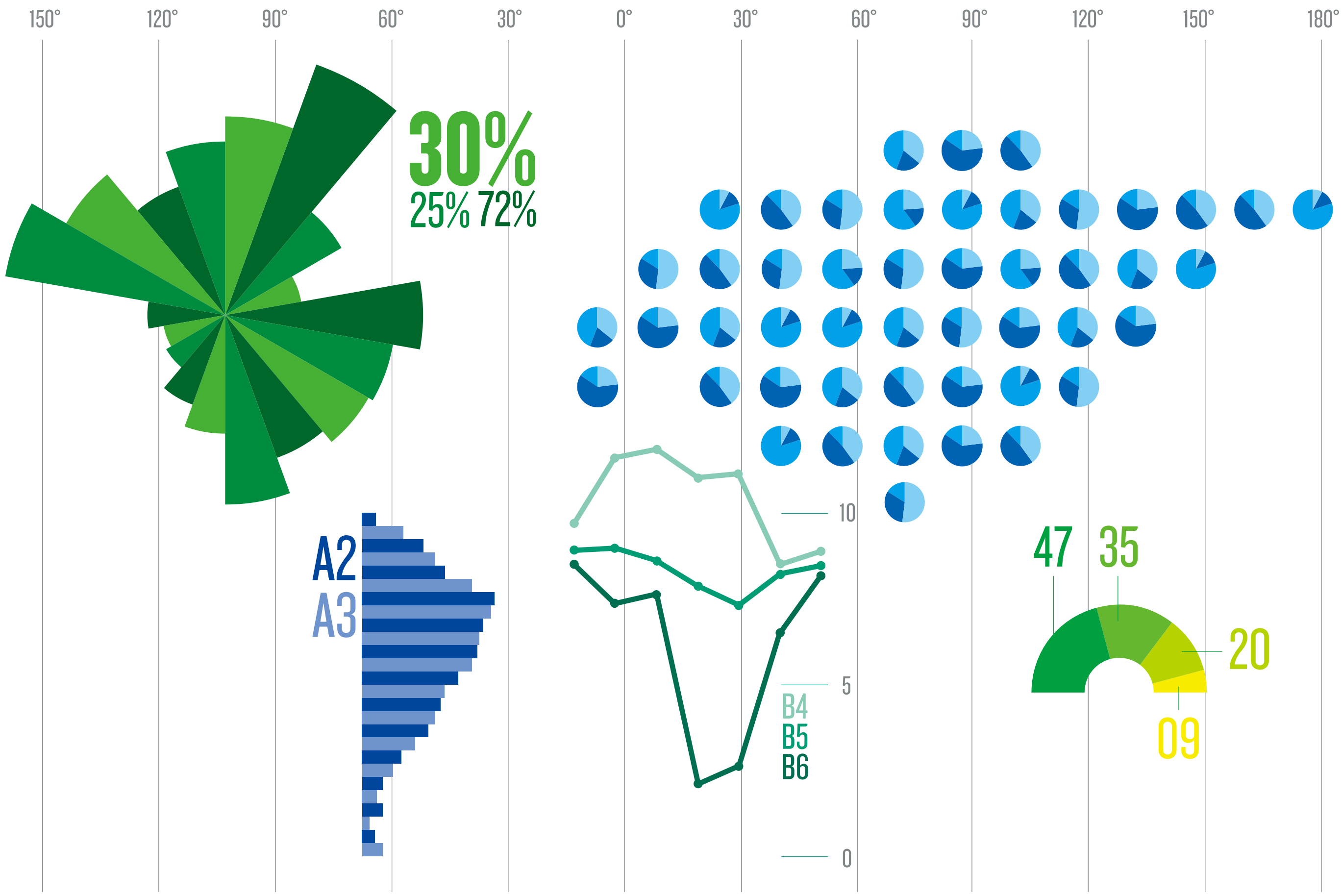
nature INDEX 2014

GLOBAL



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Jacobs Medical Center, scheduled to open in 2016, will house 245 patient beds and include three specialized hospitals that represent the future of patient care in the region. The facility will be the anchor of the La Jolla medical campus of UC San Diego Health System.

Steffanie Strathdee, Ph.D.

Adah Almutairi, Ph.D.

Lawrence Goldstein, Ph.D.

Grassroots Global Health

Fighting HIV and sexually transmitted infections means hitting the streets. **Steffanie Strathdee, Ph.D.**, mobilizes binational collaborations and students to reach out to drug users and sex workers on the Mexico-U.S. border. Her work with these underserved and marginalized populations, local police, federal authorities and nongovernmental organizations provides critical information for public policy.

Exploring the Frontier of Drug Delivery

Adah Almutairi, Ph.D., directs the Center for Excellence in Nanomedicine and Engineering. Researchers in the center are creating nanoparticles that promise new levels of precision in treating disease. They will be able to deliver drugs under highly specific conditions—when triggered by light or when they encounter a disease-related condition.

Tackling Alzheimer's With Stem Cells

Lawrence Goldstein, Ph.D., director of the new Sanford Stem Cell Clinical Center and scientific director of the Sanford Consortium for Regenerative Medicine, has created, for the first time, stem cell-derived models of sporadic and hereditary Alzheimer's disease using induced pluripotent stem cells from patients with AD. These functional neurons in a dish promise to be an unprecedented tool for developing and testing drugs to treat patients.

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2012–13 U.S. News & World Report "America's Best Hospitals" issue

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nature INDEX 2014

GLOBAL

NATURE, VOL. 515, NO. 7526 (13 NOVEMBER 2014)

COVER ART: JASIEK KRZYSZTOFIAK

This first edition of the Nature Index 2014 Global supplement provides a snapshot of results from the new Nature Index. In this supplement, we turn a spotlight on the countries and institutions around the world that contributed to some of the highest quality research over the previous calendar year.

The Nature Index provides a new way to look at the scientific literature — and to those research organizations that contribute to it. By looking at articles from only a small group of journals, most favoured by the scientific community as a place to publish their best research, we hope to provide a new level of analysis that is more targeted and hence more malleable. We want users to be able to tease out patterns of research, look at trends, analyse individual strengths, and investigate how institutions and countries collaborate. The story behind the Nature Index is outlined on page S52.

In this supplement, our analysis includes layers of information from other data sources, for example demographics, national spend on research and development, changes to science policy and funding, and even altmetrics (online and social media coverage), which help put the Nature Index data into perspective. The top level, global results can be seen on page S56.

Drilling down by region (starting with North America on page S60), we highlight the most interesting patterns in research output in this snapshot of the Nature Index. Within each region, we try to identify national hotspots for high-quality research, based not just on output quantity but also on a range of indicators — for example, the number of researchers and the ratio of collaborators — that help put the data in context and allow a more nuanced view of these patterns.

Focusing down further, we look at some of the notable institutions in each country, and use the Nature Index data to compare and contrast between them, aiming to tease out specific institutional strengths.

Above all, our hope is that this supplement, rather than providing some authoritative analysis, will act as a conversation starter and a nucleation point for ideas for further analysis. Every reader of this supplement and user of natureindex.com will have their own specific interests and questions they want to address. We encourage use of the freely-available data to do just that. And we hope the conversation we have started here will prove useful for researchers, institutions, analysts and policy-makers alike.

Nick Campbell
Executive Editor, Nature

Michelle Grayson
Senior Editor, Nature Supplements

CONTENTS

NATURE INDEX 2014 GLOBAL
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KEIO UNIVERSITY

IGNITING JAPANESE SOCIAL INNOVATION

Keio university is the oldest and one of the most prestigious universities in Japan, with a history that dates back more than 150 years. Located in the heart of Tokyo, Keio is a forward-looking, progressive institution founded on principles of scientific realism and Western philosophy, and is focused on enhancing the globalization of education in Japan.

Keio was founded by Yukichi Fukuzawa (1835–1901), an educator and intellectual leader who is considered a pioneer of modern Japan. Fukuzawa was born to a samurai family during the final years of the Edo period. He founded Keio Gijuku in 1858, as a school for Western learning in Edo, today's Tokyo. Keio Gijuku was characterized by its tenets of self-respect and independence of mind combined with an emphasis on *jitsugaku* (science). The school began offering university education in 1890, setting up its first departments in literature, economics and law, and has since continued to establish a firm reputation as a leading university in Japan. Indeed, Keio has a long history of attracting some of the world's brightest minds. For example, in 1922, the year after he won the Nobel Prize in Physics, Albert Einstein visited the university to deliver a five-hour speech, his first in Japan, in front of an audience of over 2,000 people.

Fukuzawa believed the best way for Japan to catch up with Western technology and social systems was to always strive for progress and enlightenment, and provide the academic and moral education needed to create a generation of wise and capable leaders. Graduates of Keio include prominent leaders and historical figures in all walks of life, including former prime minister, Junichiro Koizumi, and highly regarded people in the Japanese business world such as Toyota Motor Corp's incumbent chief executive officer, Akio Toyoda. Notable astronauts, writers, scientists, intellectuals and artists also number among Keio alumni.

This is also reflected by Keio's 9th place ranking in the *Times Higher Education* Alma Mater Index: Global Executives in 2013. The index ranks institutions by the number of degrees they have awarded to CEOs of Fortune Global 500 companies.

Thinking for oneself, taking responsibility for one's actions and *jitsugaku* (science)

Handwritten manuscripts and letters by Albert Einstein donated to Keio University.

Keio University

1858

CALAMVS GLADIO FORTIOR

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2-15-45 Mita, Minato-ku,
Tokyo 108-8345

Visit: www.keio.ac.jp

are basic principles held dear by Fukuzawa that Keio continues to uphold to this day. Fukuzawa emphasized the importance of freedom, equality and lifelong learning. He noted, "Heaven does not create one man above or below another man." Fukuzawa is honoured on the 10,000 yen note, Japan's highest denomination.

APPLYING *JITSUGAKU* (SCIENCE) TO SOLVE GLOBAL PROBLEMS

Keio is a comprehensive higher education institution located on six campuses across the greater Tokyo area. It has 10 undergraduate faculties, 14 graduate schools and approximately 30 research centres and institutes, including a university hospital. The institution's affiliates include two primary schools, three junior high schools, and five high schools, including one in New York. Keio is a unique academic entity that offers lifelong education. Keio has partnerships which include 266 overseas institutions and 9 international organizations in 41 countries. Partner universities include Harvard Medical School, Columbia University, Stanford University, the University of Oxford, and the University of London. International organization partnerships include the Asian Development Bank, the International Bank for Reconstruction and Development and UNESCO.

> "Keio University continues to make intellectual contributions to Japan and the world to create such affluent ageing societies."

Drawing on its vast research expertise, Keio is now focused on solving challenges in order to realize a prosperous super-mature society. This includes finding ways to promote a sustainable society while nurturing the next generation and maintaining the health of those in the prime of life and beyond.

"Today, Japan has the world's highest longevity rate. If we can establish our country as a model for a vibrant and prosperous ageing society, it means that we can set a precedent for other countries that are also greying. Keio University continues to make intellectual contributions to Japan and the world to create such affluent ageing societies," says Keio University President Atsushi Seike.

In recognition of its strengths in research and education, Keio University was recently selected by Japan's Ministry of Education, Culture, Sports, Science and Technology as one of the 13 top Japanese universities in the 2014 Top Global University Project. This 10-year grant will further strengthen Keio's capacity to promote research and education in various important fields.

Under the Top Global University Project, Keio will set up three clusters focusing on Longevity, Security, and Creativity, which will all contribute to its goal of attaining sustainable development of a super-mature society. These three multidisciplinary clusters will draw on Keio's unique heritage of innovation and *jitsugaku* (science), and harness the power of the university's strong network of collaborations with industry, academia and international organizations.

