)
- Experimental Therapeutics (molecular targeted therapies, gene and drug delivery; nanomedicine; high-throughput drug discovery; cancer imaging; Phase 0 & Phase I trials)
- Gynecologic Cancers (angiogenesis; drug resistance)
- Cancer Health Disparities (special populations, with emphasis in American Indian; health outcomes; tobacco research)

With the support of a recently completed $67 million fundraising campaign and institutional development grants of over $30 million (cancer research) and $5 million (tobacco prevention and control research) from the Oklahoma Tobacco Settlement Endowment Trust, the Stephenson has launched a major initiative to recruit 20 cancer-focused researchers over the next four years. Stephenson Shared Resources include a Biospecimen Acquisition Core and Bank, Molecular Imaging Core, Cancer Functional Genomics Core, Cancer Tissue Pathology Core, Biostatistics Core, Special Populations Core, and Proposal Services Core. The Stephenson has a large clinical trials research program and a rapidly expanding Phase I Program.

Applicants must possess a PhD, MD, or MD/PhD in a relevant discipline and have a demonstrated potential for excellence in research. Selected candidates will have an appointment in an academic department as well as the Stephenson. For additional information, please visit www.stephensoncancercenter.org.

Applicants should provide electronic copies (only) of a cover letter stating area of expertise and qualifications, synopsis of professional goals, research interests, curriculum vitae, and e-mail addresses for three references to CancerResearch@ouhsc.edu.

Confidential enquiries may be addressed to Danny N. Dhanasekaran, PhD, Deputy Director for Basic Research, at danny-dhanasekaran@ouhsc.edu.

The University of Oklahoma is an Equal Opportunity Employer.
TENURE TRACK FACULTY POSITIONS IN CANCER RESEARCH
Case Western Reserve University School of Medicine
Case Comprehensive Cancer Center

The Case Comprehensive Cancer Center (http://cancer.cwru.edu/), a National Cancer Institute-designated Comprehensive Cancer Center at CWRU, with affiliates University Hospitals Case Medical Center and Cleveland Clinic, invites applications for tenure track faculty positions at the level of Assistant and Associate Professor in cancer biology. Candidates should have an MD, PhD, or MD-PhD, post-doctoral research experience, and some faculty experience. Candidates at the Assistant Professor level are encouraged to apply and should provide a record of funding and scholarly activity and the potential to advance in cancer research. Candidates at the Associate Professor level should have a nationally-funded program and an outstanding record of cancer research achievements. We are particularly interested in the following research areas: immunotherapy, cancer cell metabolism, molecular basis of lymphoid malignancies, ovarian or gastrointestinal cancer. Priorities include innovative discovery research coupled with an interest in translational disease-oriented cancer research.

The successful candidate will have a primary appointment in the cancer center or a basic science department at the medical school such as Pathology (http://www.cwru.edu/med/pathology/), Genetics and Genome Sciences (http://genetics.case.edu/), or Pharmacology (http://pharmacology.case.edu/).

Please send curriculum vitae, a list of three or more references, and a cover letter outlining your research interests electronically to: Stanton L. Gerson, MD, Director, Case Comprehensive Cancer Center, cancercaresearch@case.edu. Please include “Cancer Research Faculty Search” in the subject line.

In employment, as in education, Case Western Reserve University is committed to Equal Opportunity and Diversity. Women, veterans, members of underrepresented minority groups, and individuals with disabilities are encouraged to apply.

Case Western Reserve University provides reasonable accommodations to applicants with disabilities. Applicants requiring a reasonable accommodation for any part of the application and hiring process should contact the Office of Inclusion, Diversity and Equal Opportunity at 216-368-8877 to request a reasonable accommodation. Determinations as to granting reasonable accommodations for any applicant will be made on a case-by-case basis.

TENURE TRACK FACULTY POSITION IN CANCER GENETICS
Case Western Reserve University School of Medicine
Case Comprehensive Cancer Center

The Case Comprehensive Cancer Center (http://cancer.cwru.edu/), a NCI-designated Comprehensive Cancer Center, at CWRU, with affiliates University Hospitals Case Medical Center and Cleveland Clinic, invites applications for a tenure track faculty position at the level of Assistant or Associate Professor with a research program in cancer genetics, genomics, statistical genetics, or tumor pharmacogenetics/genomics. Qualified individuals should have an MD, MD-PhD, or PhD. Candidates at the Assistant Professor level should have cancer research experience in the study of genes, genomics, targets, and pathways and in working with human cancer samples with clinical correlates. Candidates at the Associate Professor level should also have a nationally funded program and an outstanding record of cancer research activities.

Successful candidates will be expected to interact closely with ongoing basic and translational research, particularly research using human tissue. Candidates with interests in Gastrointestinal Cancers (colon cancer, esophageal cancer, pancreas cancer) that could align with the Case GI SPORE are particularly encouraged, as are candidates with interests in glioma, breast cancer, ovarian cancer, or hematologic malignancies who would align with cancer center scientific programs. Physician scientists are particularly encouraged to apply. Primary appointment will be in the department of training, the cancer center or the department of Genetics.

Please send curriculum vitae, a list of three or more references, and a cover letter outlining your research interests, electronically to: Stanton L. Gerson, MD, Director, Case Comprehensive Cancer Center, cancercaresearch@case.edu. Please include “Cancer Genetics” in the subject line.

In employment, as in education, Case Western Reserve University is committed to Equal Opportunity and Diversity. Women, veterans, members of underrepresented minority groups, and individuals with disabilities are encouraged to apply.

Case Western Reserve University provides reasonable accommodations to applicants with disabilities. Applicants requiring a reasonable accommodation for any part of the application and hiring process should contact the Office of Inclusion, Diversity and Equal Opportunity at 216-368-8877 to request a reasonable accommodation. Determinations as to granting reasonable accommodations for any applicant will be made on a case-by-case basis.
The Department of Sarcoma Medical Oncology is seeking applicants for an Assistant Professor, term tenured track. This is a faculty position responsible to the chair of the Department of Sarcoma Medical Oncology, who reports to the head of the Division of Cancer Medicine. This researcher/investigator conducts and coordinates original research that will enhance the overall program of the department; provides expertise in the design, conduct and analysis of clinical and laboratory research projects; and designs and executes the analyses of a broad range of biomedical research projects in their respective field. Must be able to work within a context of very intense interpersonal relationship, including physicians, patients and subordinates. A Ph.D. is required. Key functions include:

Education/Teaching:
Provide a balanced and integrated educational program in the design of research projects in a related field. Provide appropriate analytical presentations to medical residents, postdoctoral fellows and students. Attend and participate in division/department teaching and continuing education conferences. Supervise research projects conducted by graduate and undergraduate students.

Research:
Actively engage in translational research and scholarly activity to enhance the academic environment of the department. Develop programs of research and scholarly activities in keeping within the goals of the department. Seek appropriate funding mechanisms to support research; will require budget development and analysis. Contribute to the literature in their field of expertise by publishing original research in peer reviewed journals.

Service:
Represent the department in local, regional, state, national and international matters pertaining to their field of expertise. Coordinate translational activities within the department. Provide appropriate expertise to other principal investigators in the department in the design and analysis of clinical and laboratory research projects. Collaborate with physicians on research protocols incorporating concepts from areas of expertise. Refer to the Department of Sarcoma Medical Oncology Web page for additional information about the department and its programs. Interested applicants should send a copy of their curriculum vitae, references and a research plan describing their academic interests to:

The University of Texas MD Anderson Cancer Center
Sarcoma Medical Oncology, Unit 450
1515 Holcombe Blvd., Houston, TX 77030
713-794-1934
Email: rvidrine@mdanderson.org

Gordon Mills, M.D., Ph.D., Chair
The University of Texas
MD Anderson Cancer Center
Department of Systems Biology, Unit 950
South Campus Research Building II
P.O. Box 301429
Houston, TX 77230-1429
gmills@mdanderson.org

Applications will be accepted until position is filled.
Faculty Positions in Viral Immunopathogenesis at the Vaccine & Gene Therapy Institute of Florida