For example, the Longevity Cluster will focus on developing innovative solutions to the problems posed by ageing societies. It will adopt a three-pronged holistic approach that will involve considering health matters, sociopolitical issues and technological solutions; examples of each of these aspects include the development of regenerative medicine based on stem cell technology, research into the politics of ageing societies, and the use of robots to undertake nursing duties, respectively.

In the Security Cluster, Keio researchers will explore security issues relating to social, economic and geopolitical risks. Such security issues include global pollution, cyber security in financial markets and regional security in East Asia.

Professor Atsushi Seike, president of Keio University.

Meanwhile, researchers in the Creativity Cluster will investigate telecommunication and analytical technologies as well as new materials such as plastic optical fibres. In addition, they will investigate new forms of expression in new media and participate in inter-university consortia such as the Global Innovation Design programme. Finally, Keio Business School, the first in Japan to be accredited by the Association to Advance Collegiate Schools of Business, will undertake research on topics that include value creation through outstanding marketing and human resource management.

By consistently emphasizing the philosophy of *jitsugaku* (science), Keio will continue to provide leadership for the future through its commitment to education, research and medicine. Its progressive environment helps students and researchers in their pursuit of excellence, both as researchers and as individuals, and enriches global society.

Introducing the index

The Nature Index allows us to track contributions by countries and by research institutions — academic, government and commercial — to selective scientific journals, independently chosen by active scientists. Analysis of this database provides insight into global hotspots for high-quality research.

The aim of the Nature Index is to provide an indicator of patterns of high-quality research output across the globe. At its core are 68 journals, independently chosen by researchers as being where they would want to publish their most significant research. We identify author affiliations on each paper, as well as tease out the relationships between research organizations, to allow us to track scientific output for institutions and countries. Snapshot data from the Nature Index are openly available under a Creative Commons licence, so that users can analyse scientific research outputs themselves.

The group of journals at the heart of the Nature Index is chosen under the following fundamental principles:

· The journals included are selected by a panel of active scientists, independently of the Nature Publishing Group.

· The choices reflect researchers' perception of the journals' content, rather than measures such as impact factor.

We believe that, at the time of selection, the list amounts to a reasonably consensual, upper echelon of journals in the natural sciences. It includes some of the most highly selective journals within the main disciplines of the natural sciences as well as highly selective multidisciplinary journals.

The list of 68 journals used in this initial version of the Nature Index was compiled in 2011. The journals included, and their number, will be reviewed before the next edition.

JOURNAL SELECTION

We gave prime responsibility for the selection of journals to two panels of scientists, one drawn from the physical sciences, the other from the life sciences — each headed by a chairperson. Preliminary suggestions for the chairs of the panels were made by the editorial staff of *Nature* who are involved in the peer review and selection of submitted research papers. The Editor-in-Chief of *Nature* signed off on the choice of chairs:

Chair of Physical Sciences Panel: John Morton, then at the University of Oxford, now at the London Centre for Nanotechnology and Department of Electronic and Electrical Engineering, University College London

Chair of Life Sciences Panel: Yin-Biao Sun, Randall Division of Cell and Molecular Biophysics, Kings College London

At the chairs' request, an initial list of panel members was proposed by the editorial staff of Nature journals. The criteria for panel members were: they be established and fully active in research (therefore more likely to be mid-career than late-career); they should be drawn from the main disciplines of natural science; they should represent all active science regions worldwide; and there should be a gender balance.

> "WE HOPE THE INDEX WILL FIND A NICHE AMONG THE TOOLS TO TRACK AND QUANTIFY RESEARCH."

The chairs signed off on the ultimate choice of panel members. They include 68 scientists in all, not counting the chairs.

We asked each panellist to list the journals in which they would most like to publish their best work, to a maximum of 10. They were asked to list these journals in order of preference.

To aggregate these responses, each panellist's first journal was awarded ten points, the second journal nine points, and so forth. We recorded both the total number of points that a journal accumulated and the number of panellists who voted for a journal. The chairs used these scores to analyse the popularity of each journal identified.

CONFIRMATORY SURVEY

We felt it important to obtain a broader degree of input and validation, so we conducted a large-scale survey of researchers.

We emailed 100,000 scientists in the life, physical and medical sciences with an online questionnaire. We targeted a broad geographical mix of scientists across Europe, North America, Asia and the rest of the world, receiving more than 2,800 responses from across the major disciplines of the natural sciences. Only scientists who indicated that they have published in the past two years were included in the survey results, to ensure we polled active scientists.

There was a high degree of convergence between the panel and survey outputs for the most popular journals, with more divergence further down the list. But this process was not a number-crunching exercise. The purpose was to assist our panellists and especially the chairs in producing a final list of journals, taking all qualitative judgements and quantitative inputs into account. The final selection was entirely the responsibility of the panel chairs.

FINAL ADJUSTMENTS

The final step in this exercise was to compare our selected journals against the total output of research papers. Our aim was that the ratio of disciplines within the Nature Index should be roughly in line with annual scientific output, with no single discipline contributing to the Nature Index to an inequitable degree. If there are any gross imbalances, these should be acknowledged so that users can take them into account when assessing the patterns of high-quality research output.

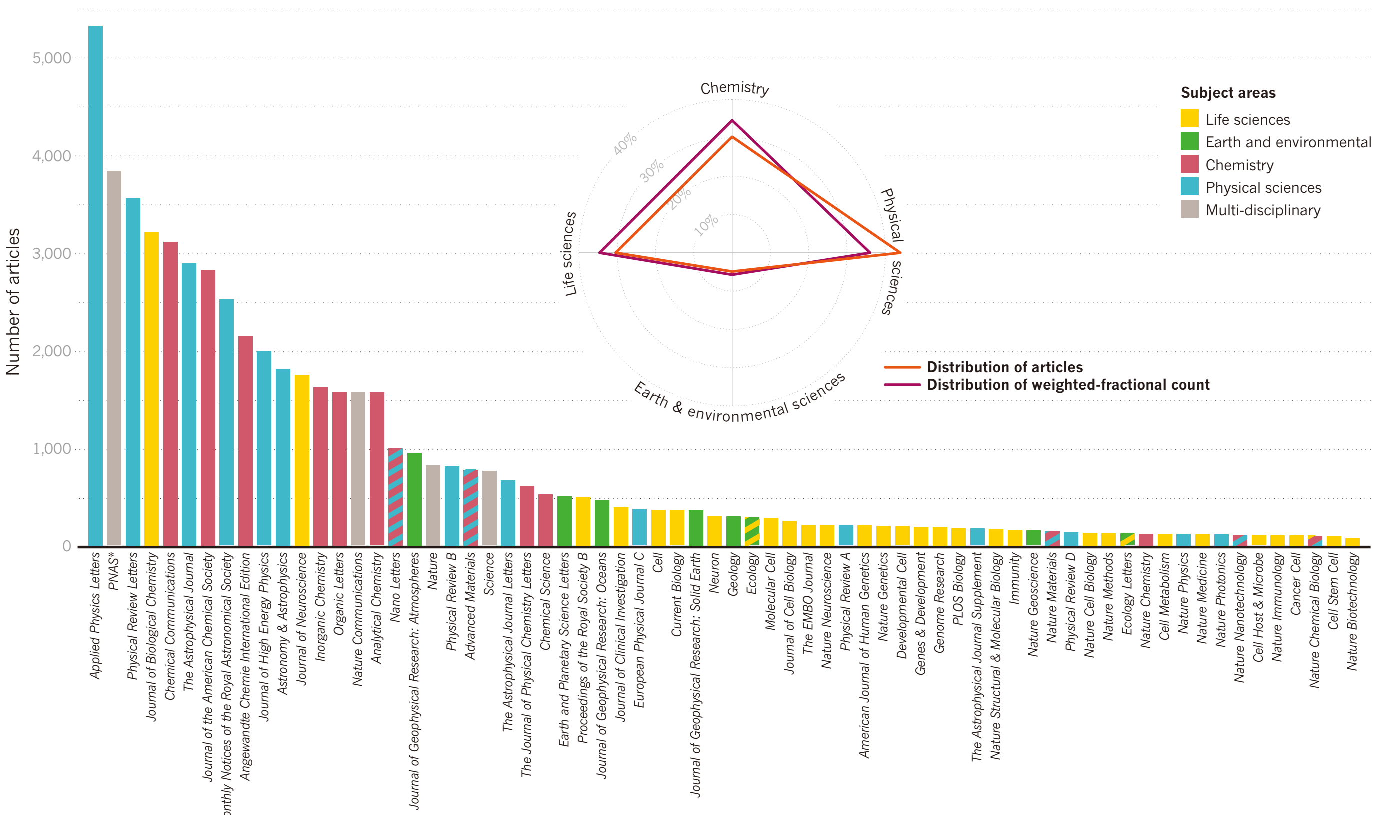
For this reason we provide three measures within the index: the raw article count (AC); the fractional count (FC), which apportions article count for each contributor; and a weighted-fractional count (WFC), which applies a weighting to correct for the one gross imbalance we identified in terms of discipline representation in the Nature Index (for more about how these are calculated, see 'A Guide to the Nature Index', page S94).

That one striking imbalance was in the field of astronomy and astrophysics, where our selected journals represent about 50% of all papers published in international journals in this discipline.

This proportion was approximately five-times the equivalent figures for other fields. Therefore, although the data for astronomy and astrophysics are compiled in exactly the same way as for all other disciplines, in the WFC articles from these journals are assigned one-fifth the weight of other articles. Or to put it another way: the fractional count from those journals is multiplied by 0.2 to derive the WFC.

JOURNAL, ARTICLE AND SUBJECT DISTRIBUTION

There are 68 journals in the Nature Index. The number of articles published in 2013 and included from each journal is shown below, alongside how these map to the four main subject categories. Note: for *Physical Review A*, *Physical Review B* and *Physical Review D* only research papers in the Rapid Communications section and/or those selected to be 'Featured in Physics' (the website that spotlights the research of broad interest from the American Physical Society journal collection) were included in the Nature Index.



*Proceedings of the National Academy of Sciences of the United States of America.

This is intended to provide due representation to all fields covered by the Nature Index in any multi-disciplinary analysis of institutional outputs.

In the freely available Nature Index dataset, we leave it to the user to decide how best to use the three measures.

Clearly different measures and different subsets of the index will be more appropriate depending on the particular interests of the user. However, for the purposes of analysing and assessing global patterns within this supplement, we have, in general, focused on the WFC and the AC because they provide interesting and complementary information.

We recognize that the weighting we have applied as a broad-brush correction for the over-representation of astronomy articles is only one of many that might be applied.

More intricate and complicated weightings aimed at normalising the data for factors such as funding levels, numbers of researchers and so on, are just some of the measures that might be taken into account in assessing the patterns within the Nature Index. We encourage users to suggest and apply their own ideas for weighting the data.

The approach applied to the weighted-fractional count and all decisions regarding the selection of journals in the Nature Index were signed off by the chairs of the journal-selection panels.

SIGNIFICANCE OF THE NATURE INDEX

The journals at the heart of the Nature Index were selected for this purpose alone. They reflect the judgment of the panellists and, ultimately, the panel chairs. This exercise was not intended to provide any absolute comparison between journals within disciplines. The process is founded on a pragmatically minded aggregation of judgments, and the lower-cut-off point is entirely subjective. There is no implication that a journal lying below that threshold is in any way inferior to all of those above it. And indeed, there is every chance that these journals will be included in future iterations of the index.

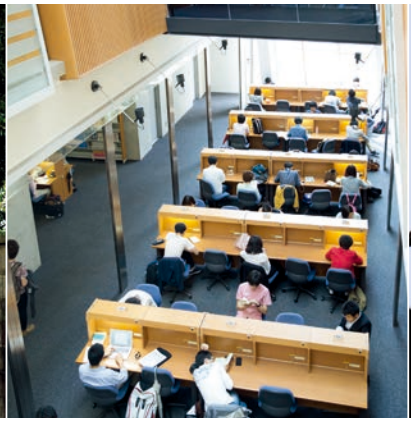
We hope that the Nature Index will find a niche among the tools that research organizations use to track and quantify research outputs and to develop comparisons across peer institutions.

Snapshot data from the Nature Index are openly available under a Creative Commons licence at natureindex.com. Data are updated monthly, and cover the most recently processed 12 months. ■

ORIGINS OF THE NATURE INDEX

In 2005, NPG began compiling the Nature Publishing Index (NPI). This counted the contribution of research institutions exclusively to *Nature* and all the *Nature* research journals. The most recent supplement, specifically for the Asia-Pacific region, was published in March 2013 and can be found at nature.asia/publishing-index-asia-pacific. As there is no need for a journal selection process, the NPI involved no external advisors or selection panels.

The NPI showed that this type of analysis was feasible — and moreover would be useful. The Nature Index is intended to be a more inclusive database of contributions by research institutions to the scientific literature, ranging well beyond the *Nature* journals — and not necessarily including them all (for example, the current Nature Index does not include *Nature Climate Change*, which at the time of the panel's selection exercise was too new to have established a reputation). Nevertheless, the Nature Index builds on the same principles as the NPI, albeit on a much bigger scale.



THE UNIVERSITY OF TOKYO

RESEARCH WITH A BANG

Whether plumbing the depths of space to unravel questions of scientific and philosophical importance or contributing solutions to the most pressing problems that face Japanese society, researchers at the University of Tokyo strive to make their science count. The following three initiatives show what can be achieved through the university's unique commitment to interdisciplinary work and innovation.

The Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU), bridges mathematics, astronomy, theoretical and experimental physics and has kept up a frenetic pace of achievement. Mathematician Yukinobu Toda's recent breakthrough proving the equivalence of two geometric theories of space marked an important step in the elucidation of string theory, and landed him a lecture at the International Congress of Mathematicians this year. Robert Quimby led a group of astronomers, physicists and a mathematician in correcting the scientific record—showing that claims of an unprecedentedly bright supernova by Harvard University researchers were actually the result of a gravitational lensing effect by a faint galaxy, which had not been previously detected.

Theoretical physicist Hirosi Ooguri created a hot topic in mathematics with his discovery of the mysterious relationship between the geometry of a special four-dimensional space and a big discrete group with 244823040 elements—now known as 'Mathieu Moonshine'. In experimental physics, Alexander Kozlov joined a race to demonstrate the conversion between matter and anti-matter using the Kamioka liquid scintillator antineutrino detector (KamLAND). The KamLAND-ZEN collaboration produced the world's most precise data to date. Hitoshi Murayama, Kavli IPMU's director, discovered a unified theory of the low-temperature limits of many systems ranging from magnets, superfluids, cold atoms, to neutron stars and cosmic defects, fifty years after various elements of these system were first theorized.

Kavli IPMU's research activities are set to expand beyond this extensive, crosscutting research base. The Subaru measurement of images and redshifts (SuMIRe) project, led by Kavli IPMU, has started to produce wide-field images of high-redshift galaxies using the Hyper Suprime-Cam on the Subaru Telescope, and a new robotic multi-fibre spectrograph, now under construction, will allow simultaneous observation of 2400 astronomical targets, making possible unprecedented surveys. Kavli IPMU also initiated a collaboration for a next-generation satellite, named LiteBIRD (which stands for 'Light satellite for the studies of B-mode polarization and inflation from cosmic background radiation detection'), which will deliver evidence for cosmic inflation and measure its characteristics. Murayama also plans to add statistics as another focal point, which "will create new synergies between astronomy and mathematics."

The institute has also been spreading creative ideas about how to organize and support science. To a rigid Japanese system, Murayama has introduced split-appointments, merit-based salaries, and lengthy, negotiated recruitment procedures, all of which made it possible to assemble top talent from around the globe. "This is very different from what is traditionally done in Japan," says Murayama. For an institute that gets nearly 1000 applications every year, more than 80% of which are from abroad, it is also a tremendous effort. Murayama

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intends to keep stretching the boundaries of Japanese academic research with a new international graduate program.

A radically new organizational system, called the Todai Institute for Advanced Study (TODIAS) introduced in 2011, helped Kavli IPMU achieve the flexible system that enabled its growth. The TODIAS system then opened the path for another ambitious, interdisciplinary initiative, one targeting a topic of grave concern.

The Integrated Research System for Sustainability Science (IR3S), the second TODIAS institute, "was founded with the vision of providing cutting-edge research for building a sustainable society through linking global, social and human dimensions," says director Kazuhiko Takeuchi. Takeuchi is convinced "that the problems our society currently faces, such as climate change, biodiversity loss, and poverty, are complicated, rapidly changing and difficult to solve through the 'single mindsets' of existing academic disciplines."

IR3S breaks down these walls, and its researchers, who represent fields ranging from ecology and environmental sciences, to economics, engineering and public health, are involved in highly interdisciplinary research. Their aim is to become a driver of social innovation and catalyze reform within other scientific fields. Ongoing studies, which have taken IR3S researchers across Asia and Africa, are as diverse as adaptation and resilience to climate and ecosystems change, health and global change, the impact of bioenergy, agricultural sustainability, and green economy.

"In all these projects we routinely work with local partners and adopt a problem-oriented and interdisciplinary approach that considers the information needs of end-users," says Takeuchi. During a recent visit to Ghana, for example, IR3S researchers communicated findings that will help local communities deal with increased flood and drought hazards. The published results of these projects have been used to formulate policy advice to local and international stakeholders.

This global vision, inherent in an institute where 70 per cent of the workforce is international (compared to fewer than 10 per cent in most Japanese universities), is further bolstered by high-powered advisors, including Rajendra K. Pachauri, chairman of the Nobel Peace Prize winning Intergovernmental Panel on Climate Change.

IR3S recently entered a strategic collaboration with the Science Council of Japan, to host one of five globally distributed secretariats of Future Earth, an international initiative that will coordinate interdisciplinary research efforts globally. Involvement with Future Earth will allow IR3S "to set the research agenda, fundraise, and build capacity for sustainability research globally in the next decade", says Kensuke Fukushi, Interim Director of the Tokyo hub of Future Earth Secretariat. IR3S is also establishing an Asia-wide university network on climate change mitigation, called the 3E Nexus Initiative whose aim is to assist the implementation of the Japanese Government's Joint Crediting Mechanism (JCM) in countries of Asia-Pacific. Involvement in other initiatives, including the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the International Society for Sustainability Science (ISSS), further highlight the leading role that IR3S plays within the international sustainability science community.

The university's innovative initiatives are also tackling urgent problems closer to home. Facing a declining birthrate and increasing longevity, in 2013, the government awarded the university funds to form a Center of Innovation (COI) entitled "Sustainable life care, ageless society" whose mission, says director Tomihisa Ikeura, is to "realize a sustainable society where people can live longer in good health, thus alleviating the burden of the younger generation and allowing the elderly and younger populations to happily coexist and prosper."

The center's efforts will fall on three intersecting axes: minimally-invasive diagnosis and treatment; high-performance and low-cost drug discovery; and the health care and sick care data platform.

The University of Tokyo provides a fertile ground in which to realize such a vision. The center will take advantage of the university's outstanding seeds of innovative science and technology, the scientific resources at the medical, engineering, and pharmaceutical science schools, the clinical resources at its hospital, and its ability to provide stable funding that reduces the risk for the many member companies who have joint research projects. Flexible hiring policies, including laxer regulations on dual appointments, has helped the center land elite staff.

Ikeura, who was a managing executive officer at Mitsubishi Chemical Holdings, is well aware of the need for supportive regulatory framework, and the center will also collaborate with the Pharmaceuticals and Medical Devices Agency and the National Institutes of Health Sciences (NIHS) to streamline the regulatory path.

To encourage cooperation among the sectors, the center launched the "Healthy Long Life Loop Society" which will invite both COI member and non-member companies spanning from electronics, mechanical equipment, information and technology, chemical and pharmaceutical technologies to food, transportation, nursing care, fitness, and life insurance, in order to exchange information related to health care, medical device regulation, and other relevant matters. "This will create an environment where new businesses, new inter-business alliances, joint businesses, overseas research and business expansion opportunities are spontaneously fostered," says Ikeura.

Ikeura hopes that eventually the center will, as an independent and sustainable organization within the University of Tokyo, realize a fundamentally novel medical system, one "that dramatically reduces costs of medical and nursing care, creates new markets and globally competitive new medical industries, and establishes a sense of security through the bonding of people across generations." When it achieves this, it will no doubt become a model for other countries grappling with similar problems.

While these initiatives are all anchored in research groups situated in Japan, like the university's hundreds of other cutting-edge scientific projects, their influence reaches far beyond Japan's borders.

GLOBAL OVERVIEW

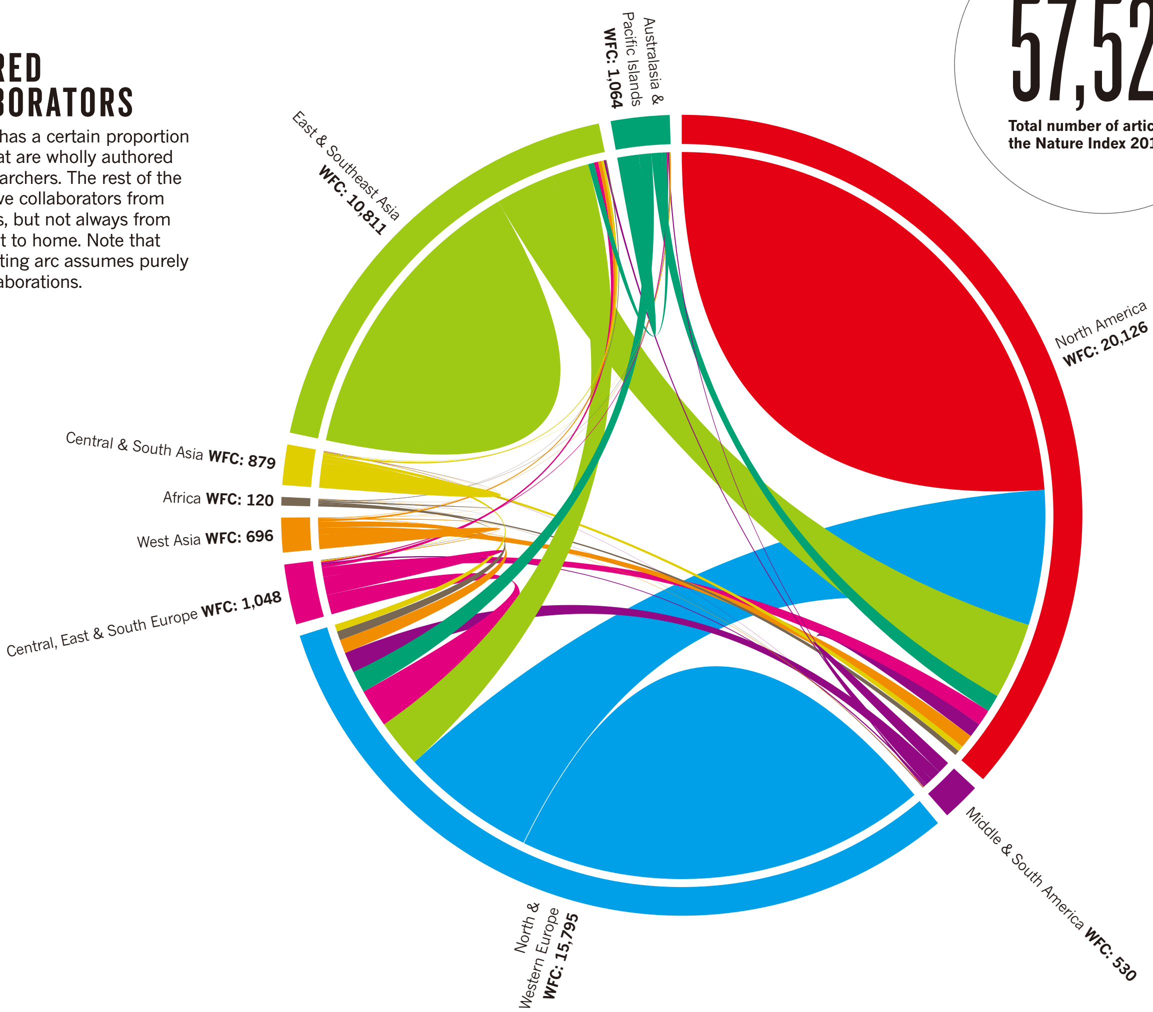
High-level results from the Nature Index show three strong regions, but also reveal a more nuanced picture.