The Vaccine & Gene Therapy Institute of Florida (VGTI Florida) is seeking to recruit outstanding immunologists/virologists to direct research programs in basic and translational human immunology. Priority areas of research include immunopathogenesis, emerging viral pathogens including influenza and flaviviruses, vaccine development, adjuvants, and inflammation. We are seeking scientific leaders in the areas of molecular virology, immune response to infection and antiviral/vaccine strategies. Priority will be given initially to established investigators with vigorous research programs investigating HIV, influenza, Dengue and emerging viruses. VGTI Florida is one of the internationally recognized research institutes invited to locate to Florida as part of a State-sponsored initiative to enhance biomedical research. Research at VGTI Florida focuses on human innate and adaptive immune responses to infectious diseases and cancer.

Research themes at VGTI Florida include:
- HIV-1 and emerging viral pathogens
- Vaccine development and adjuvants
- Cancer Immunology and immunotherapy
- Inflammation and diseases of aging

VGTI Florida occupies a new 100,000 sq. ft. state-of-the-art facility in Port St. Lucie, FL, located on the sunny Atlantic coast in a Biotech corridor just north of Palm Beach. Successful candidates (PhD and/or MD) will have an established extramurally-funded research program and a strong publication record in one of the priority areas described above. The positions have highly competitive salary and startup packages, with access to cutting edge Genomics, Bioinformatics and Flow Cytometry core facilities as well as BSL3/ABSL3 containment facilities within the Institute. For more information, including a description of the Faculty and their research interests, please visit: www.vgtif.org. Qualified candidates should submit their curriculum vitae, a 2-page description of their proposed research program and the names/contact information of three references to:

Jill Hackett
Executive Director, Human Resources
Vaccine & Gene Therapy Institute of Florida

Applications must be sent via email to: search@vgtif.org. Review of applications will commence immediately and continue until the positions are filled.

VGTI Florida is an Equal Opportunity Institution committed to recruiting, hiring, and promoting qualified minorities, women, individuals with disabilities, and veterans.

Keck School of Medicine of USC

Tenure-track Associate and/or Full Professors at the University of Southern California Norris Comprehensive Cancer Center and Department of Biochemistry and Molecular Biology

The University of Southern California is seeking one or more outstanding cancer research scientists to fill new tenure-track faculty positions at the rank of Associate or Full Professor in the Department of Biochemistry and Molecular Biology at the USC Norris Comprehensive Cancer Center and Keck School of Medicine. Successful candidates should have well-established research programs and be considered leaders in their fields. They will be housed in the USC Norris Comprehensive Cancer Center, one of the longest-standing NCI-designated Comprehensive Cancer Centers, and will perform basic and/or translational cancer-related research that falls within the broad scope of topics covered by the Department of Biochemistry and Molecular Biology. This would include, but is not strictly limited to: biochemistry and molecular biology; genetics and genomics; epigenetics and epigenomics; gene regulation and signal transduction; and cancer-oriented developmental and stem cell biology. Faculty appointments will be made at the Full Professor or Associate Professor rank. Exceptional candidates may be considered at a higher rank, based on their achievements.

To apply, please visit our website at http://jobs.usc.edu/postings/18085 and submit a single PDF file containing the following information by June 1, 2014: a cover letter, Curriculum Vitae, 1-page statement of future research plans, and names and contact information of 3 references.

USC values diversity and is committed to equal opportunity in employment. Women and men, and members of all racial and ethnic groups are encouraged to apply.
Chair in Inflammation  
Princess Margaret Cancer Centre  

Princess Margaret Cancer Centre and the Arthritis and Autoimmunity Research Centre (AARC) at the University Health Network in Toronto, invite highly productive individuals to apply for the position of Scotiabank Chair in Inflammation Research at either the Scientist or Senior Scientist level.

Research interests focused on inflammation pertaining to tumor biology and/or autoimmunity are encouraged. Applicants must have an M.D. and/or Ph.D. degree(s) and a proven track record, as evidenced by a number of high impact publications. The successful candidate will be expected to establish an original, competitive and independently funded research program, and to have a commitment to education in immunology.

Princess Margaret Cancer Centre is the largest centre for cancer research in Canada covering the full spectrum of applied and fundamental research. The AARC is the most comprehensive research centre for autoimmune diseases in Canada, combining clinical and applied studies with basic science research. The downtown location provides an extraordinarily rich scientific environment, adjacent to other major academic institutions including the University of Toronto St. George campus, the Toronto General Research Institute, the Hospital for Sick Children, the Samuel Lunenfeld Research Institute, the Toronto Western Research Institute, and the Ontario Institute for Cancer Research.

The successful applicant will receive full salary commensurate with the position and a generous start up package. Applicants will also be eligible for appointment at the Associate or Full Professor level in the Department of Immunology at the University of Toronto.

Interested candidates should send their CV and a 2 page description of research interests to:

**Inflammation Chair Search Committee,**  
Princess Margaret Cancer Centre  
620 University Ave  
Toronto ON M5G 2M9  
cwells@uhnresearch.ca

This search will remain open until a suitable candidate is identified.

*The Princess Margaret Cancer Centre is the Research Institute of Princess Margaret Hospital, which, along with the AARC, Toronto General Hospital, Toronto Western Hospital and Toronto Rehabilitation Institute are members of the University Health Network, an Equal Opportunity Employer.*

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**AAAS is here – promoting universal science literacy.**

In 1985, AAAS founded Project 2061 with the goal of helping all Americans become literate in science, mathematics, and technology. With its landmark publications *Science for All Americans* and * Benchmarks for Science Literacy*, Project 2061 set out recommendations for what all students should know and be able to do in science, mathematics, and technology by the time they graduate from high school. Today, many of the state standards in the United States have drawn their content from Project 2061.

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DR. SHIRLEY MALCOM

To Dr. Shirley Malcom, born and raised in the segregated South more than 65 years ago, a career based on her studies in science seemed even less likely than the launch of the Soviet’s Sputnik. But with Sputnik's success, the Space Race officially started and, in an instant, brought a laser-like focus to science education and ways to deliver a proper response. Not long after, Dr. Malcom entered the picture.

Although black schools at the time received fewer dollars per student and did not have sufficient resources to maintain their labs at a level equivalent to the white schools, Dr. Malcom found her way to the University of Washington where she succeeded in obtaining a B.S. in spite of the difficulties of being an African American woman in the field of science. From there she went on to earn a Ph.D. in ecology from Penn State and held a faculty position at the University of North Carolina, Wilmington.

Dr. Malcom has served at the AAAS in multiple capacities, and is presently Head of the Directorate for Education and Human Resources Programs. Nominated by President Clinton to the National Science Board, she also held a position on his Committee of Advisors on Science and Technology. She is currently a member of the Caltech Board of Trustees, a Regent of Morgan State University, and co-chair of the Gender Advisory Board of the UN Commission on Science and Technology for Development. She has held numerous other positions of distinction and is the principal author of The Double Bind: The Price of Being a Minority Woman in Science.

Of her active career in science, Dr. Malcom says, “I guess I have become a poster child for taking one's science background and using that in many other ways: we ask questions; we try to understand what we find; we consider what evidence we would need to confirm or refute hypotheses. And that happens in whatever setting one finds oneself.”

At Science we are here to help you in your own scientific career with expert career advice, forums, job postings, and more — all for free. Visit Science today at ScienceCareers.org.
The University of Texas Southwestern Medical Center is seeking outstanding candidates interested in becoming the next Chair of the Department of Physiology. Applicants should have an exceptional record of research achievement in areas relevant to modern physiology, as well as broad vision and strong leadership skills. Resources commensurate with these qualifications will be made available to the successful candidate. The Department occupies new laboratory space and has existing strengths in multiple areas of physiological research.

Qualified candidates are encouraged to submit a curriculum vitae to the chair of the search committee, Dr. Eric N. Olson, via email at: eric.olson@utsouthwestern.edu

UT Southwestern Medical Center is an Affirmative Action/Equal Opportunity Employer. Women, minorities, veterans and individuals with disabilities are encouraged to apply.