57,528

Total number of articles in the Nature Index 2014.

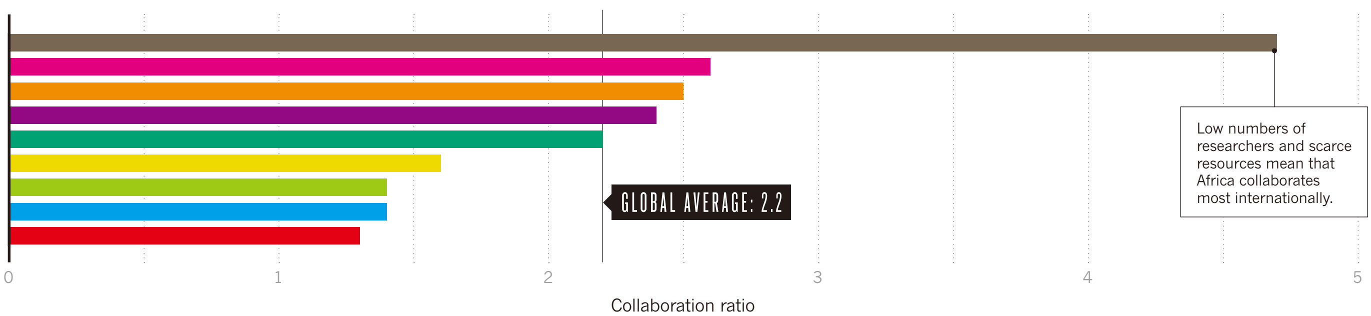
FAVOURED COLLABORATORS

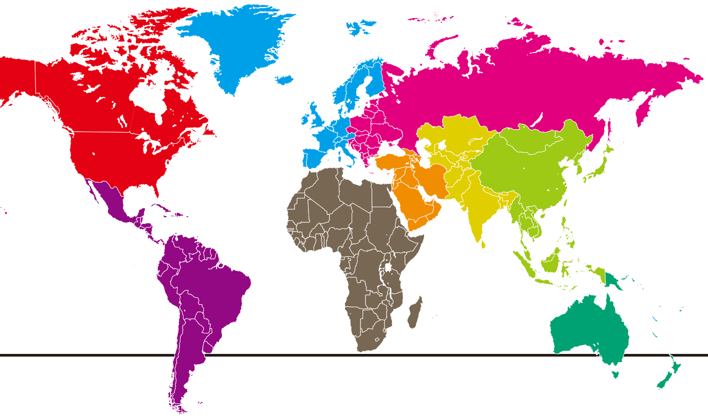
Each region has a certain proportion of papers that are wholly authored by local researchers. The rest of the papers involve collaborators from other regions, but not always from those nearest to home. Note that each connecting arc assumes purely bilateral collaborations.



FREQUENCY OF COLLABORATION

The ratio of article count (AC) to fractional count (FC) gives a measure of the region's propensity to collaborate. A higher number means more collaborators from outside the region per paper.





Regions
- North America
- Middle & South America
- North & Western Europe
- Central, East & South Europe
- West Asia
- Africa
- Central & South Asia
- East & Southeast Asia
- Australasia & Pacific Islands

Acronyms

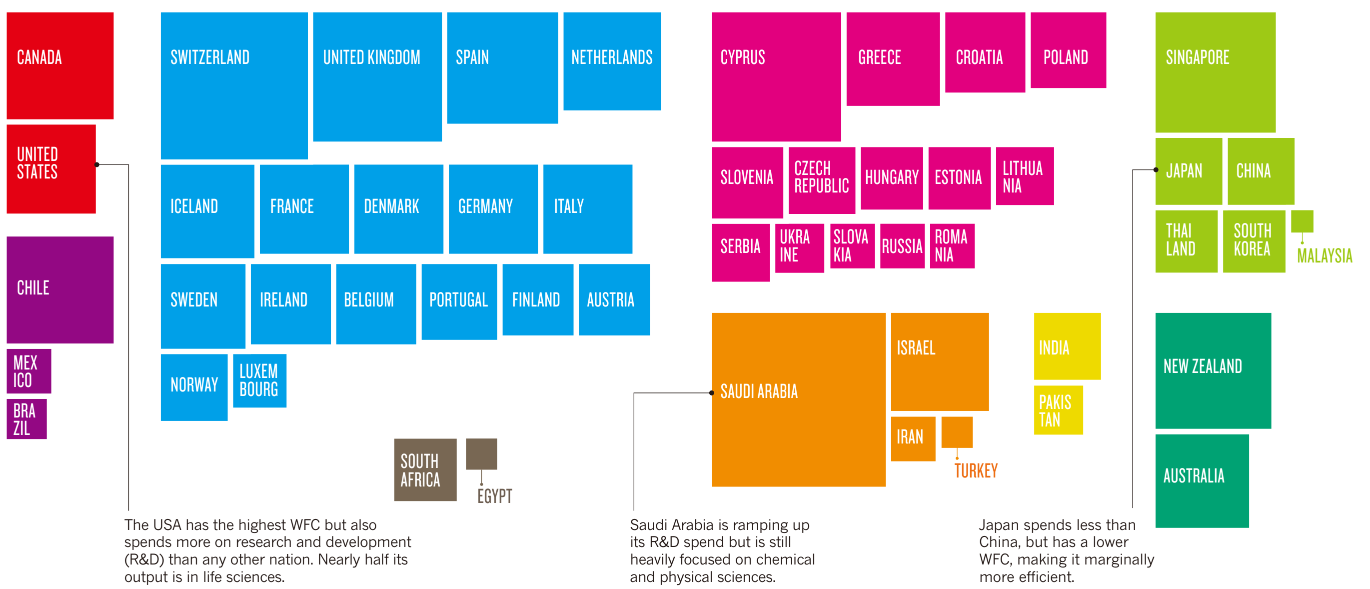
AC: article count
(number of papers)

FC: fractional count
(apportions article count for each contributor)

WFC: weighted fractional count
(applies a weighting to FC to correct imbalance in number of astrophysics papers)

FINANCIAL EFFICIENCY

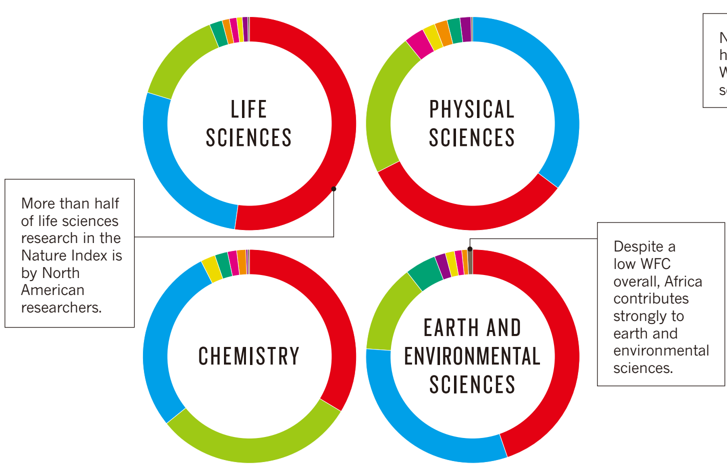
Dividing a country's weighted fractional count (WFC) by its gross domestic expenditure on research and development (GERD, per US$100,000, by purchasing power parity) gives a measure of its financial efficiency. So the larger the square, the higher the Nature Index output (as measured by WFC) per dollar invested.

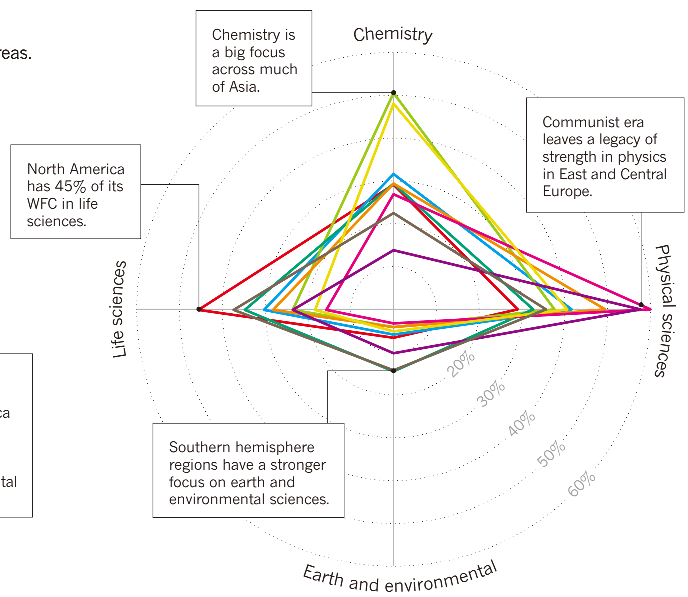


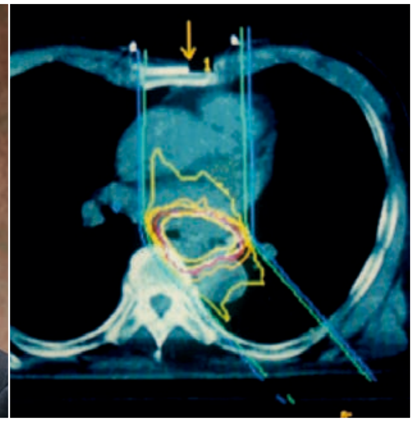
1. Only countries with a WFC>10 and GERD data from 2008 or later are included. Source: United Nations Educational, Scientific and Cultural Organization (UNESCO).

SUBJECT STRENGTHS

On a regional basis, North America has the highest WFC in three of the four subject areas. However, each region has a unique subject footprint.







GUNMA UNIVERSITY

LEADING THE WORLD IN NEXT-GENERATION CANCER THERAPY

Established just four years ago as a state-of-the-art facility for cancer therapy, the Gunma University Heavy Ion Medical Research Center is taking next-generation ion beam therapy even further with precise unrivalled beam control and dose shaping, bringing non-invasive microsurgery closer to reality.

It is an unfortunate fact of modern life that each of us has an almost 50 per cent chance of being diagnosed with cancer within our lifetime. This lifetime cancer risk has risen steadily in developed countries from as low as one in four 40 years ago, and is predicted to continue to rise alongside life expectancy. This close association with advancing age and cancer incidence is of particular importance in Japan.

"Cancer care is a pressing issue for Japan," says Takashi Nakano, director of the Gunma University Heavy Ion Medical Research Center, "not only in terms of developing therapies to increase cancer survival rates, but also in the need for minimally invasive therapies that emphasize a high quality of life."

For many years, X-ray radiation therapy has been one of the few treatment options available for inoperable cancer. Radiation therapy can be effective but the procedure is not sufficiently precise to prevent radiation damage to surrounding healthy tissue. This is particularly true in the brain and for tumours near radiation-sensitive tissue, as is the case for prostate cancer and pancreatic cancer. In the 1990s, proton beam therapy was introduced in hospitals as an alternative to radiation therapy, offering more precise dose targeting and lower extraneous radiation damage. The technique has since been adopted widely throughout the world with over 40 facilities now available, mostly in Japan, the United States and Europe. However, proton beam therapy still has its limitations.