The Aaron Diamond AIDS Research Center (ADARC), the world’s largest private HIV/AIDS medical research facility, is seeking candidates for the position of Chief Executive Officer and Scientific Director.

The successful candidate must be of high scientific caliber in the field of HIV research and have led a successful independent research program in an academic or industry-related environment. In addition, s/he must have the standing to be appointed to the position of Head of Lab at Rockefeller University. The candidate must also have experience or demonstrated ability to manage substantial resources, scientific and administrative staff and in leading fundraising efforts.

The major responsibilities of the Chief Executive Officer and Scientific Director will be to work with:
• The Board of Directors and its Committees in the overall administration of ADARC. S/He will assure corporate governance, develop policies, create short and long-term plans and assume the lead for implementation and follow-up.
• The External Scientific Advisory Board (SAB) to evaluate the scientific progress of ADARC’s Staff Investigators and strategize on the future scientific direction and growth of the organization.
• ADARC Faculty to provide guidance on individual scientific programs, help to secure program stability and funding.
• Senior Management, by delegating responsibilities appropriately to guarantee the accountability of ADARC to its diverse constituents and to oversee administrative and financial activities to ensure a smooth functioning, efficient and financially secure organization. S/He will have final executive decision-making authority for operation of the Center.

Application: Those interested should initiate the application process by sending a cover letter detailing previous experience and reasons for interest in the position, a curriculum vitae, and the names and contact information of 5 professional references. Direct all inquiries and applications to HR@adarc.org with the identifier ‘Chief Executive Officer/Scientific Director’ in the subject line.

ADARC is an Equal Opportunity Employer and will not discriminate against any employee or applicant on the basis of age, color, disability, gender, national origin, race, religion, sexual orientation, veteran status, or any classification protected by federal, state, or local law. Consistent with its obligations under federal law, each company that is a federal contractor or subcontractor is committed to taking affirmative action to employ and advance in employment qualified women, minorities, disabled individuals, special disabled veterans, veterans of the Vietnam era, and other eligible veterans. ADARC is a smoke-free and drug-free environment.
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Every month, over 400,000 students and scientists visit ScienceCareers.org in search of the information, advice, and opportunities they need to take the next step in their careers.

A complete career resource, free to the public, Science Careers offers a suite of tools and services developed specifically for scientists. With hundreds of career development articles, webinars and downloadable booklets filled with practical advice, a community forum providing answers to career questions, and thousands of job listings in academia, government, and industry, Science Careers has helped countless individuals prepare themselves for successful careers.

As a AAAS member, your dues help AAAS make this service freely available to the scientific community. If you're not a member, join us. Together we can make a difference.

To learn more, visit aaas.org/plusyou/sciencecareers
The University of Konstanz with its »Institutional Strategy to promote Top-Level Research« has been receiving continuous funding since 2007 within the framework of the Excellence Initiative by the German Federal and State Governments.

The Faculty of Sciences, Department of Chemistry, seeks to fill a 

**W1-Professorship of Magnetic resonance spectroscopy of complex molecular systems**

to be filled as soon as possible.

The research focus of the professorship within nuclear magnetic resonance spectroscopy is in the area of investigations of bio molecules and should complement the research activities of the Department of Chemistry. It should further strengthen and deepen the existing cooperation with the neighbouring disciplines and strengthen the collaborations with the Department of Biology.

Further information (reference number 2014/057) please visit our homepage: [http://www.uni-konstanz.de](http://www.uni-konstanz.de) or by contacting Mr. Hanns Fahlbusch, e-mail: Hanns.Fahlbusch@uni-konstanz.de or by phone: +49 (0) 7531/88-2413.

Applications comprising a cover letter, curriculum vitae, publication list, a list of grants and awards, details of teaching experience, as well as statements of current research topics, future research directions and interests, copies of academic degrees (see pdf-link below) should be sent electronically until 30. April 2014 formatted into one pdf-file to: Prof-2014-057@uni-konstanz.de.