"Proton beam therapy has superior dose distribution to radiation therapy, but it is not perfectly sharp and still results in some radiation damage to surrounding tissue," explains Nakano. "In addition, because of its similar biological effectiveness to X-rays, some types of tumour tissue are also resistant to proton irradiation, such as hypoxic tumour cells and cancer stem cells, which are recognized as being quite important factors in cancer control. In the 1990s when proton beam therapy had just been introduced, my colleagues and I began researching an alternative beam therapy involving the use of heavy ions, specifically carbon ions, at the National Institute of Radiological Science (NIRS). Twenty years later, we now have this state-of-the-art, next-generation carbon ion radiation therapy centre here in Gunma."

THE MANY BENEFITS OF CARBON IONS

Carbon ion radiation therapy has some very specific advantages as a therapeutic tool even compared to proton beam therapy. For a start, because of its stronger biological effectiveness than X-rays and protons, all cancer cells, even radiation-resistant cells, are affected almost equally by the carbon ion beam, meaning that tumour cells resistant to other forms of radiation therapy, including hypoxic tumour cells and cancer stem cells, are treated effectively. The dose distribution can also be 'shaped' in three

NATIONAL UNIVERSITY CORPORATION
Gunma University

LEARN MORE
Takashi Nakano, Director
Gunma University Heavy Ion Medical Research Center

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dimensions to match the exact shape of the tumour.

"We set the shape of the dose distribution by computer using some sophisticated beam focusing equipment," says Nakano. "Carbon ions have much lower scatter than protons, and the dose shape is very sharp, so we can achieve much better dose accumulation in the tumour, and much less damage to surrounding tissue."

"The technology might be expensive and difficult to access now, but in the same way that computers have evolved from room-sized calculators to powerful multi-function devices that can fit in the palm of your hand, it is not hard to imagine that ion beam therapy may one day be found in most cancer centres, providing precise, non-invasive therapies for everything from simple lesions to advanced cancer."

Together, these features of carbon ion radiation therapy make it possible to deliver higher, more effective radiation doses to tumours with almost no damage to surrounding tissue, allowing treatment to be completed in as few as one or two sessions. "We can also treat tumours of any size with equal ease. It means a much higher quality of life for patients, fewer and less severe complications, and we hope much improved survival rates," says Nakano.

Carbon ion radiation therapy offers a real and effective option for inoperable cancer, and for cancer patients with complications such as asthma, which would normally rule out any form of surgery. Although carbon ion radiation therapy is still relatively expensive due to the limited facilities currently available around the world, the treatment is attractive compared with the other available options, offering the possibility of significantly improved survival rates and much higher quality of life compared with difficult palliative therapies such as chemotherapy.

SURGICAL PRECISION

There are now a handful of heavy ion beam therapy units in operation around the world, but where the Gunma facility stands out is in its unmatched beam control. "We have developed systems that provide control of the position of the beam and the shape of the dose with sub-millimetre precision," explains Nakano. "At this level of precision, highly responsive and accurate respiratory gating is very important, as well as precise knowledge of the location of the tumour. We use computed tomographic image guidance to achieve the sub-millimetre resolution of tumour boundaries we need to target the beam and dose. We are also developing an even more advanced and precise imaging system based on Compton cameras at multiple wavelengths. We are continually pushing the limits of this technology."

With a tool this precise, a range of other uses for the carbon ion beam become possible. One of the most exciting potential uses of the technology is in non-invasive microsurgery. "This is something found nowhere else in the world. We have a treatment room at the Gunma facility set aside for the development of this microsurgery technique. Not only can we treat tumours in very sensitive locations, such as adjacent to the spinal cord, we can also treat other benign diseases, such as vascular legions, acoustic neuroma near the inner ear, and age-related macular degeneration – all conditions that would be difficult to treat even by a surgeon, yet we expect to be able to achieve even greater surgical precision."

A GLOBAL RESEARCH CENTRE

Nakano has been involved in the development of the carbon ion beam technology since the idea was first proposed at the NIRS. He then moved to Gunma University as a professor of radiation oncology, where he began work on the carbon ion radiation therapy facility. In collaboration with the NIRS, Nakano's team began developing a compact carbon ion beam technology. With the support of Gunma Prefecture and the technical expertise of Mitsubishi Electric Cooperation, construction of the compact Gunma facility adjacent to Gunma University Hospital began in 2008 and the medical centre was finally opened in 2010. Nakano became head of the new medical centre, and continues to drive its development through the establishment of world-class doctoral programs aimed at cultivating global leaders in ion beam therapy.

"There is a shortage in Japan of the radiation oncologists and medical physicists needed to develop ion beam therapy further," says Nakano. "Our centre has received a significant grant from the Japanese government to run a PhD program to develop the next leaders in this field."

Establishing Gunma Prefecture as a global technological centre of excellence for ion beam therapy is also one of the major aims of the Gunma University Heavy Ion Medical Research Center. Nakano has secure government funding to cultivate the medical and engineering industries needed to support and advance the technology, with the Gunma centre acting as a think tank.

"I believe that in the future, most developed countries will be able to offer carbon ion radiation therapy and enjoy its many benefits," says Nakano. "The technology might be expensive and difficult to access now, but in the same way that computers have evolved from room-sized calculators to powerful multi-function devices that can fit in the palm of your hand, it is not hard to imagine that ion beam therapy may one day be found in most cancer centres, providing precise, non-invasive therapies for everything from simple lesions to advanced cancer."

North America

For many decades, North America has led the world with the breadth and depth of its science, and its continued dominance is apparent in the Nature Index results.

ARTICLE COUNT (AC): 29,325
FRACTIONAL COUNT (FC): 22,276
WEIGHTED FRACTIONAL COUNT (WFC): 20,126

North America is strides ahead of all other regions, including its nearest rival North and Western Europe, in producing high-quality science. Boasting a WFC of more than 20,000 in the Nature Index, its two constituent countries, Canada and the United States, have long enjoyed strong support for natural science, mostly from their research universities. But both are adapting to significant shifts in public funding in recent years. The United States, comfortably the global leader in the index, is weathering funding cuts that have curtailed many research agencies. Canada, which comes in seventh globally and has notable strengths in life sciences and earth and environmental sciences, is attempting to tie its research more tightly to commercial innovation.

The United States dwarfs its northern neighbour on nearly every measure, but the index reveals more nuanced information about how it uses its resources. For example, according to UNESCO, there are 1.25 million researchers employed in the United States, which is 3,979 per million citizens; Canada has only 157,000 researchers, but this translates to 4,563 per million people — a higher density. The Nature Index, however, shows that the United States is better able to leverage its researchers, producing a WFC of 14.9 per thousand researchers compared to Canada's 9.4 (see 'Researcher efficiency').

Researcher efficiency may be a factor in the relative lack of collaboration with countries outside the region, a metric that is lower than the global average across all subjects. The United States is relatively self-sufficient, particularly when it comes to papers in either *Nature* or *Science* (see 'Collaboration rate').

"CHINA, OF COURSE, IS NOT THE ONLY NATION RAMPING UP R&D WHILE WE REST ON OUR LAURELS."

The region shows an above-average contribution to the life sciences, which accounts for nearly half of its output (see 'Research strengths'). For the United States, that focus has historically been encouraged by funding from the government's medical research agency, the National Institutes of Health (NIH) — whose budget, however, is shrinking — in real terms, it is now four-fifths of its value a decade ago (NIH Box). Its Canadian counterpart, the Canadian Institutes of Health Research, also has seen its purchasing power wane in recent years.

UNITED STATES: SEEKING STABLE GROWTH

The United States' WFC in the Nature Index is 18,643, more than triple that achieved by second-place and ascendant challenger China. But maintaining this supremacy might prove difficult: 2013 budgets for many US research agencies were flat. The prospect of prolonged federal funding constraints gravely worries many in the research community. "China, of course, is not the only nation ramping up R&D while we rest on our laurels, seemingly attached to the groundless belief that the US is so ahead of other nations that we can operate on cruise control," observes Mary Woolley, president of advocacy group Research!America in Alexandria, Virginia.

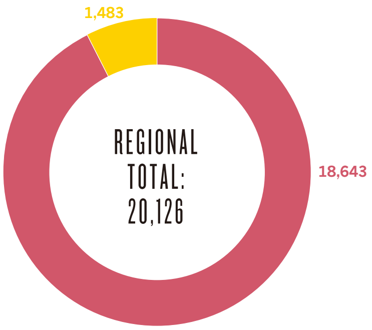
The past decade has seen a drop in overall US research and development (R&D) funding of about 12% in real terms, say Matt Hourihan, director of the R&D Budget and Policy Program at the American Association for the Advancement of Science. Most of that budget decline hit defence-related R&D. "I think we will be treading water for at least a few years to come," he adds. The Obama administration has proposed near-level funding of US$64.7 billion for basic and applied research in fiscal year 2015, and of US$68.0 billion for developmental research.

Life sciences are particularly strong in the United States. In 2013, the Nobel Prizes in

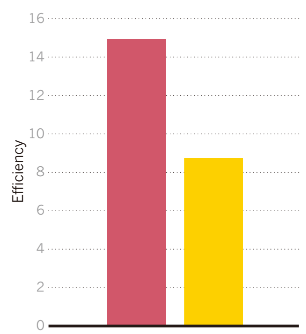
NORTH AMERICA ANALYSIS

United States | Canada

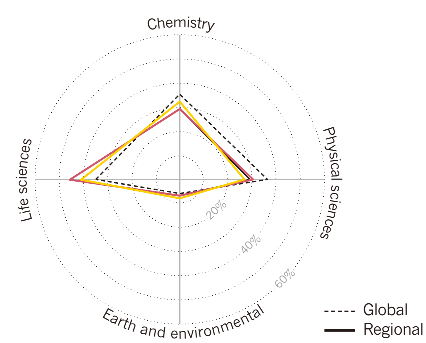
Countries' weighted fractional count (WFC)
The United States dominates the region and leads the world.



Researcher efficiency
WFC per 1,000 researchers[1].



Research strengths
Both countries are above the global average for life sciences research[2].



1. Source: UNESCO. 2. Subjects overlap, so the total for each country can be >100%.

Chemistry and in Physiology or Medicine both went to scientists based either wholly or partly in the United States. In the Nature Index, the country is also most dominant in the life sciences, where it accounts for just under half of the global WFC (See 'Life science share').

However, 2013 was a troubled year for US research, with federal sequester cuts in March, triggered by the failure of Congress to otherwise lower the budget deficit. These cuts hit science spending, for example slicing off about 5% of the NIH budget. Related turmoil effectively shut down most of the federal government in October, halting research at many labs. The NIH was forced to send 12,000 scientists home for "16 very, very long days," says Lawrence Tabak, NIH principal deputy director. Uncertainty about a national commitment to science "casts a pall on young people who are considering a career in biomedical research", he adds.

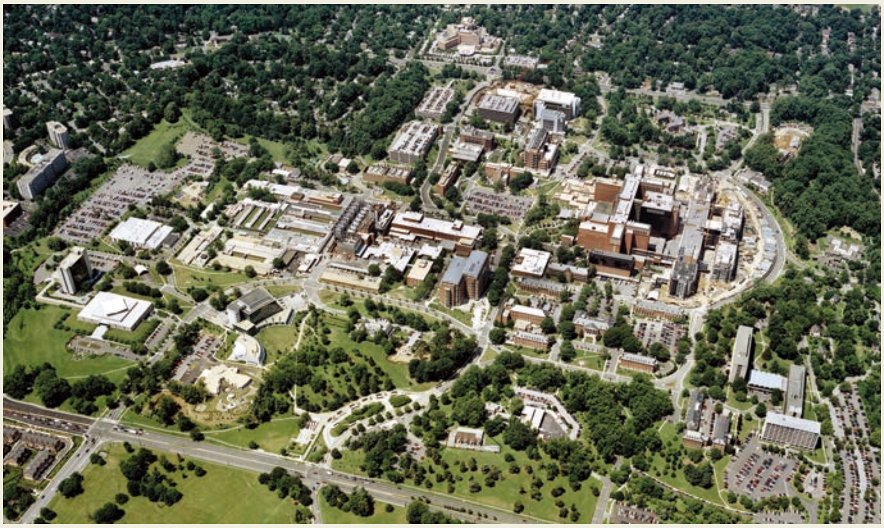
Overall spending has since crept up to around pre-sequester levels, but budget uncertainties continue. Another round of sequester cuts is scheduled for fiscal year 2016 unless federal deficit-reduction targets are met, says Hourihan.

CANADA: GETTING DOWN TO BUSINESS

Canada's WFC of 1,483 belies its relatively small population of 35 million (just 2 million more than Morocco), and the country "continues to punch above its weight in global science," according to Paul Dufour, an independent science and technology policy consultant based in Gatineau, Quebec. Its strength is "largely a function of the enormous expenditures since the mid-1990s in higher-education research," he says. Annual spending on natural science and engineering research by academic institutions has more than tripled in real terms, from Can$3 billion in 1996. (However, despite the long-term upwards trend, overall federal spending on science and technology from government, industry

NATIONAL INSTITUTES OF HEALTH

Realigning for reductions



NATIONAL CANCER INSTITUTE/SCIENCE PHOTO LIBRARY

The National Cancer Institute is the NIH's biggest institute

The US National Institutes of Health (NIH) is the country's largest civilian research agency, with an annual budget of around US$30 billion. About 10% of the budget goes on intramural research, mostly at its headquarters in Bethesda, Maryland.

When *Science* declared cancer immunotherapy as its Breakthrough of the Year in 2013, one of the two types of immunotherapy honoured was adoptive T-cell therapy, a field in which NIH researcher Steven Rosenberg played a pioneering role. That was just one mark of excellence for the NIH's intramural programme – the tenth largest contributor to high-quality scientific output in the Nature Index by WFC, and second to Harvard when just the life sciences are considered. However, much of the NIH's work covers clinical trials, and clinical journals are not yet included in the Nature Index.

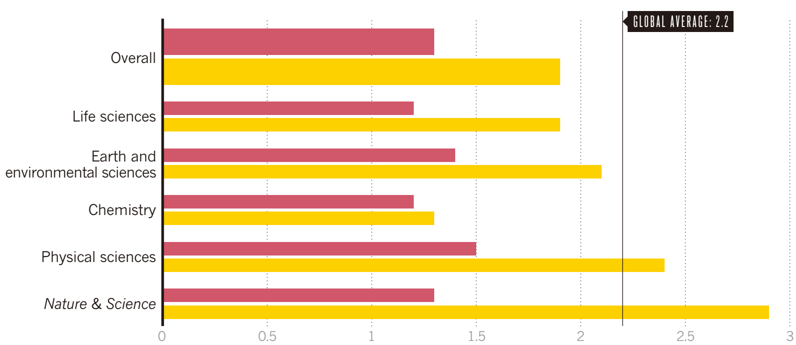
Overall, NIH published 35 papers in *Nature* and 25 in *Science* in 2013, together accounting for just over 7% of its output, with a combined WFC of 28. This places the NIH fifth in the index, just under Germany's Max Planck Society, which had about €1.53 billion (US$1.97 billion) in public funding that year.

"We're seeing tremendous basic science opportunities," says Lawrence Tabak, NIH principal deputy director. However, Tabak points out that NIH overall has lost about 20% of its purchasing power in the past decade. Tabak echoes the sentiments of other observers of US science: "We need to get on a more stable trajectory."

United States Canada

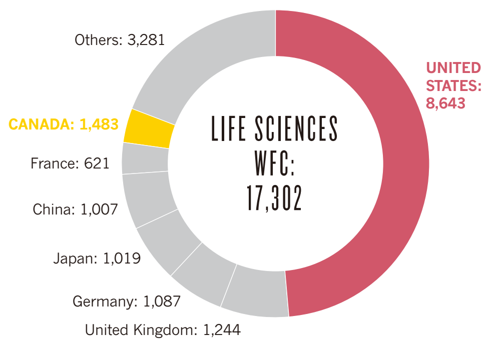
Collaboration rate

Dividing AC by FC gives a proxy for average number of collaborators per paper from outside the country.



Life science share

Nearly half of all life sciences research in the Nature Index was conducted by US scientists.



MJBS/ THINKSTOCK


Life sciences are Harvard's strength

IT IS IN THE NATURE AND SCIENCE COUNT THAT HARVARD REALLY SHOWS ITS STRENGTH.

and academia has been heading south for several years.)

Canada spends about 1.9% of its gross domestic product (GDP) on R&D, a similar ratio to that of China and considerably less than that of the United States at 2.8%, according to estimates by Battelle Memorial Institute. R&D spending by industry and by national defence agencies, however, is much lower in Canada than in the other two countries.

Recently there has been a strong federal push to tie research more closely to business. One prominent example, Dufour notes, has been a retooling of the premiere lab, the National Research Council, to focus on business-led research. Also, "new funding going to universities has interesting clauses trying to target work closely to businesses," Dufour says.

A number of federal initiatives have strengthened research efforts. Since 1997, the Canada Foundation for Innovation programme and its partners have poured more than Can$12 billion (about US$11 billion) into new buildings, facilities and other research infrastructure. Beginning in 2000, the Canada Research Chairs programme has created about 2,000 research professorships, with an annual budget of about $265 million.

Key areas of research such as quantum computing and neuroscience are supported by the related programme Canada Excellence Research Chairs, which allows Canadian universities to compete for leading international researchers. "Budgets and funding are limited, but the return on investment is worth it if Canada makes strategic investments in areas of global impact," says Feridun Hamdullahpur, president and vice-chancellor of the University of Waterloo and chair of the U15 Group of Canadian Research Universities.

The Canada Excellence Research Chairs programme seeks to maintain the country's long-standing success in attracting researchers from abroad. According to a 2014 report from The Council of Canadian Academies, 51% of individuals holding science, technology, engineering, and mathematics degrees in Canada are immigrants. (That's about twice the percentage of foreign-born college-educated scientists and engineers working in the United States, according to National Science Foundation estimates.)

THREE NORTH AMERICAN LEADERS

Three institutions exemplify the strengths of major North American academic organizations: the two US institutions that place highest in the Nature Index, Harvard University and Stanford University, and the top Canadian institution, the University of Toronto. The index reveals that these three have quite different research profiles.

Harvard has about 2,100 faculty members and its sponsored research funding totalled US$821 million in 2013. Stanford employs roughly the same number of faculty, with a sponsored research budget of $1.35 billion (including $452 million for the SLAC National Accelerator Laboratory, which Stanford operates on behalf of the Department of Energy).

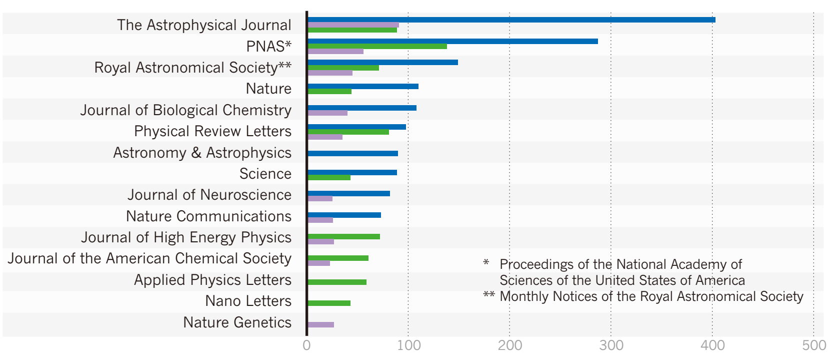
The University of Toronto, with a faculty of about 12,500, is the largest research organization in Canada. The university and its partner hospitals received sponsored research funding of about Can$1.1 billion (US$1.0 billion) for 2013. As a public institution, it has about 67,000 undergraduate students, an order of magnitude more than Harvard or Stanford.

Posting a WFC of 852, Harvard comes in second among global research institutions, behind the gigantic Chinese Academy of Sciences with a WFC of 1,209. Stanford comes fifth with 553, and Toronto is 28th overall with 242.

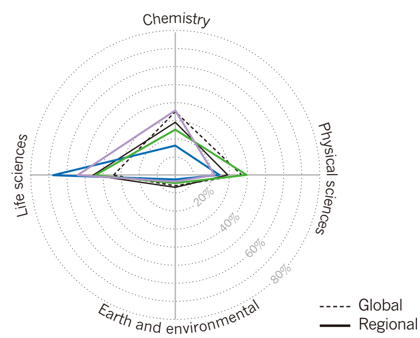
Both Harvard and Toronto publish most in *The Astrophysical Journal*, with 403 papers from researchers at Harvard (representing 14% of all 2013 papers in this journal) and 91 from Toronto. There were also 89 papers from Stanford, although this Californian institution published most frequently in the

Harvard | Stanford | Toronto

Top ten journals
Astrophysics is strong for all universities. After that, Harvard's publications are mixed; Stanford shows preference for the physical science journals, whereas Toronto favours life sciences.



Institutional subject spread
More than two-thirds of Harvard's output is in the life sciences[1].



1. Some subjects overlap, so total can be >100%

interdisciplinary journal *Proceedings of the National Academy of Sciences* (PNAS) (see 'Top ten journals'). Nevertheless, the institution with the strongest slant towards physics overall is Stanford, with 39% of its output in this field. (see 'Institutional subject spread')

Stanford's five top journals in the Nature Index are all in the physical sciences. The university hosts the SLAC Lab, which on its own achieved a WFC of 56. Among SLAC's accomplishments was a *Nature* paper that a made a significant step toward creating an electron accelerator on a chip. However, it is the Massachusetts Institute of Technology (MIT) that published more physical sciences papers than any other North American institute, with a WFC of 228 – that's more than Stanford's 215 and Harvard's 195 (see physical science table, page S107).

> "CANADA CONTINUES TO PUNCH ABOVE ITS WEIGHT IN GLOBAL SCIENCE."

Earth and environmental sciences makes up only a small proportion of the total Nature Index papers, and all three institutions publish fewer than the global average in this field. The top North American institutions are two government agencies: NOAA and NASA (see E&E table, page S105). Stanford is fifteenth globally, but is in the process of expanding its Earth Sciences department — and in 2013 two of its faculty were given prestigious MacArthur Fellowship ("genius") awards.

One of Stanford's high-profile papers in this field was published in *Science*, and found that current climate change is happening an order of magnitude faster than at any other time in the past 65 million years.

All three institutions published most of their papers in the life sciences, particularly Harvard where this subject accounted for more than two-thirds of its output. Indeed, Harvard is the leading institution in the Nature Index for life sciences (see life sciences table, page S104); this is the only subject where the Chinese Academy of Sciences is not top.

This achievement partly reflects the sheer size of Harvard Medical School, which has more than 10,000 academic appointments in affiliated teaching hospitals alone, compared to around 700 for Toronto and 600 for Stanford. Harvard's interdisciplinary groups, such as the Harvard Stem Cell Initiative and Wyss Institute for Biologically Inspired Engineering, also did well in *Nature* and *Science*.