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**Young Group Leader Positions In Stem Cell Biology**

The Institut Pasteur (Paris, France) announces an international call for candidates wishing to establish independent research groups. As part of the Revive Laboratory of Excellence programme on “Stem Cells and Regenerative Biology and Medicine” ([www.pasteur.fr/revive](http://www.pasteur.fr/revive)), candidates will be integrated into the cutting edge interdisciplinary environment provided by the Department of Developmental & Stem Cell Biology. Candidates specializing in the field of stem cells in the context of developmental and cell biology, genetics, epigenetics, regeneration, translational research and ageing are encouraged to apply.

To be eligible, candidates must have defended their PhD on or after May 31, 2006 (women with children are eligible up to 11 yrs after their PhD). Successful candidates will be appointed as head of a group of up to 6 people for a period of 5 years. The budget (up to €1,500,000 over 5 years) includes the salary for the group leader, a three-year postdoctoral position, a technician’s position, part-time secretarial assistance, a substantial contribution to running costs and equipment, and access to on-campus facilities including state-of-the-art technology core facilities. Candidates should send their formal applications by E-mail to the Director of Scientific Evaluation, Prof. Alain Israel, at the Institut Pasteur (gSrevive@pasteur.fr); the application deadline is May 31, 2014.

Short-listed candidates will be contacted for interview in early September 2014 and recruitment decisions announced by October 2014.

Applicants should provide the following (in order) in a single pdf file:

1. A brief introductory letter of motivation, including the name of the proposed group. Candidates are encouraged to contact the coordinator of the Revive programme Shahragim Tajbaksh (shaht@pasteur.fr).
2. A Curriculum Vitae and a full publication list.
3. A description of past and present research activities (up to 5 pages with 1.5 spacing; Times 11 or Arial 10 font size).
4. The proposed research project (up to 10 pages with 1.5 spacing; Times 11 or Arial 10 font size).
5. The names of 3 scientists from whom letters of recommendation can be sought, together with the names of scientists with a potential conflict of interest from whom evaluations should not be requested.
POSITIONS OPEN

ASSISTANT PROFESSOR
Immunology and Microbiology

The Department of Microbiology/Immunology at A.T. Still University invites applications for a 12-month, tenure-track position available after July 1, 2014. The successful candidate must demonstrate strong potential to develop an independent research program in an area of immunology or medical microbiology, and be an innovative educator for medical and dental students at our Kirksville, Missouri campus. Applicants must have a doctorate degree and significant postdoctoral research experience. Position details are described at website: http://www.hrjobs.org/kcom-assistant-professor-microbiology-and-immunology/job/4433238. Send letter of application, curriculum vitae with research interests, and contact information for three references to: Neil Sargentini, Ph.D., Department Chair, e-mail: nsargentini@atsu.edu. ATSU is an Equal Opportunity Employer and does not discriminate on the basis of race, color, religion, national origin, sex, gender, sexual orientation, age, or disability.

FOREST GENETICS RESEARCH LEADER

The Washington State Department of Natural Resources is seeking candidates in the fields of molecular genetics, microbiology, mycology, dendrology, or related field to fill a new research position. This position will serve as an expert in the field of forest genetics, independently performing original scientific research to improve the health and productivity of native conifer trees. The position resides in Olympia, Washington, monthly salary up to $8,167 (depending on qualifications), benefits package, and potential moving expense allowance. For information call telephone: 360-902-1228 or go to our jobsite at website: http://www.dnr.wa.gov/AboutDNR/Employment/Pages/Home.aspx scroll down to Forest Genetics Research Leader announcement.

FACULTY POSITIONS - MEDICAL SCHOOL

The Saint James School of Medicine, an international medical school (website: http://www.sjsm.org), invites applications from candidates with teaching and/or research experience in any of the basic medical sciences for its Caribbean campuses. Faculty positions are currently available in Pathology, Genetics, Neuroscience, and Biochemistry. Applicants must be M.D., and/or Ph.D. Teaching experience in the U.S. system is desirable but not required. Retired persons are encouraged to apply. Attractive salary and benefits. Submit curriculum vitae to e-mail: jobs@mail.sjsm.org or mail to: HRD& Inc., 1480 Renaissance Drive, Suite 300, Park Ridge, IL 60068.

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