It is in this count where Harvard really shows its strength. In 2013 Harvard contributed to 199 papers in total in *Nature* and *Science*, (see 'Nature and Science output') accounting for 9% of the total Nature Index articles it contributed to, making it by far the global leader by this metric. In fact there are three US institutions in the top three *Nature* and *Science* list by WFC: Harvard is followed by MIT and then Stanford (see Nature and Science table, page S108). The University of Toronto published 34 papers in *Science* or *Nature*, representing 6% of its output in the index. All three North American universities are comfortably above the world average of just over 3%. (See 'State analysis'.)

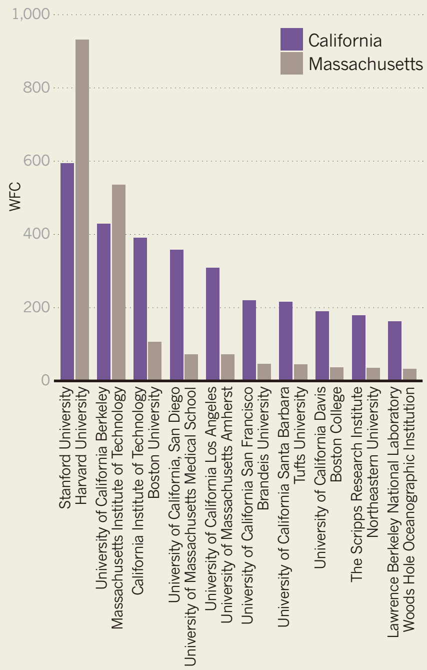
In terms of online attention (everything from Twitter to news articles) for scholarly papers, Altmetrics provides some interesting data. In this respect, Harvard has a higher visibility than the other two institutes. One of its papers from *Science*, "Poverty impedes cognitive function" (see 'Harvard's online visibility'), is in the top five papers of the year according to altmetric.com (as of 22 September 2014). However, it is a Stanford *Nature* paper, "Structural and molecular interrogation of intact biological systems", about a way to make biological tissue transparent, that gained the highest score for papers from a single institution. ■

STATE ANALYSIS

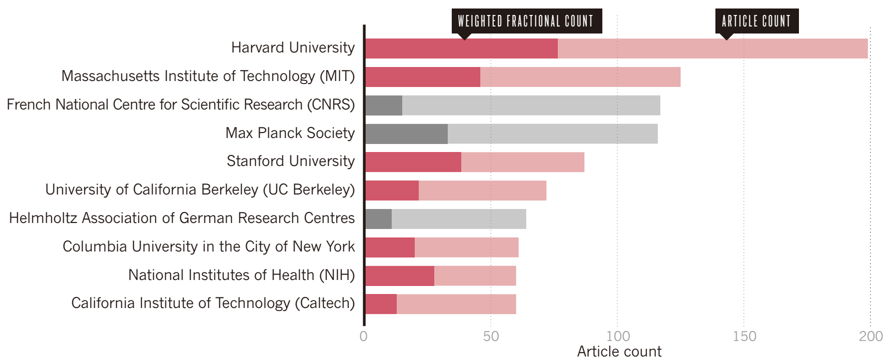
Massachusetts v. California

While Harvard might be dominant on an individual institution basis, it is Stanford's home state of California that shows the most scientific muscle. In the Nature Index there are 159 research institutions in California that contribute to Nature Index papers (including 12 separate campuses of the University of California) compared to only 64 in Massachusetts. After Harvard and MIT there is a big drop-off for the northeastern state, whereas California's top institutions are still delivering strong WFC scores down to the twentieth institution and beyond.

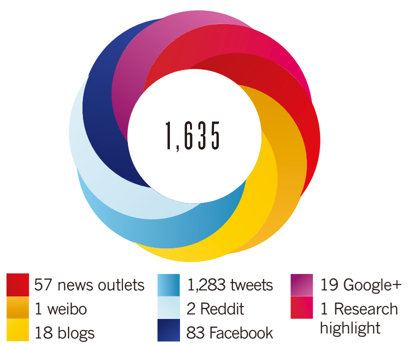
Harvard boosts its home state of Massachusetts, but California has a deeper research base.



Top ten for *Nature* and *Science*
Harvard leads when just article count in these two highly selective journals are considered.



Harvard's online visibility
Harvard's most-shared paper by altmetric score is also one of the top-scoring papers[1] in all of *Science*.



1. DOI: Science 341/6149/976. Data taken from altmetric.com on 22 Sept 2014.

North & Western Europe

A mature scientific system helps this region to produce a strong scientific output, and support for science is high — even during an economic slump. But a heavy administrative and bureaucratic burden makes collaborations difficult.

ARTICLE COUNT: 25,355
FRACTIONAL COUNT (FC): 18,458
WEIGHTED FRACTIONAL COUNT (WFC): 15,795

North and western Europe is second to North America overall in the index, and is ahead in terms of the number of physical sciences papers.

Germany leads the region by article count (AC) and weighted fractional count (WFC) – a measure that adjusts AC to reflect the relative contribution of each country or institution – and is also the country that spends the most of its gross domestic product (GDP) on research and development (R&D). Over the last decade, this percentage has increased from 2.5% in 2005, to just over 2.9% in 2012. Germany's Chancellor Angela Merkel, herself a physicist, came to power in 2005 and is widely credited with pushing these priorities. During this time, the government's spending on science has risen by 60% to €14.4 billion (US$18.5 billion), including annual increases for the large German science organizations such as the Max Planck Society (MPS).

Germany's spend as a fraction of GDP is above the average of 1.97% for the 28 European Union (EU) countries, including 2.26% for France and 1.72% for the United Kingdom, according to the Organisation for Economic Cooperation and Development (OECD). "Most EU countries have increased their R&D to GDP spending in the last 10 years, although at a slower rate since the 2008–09 economic crisis," says Dominique Guellec, head of country studies and outlook at the OECD's Science, Technology and Innovation directorate. "The one exception is the United Kingdom, where the ratio has stagnated over the past decade."

Lidia Borrell-Damián, Director for Research and Innovation at the European University Association (EUA) in Brussels, says that Europe's R&D budgets at a regional level may be on a par with North America and East Asia, but the disparity of investment between European countries creates a problem. "Some are investing a lot, and others are investing almost nothing," she says.

The EU is trying to spur R&D spending with its Horizon 2020 Research and Innovation programme, which will provide nearly €80 billion (US$100 billion) in funding between 2014 and 2020. But this works out as a modest annual investment compared with the €260 billion the 28 EU countries spent on R&D in 2012, Guellec notes.

North and Western Europe's success comes partly from its ability to leverage its researcher base. In terms of efficiency (shown here as WFC per 1,000 researchers), many countries in this region are among the strongest in the world. Switzerland tops the region by an enormous margin, and is also the highest in the Nature Index (see 'Researcher efficiency'). It regularly tops global surveys of competitiveness and innovation, and its science spend as a proportion of GDP is above the EU average.

The top universities in Switzerland are the two parts of the Swiss Federal Institutes of Technology: the Federal Institute of Technology Zurich (ETH) and the Federal Polytechnic School of Lausanne (EPFL), which come sixth and eighth in the region respectively. Philippe Gillet, provost of EPFL, outlines factors that contribute to Switzerland's success: unlike France, for example, establishments in Switzerland have autonomy and total freedom over scientific and education policy; higher education, research and innovation are a priority for the country; and part of the polytechnics' mission is to help spur the economy.

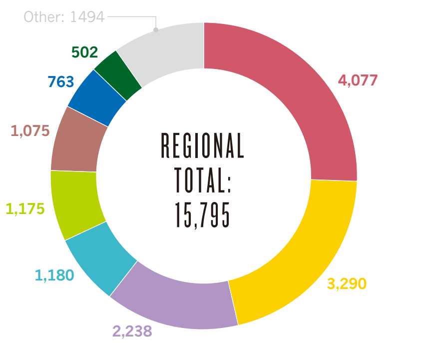
Gillet moved from his native France to Switzerland specifically to experience the system "which works". Many countries, such as France, proclaim that higher education and research are a priority, he says, but "they do not follow through with enough resources and structural reform".

Scientists in North and Western Europe are less likely to collaborate with researchers from other regions than the global average (see 'Collaboration rate'). The breadth of languages (23 official ones) in the EU is not necessarily the culprit in lack of scientific collaborations, says Bernard Meunier, vice president of the French Academy of Sciences. He says that it is very much determined by discipline. "In particle

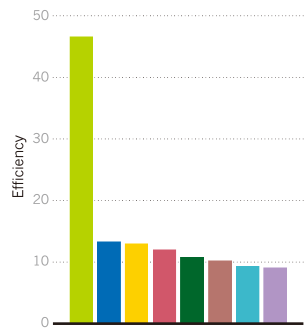
NORTH & WESTERN EUROPE ANALYSIS

Germany | United Kingdom | France | Spain | Switzerland | Italy | Netherlands | Sweden

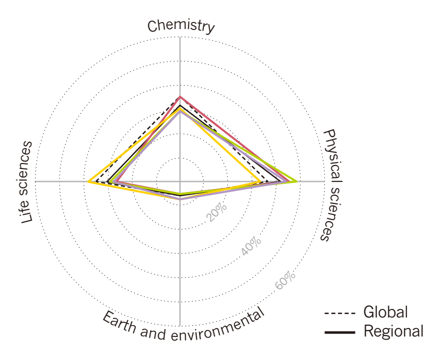
Countries' weighted fractional count (WFC)
There are 23 countries in this region, and all but 4 have a WFC of at least 1.



Researcher efficiency
WFC per 1,000 researchers[1].



Research strengths
The UK is strongest in the life sciences, whereas mainland Europe focuses more on physical sciences[2].



1. Source: UNESCO. 2. Subjects overlap, so the total for each country can be >100%.

physics, about 500 scientists collaborate in projects at the European Organization for Nuclear Research (CERN), whereas in biology, chemistry and pharmacology, research teams are in competition with each other," he explains. "Astrophysicists work with colleagues from around the world, but mathematicians lead a solitary life."

Another reason for the low level of collaboration in the EU could be the heavy administrative burden for researchers navigating different funding structures. The red tape can discourage researchers from looking abroad for collaborators, says the EUA's Borrell-Damián. At a recent university conference in Italy, one rector said the research projects in progress at his university involved 150 different funding regimes, which created huge management problems. "I am sure he is not alone in this, and that large universities would have even more than 150," Borrell-Damián says. "The administrative requirements should be rationalized."

Increasing collaboration is an attractive goal, given that benefits include enriching scientists' careers, raising the profile of universities and conducting research in the best conditions possible. International cooperation means that "universities are competitive worldwide and are at the forefront of their field and even driving it," she says. That is "good for researchers, good for institutions and good for the advancement of science."

SUBJECTIVE SPREAD

Of the countries in this region, the United Kingdom is most heavily skewed towards life sciences, which comprises a third of its output in the index. On its own, the United Kingdom contributes to 7% of all the life sciences research in the index (the largest after the United States). Of the seven European institutions in the top 50 globally for life sciences, three are in the United Kingdom, led by the University of Cambridge (see life sciences table, page S104).

Duncan Maskell, Head of the School of Biological Sciences at the University of Cambridge, says that the UK's strength in this field is the result of a supportive political and financial environment. "The government appears to understand the contribution that science – and in particular the life sciences – makes to people, and currently fosters an environment conducive to research. It's encouraging to see that it now even has a minister focused entirely on the life sciences, for example."

Germany's strength lies in the physical sciences, where it makes up 10% of the Nature Index — on par with China. Its largest research institution, the MPS, is second only to the Chinese Academy of Sciences in WFC in this field, and MPS has overall contributed to more papers in the Nature Index.

Christoph Ettl, senior scientist in the Presidential Division of the MPS, says Germany has a very strong history of physics, with Max Planck, Albert Einstein and Werner Heisenberg among others having contributed to the bedrock of quantum mechanics. Until 1976, physicists born in Germany topped the list of Nobel laureates. And the discipline has many applications beyond science, says Ettl — who is also a physicist. "Physicists have the quantitative tools for simulation, applicable to almost any field from society to the stock market."

INSTITUTIONAL COMPARISON

In most European countries, the production of papers is spread between many institutions. In the United Kingdom, universities — or tertiary educational institutions — produce the bulk of the country's research in the index; in Germany, it tends to be research-only societies and associations that dominate, including MPS, and the Helmholtz and Leibniz Associations.

The story is very different in France, where the National Centre for Scientific Research (CNRS) towers above all other institutions with a WFC of 719 — similar to Germany's MPS at 726 (see France). Then there is a notable drop-off: the next French research institution, the Atomic Energy and Alternative Energies Commission, has less than a fifth of this score, and the highest placed university is the Pierre and Marie Curie University (UPMC) in Paris, with a WFC of 138 (see 'Institutional subject spread').

Physicist Paul Indelicato, President of Research and Innovation at UPMC, does not believe the enormity of the CNRS has a negative impact on his or other research institutions. "On the contrary, it is a strength," he says.

Comparing like-for-like single institutions across the three leading Northwest European countries pits Germany's Ludwig Maximilian University of Munich (LMU) against UPMC and the University of Cambridge.

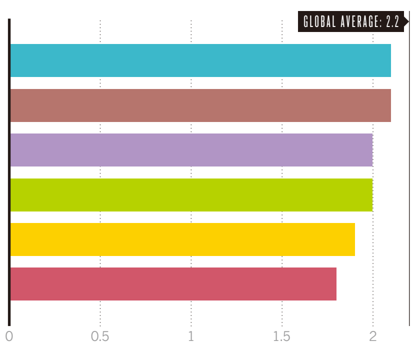
UPMC has strong output in the physical sciences (see 'Institutional subject spread'), particularly in space sciences: more than a third of its 1,319 papers in the Nature Index are in astrophysics journals. Indeed, astronomy is a historical legacy at UPMC through its longstanding links with the Paris Observatory. UPMC founded its Paris Institute of Astrophysics in the 1930s, which a few years ago became a joint lab with the CNRS. However, because of the downweighting of astrophysics journals in the Nature Index (see 'An introduction to the Nature Index', page S52), UPMC ends up with a WFC of only 95. UPMC's namesakes — Pierre and Marie Curie — are of course famous for research in the physical sciences. "The spirit in which they conducted research still has an important influence on how we work today," says Indelicato. "We are extremely attached to Marie Curie's name and to her demand for quality research." Since the 1960s, the UPMC's mixed labs have produced three Nobel laureates in quantum physics.

LMU, in contrast, has a more even distribution of publications across several journals, which translates into an even subject split between chemistry, physics and biology, each of which comprises roughly a third of its WFC (overlap between the subjects means that the total can be more than 100%).

Of the three, Cambridge is the strongest in the life sciences, with a WFC of 151, three-times that of LMU's. It also leans marginally more towards this field in its overall subject

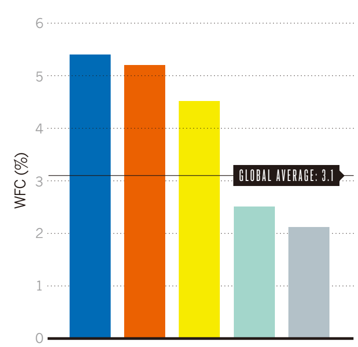
Germany | United Kingdom | France | Spain | Switzerland | Italy

Collaboration rate
Dividing AC by FC gives a proxy for average number of external collaborators per paper.

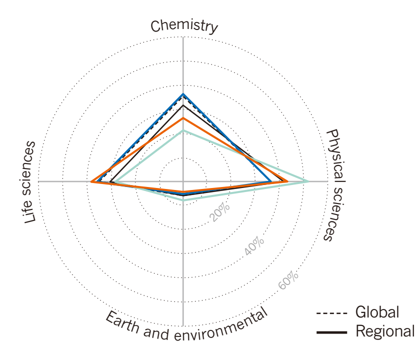


LMU* | University of Cambridge | Max Planck Society | UPMC** | CNRS***

***Nature* and *Science* split**
Cambridge publishes most in these two journals, but its average percentage is similar to LMU's.



Institutional subject spread
Just over half of UPMC's output is in the physical sciences, whereas the others have a more even split[1].



*Ludwig Maximilian University of Munich **Pierre and Marie Curie University ***French National Centre for Scientific Research. 1. Some subjects overlap, so total can be >100%.

spread. A lot of this strength comes from neuroscience: the *Journal of Neuroscience* is one of the university's top journals by WFC. Cambridge's Maskell identifies the university's cross-disciplinary activities, including its Strategic Research Initiatives (one of which is in neuroscience), as helping to make it a leader in this field. "We have excellent opportunities to go from very basic research right through to translation, across the spectrum from areas like agricultural and conservation biology to clinical medicine." Notably, Cambridge also has the most wholly-authored papers of the three: 138 compared to 53 from LMU and none from UPMC.

When it comes to the highest impact science, both Cambridge and LMU are strong in publications in *Nature* and *Science*, well above the global average (see 'Nature and Science split').

In raw numbers, Cambridge is more successful at publishing in these two journals, but in terms of proportion of its overall output there is little to choose between the UK and German institutions.

Less-traditional measures of the impact of research, called altmetrics, track a paper's visibility in the online world including social media. All three west European institutions have contributed to papers that have scored highly, according to altmetrics.com, but it is Cambridge that appears to be the most successful. Its top paper is from 2013, involving two authors from Cambridge's Psychometrics Centre, along with a researcher from the nearby Microsoft lab. The paper seems made for social media: it describes how a variety of personal information can be gleaned by reviewing someone's Facebook "likes" (see 'Cambridge's online visibility').

Altmetrics may be a new rating system, but Maskell sees its benefit for the university. "A high score in altmetrics reflects a high level of engagement with our research, within the sector and with the wider public. We cannot expect the public to support research if they don't know what we're doing." ■

FRANCE

Centre national de la recherche scientifique

The French National Centre for Scientific Research (CNRS) is the largest basic research agency in Europe and the largest public funding agency in France. The initial budget for 2014 stands at just under €3.3 billion (US$4.2 billion), down from €3.4 billion in 2013. France's only multidisciplinary research agency, it employs more than 11,000 tenured researchers and 13,000 engineers and support staff. It runs 1,028 research units, more than 90% of which are joint labs with universities, specialized research organizations and industry.

The collaborative structure of the CNRS is reflected in its above-average ratio of AC to FC across all subject areas. The CNRS has more than 4,500 papers in the index, more than any other institution. But of these, publications in *Nature* and *Science* represent just 2.1% of the CNRS output, below the index average of 3.1% (see 'Nature and Science split').

The agency is often criticized for its heavyweight administration. In an interview with French economic daily *Les Echos* two years ago, Bernard Meunier, vice-president of the French Academy of Sciences, said that the number of administrative posts in the CNRS had increased nine-fold since the early 1960s, while the number of researchers had increased only four-fold. "The administration is in the process of stifling research," Meunier said. "Researchers spend their day filling out administrative documents to the detriment of their real work."

The CNRS and Germany's Max Planck Society (MPS), which have similar WFCs in the index, are both large, mainly or entirely publicly funded and offer tenured jobs. But there the similarities end, says Christoph Ettl, Senior Scientist in the Presidential Division of the MPS. The CNRS budget is double Max Planck's, but MPS is independent at all levels, with neither the government or its top managers having a say in the work its scientists undertake or in the appointment of the society's president, he notes.

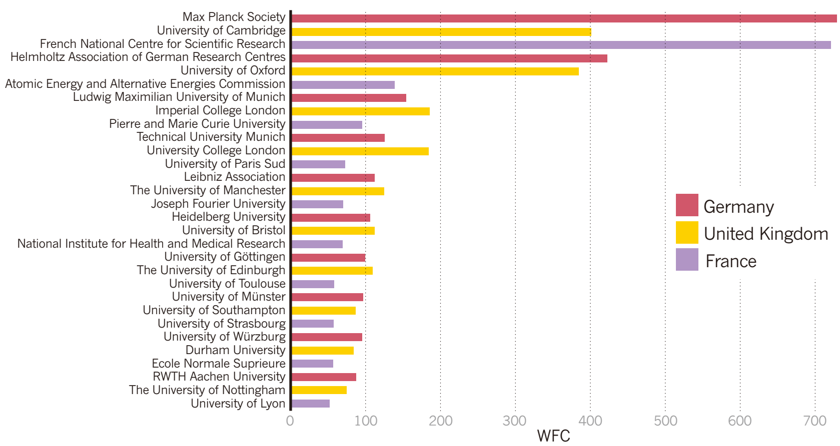
In contrast, the CNRS president is appointed by the government. The agency's scientists have freedom over their work, but are poorly paid and hold on to their jobs even if they are not productive because of civil servants' sacrosanct status in France, an economic analyst said. "MPS keeps only the productive researchers and pays them well. But, there is neither stick nor carrot in France".

CNRS PHOTOTHÈQUE/NICOLE TIGET

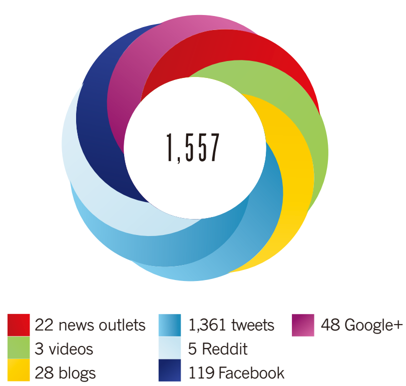
CNRS now spends about 85% of its budget on salaries, whereas MPS spends only around 40%, says Ettl and therefore has much more money available for its 80-plus research institutes. Meunier says this is a problem that is widespread in France. "Salaries should account for no more than 65% of the total," he says.

Another issue, Meunier adds, is that France concentrates too much on research structures rather than individuals. "In basic research, the government should follow the example of the European Research Council's Principal Investigator by selecting lead scientists of quality rather than focusing on institutions or labs." Many of these issues have so frustrated French researchers, that several thousand of them recently marched to Paris from many parts of the country in protest.

Institutional spread for top three countries
The Max Planck Society and France's CNRS dominate, but the UK has more medium-strength institutions.



Cambridge's online visibility
This paper[3], analysing people's patterns of Facebook 'likes', was one of the highest scoring on altmetrics.com in 2013.



3. DOI: 10.1073/pnas.1218772110. Data taken from altmetrics.com on 22 Sept 2014.

Germany's top technical university — a global career destination

Discover TUM. The Entrepreneurial University.

Wolfgang A. Herrmann
PRESIDENT
Technische Universität München

The Technische Universität München (TUM) is one of Europe's leading universities of science and technology, engaged with society and open to the world. Consistently ranked by far number 1 among Germany's technical universities, TUM is taking action to become one of the world's most rewarding career destinations as well – for students, doctoral candidates, postdocs and faculty alike. As President, I want to extend my personal invitation: Find out more about Germany's "entrepreneurial university" in Munich, and consider the unique opportunities it offers.

Why Germany? Why not?

It's easy to say why Germany should be attractive to bright, talented people from all over the world. Our economy is strong and largely based on scientific discovery and technological innovation. Science is valued and broadly supported by our society. Students can get a world-class education here without taking on a crushing burden of debt. Researchers have access to funding sources that are well endowed and managed progressively, with a long-term perspective. The quality of life, by any measure, is excellent.

And yet we know there are barriers that can stand in the way. One of these, the perception that the German language is hard to learn, is understandable but out of date. We offer dozens of degree programs in English, more every year. This benefits not only international students but also young Germans competing in a global labor market where English is the *lingua franca*.

There is a more serious barrier, which mainly concerns those considering academic careers: the perception that the way German universities recruit and promote professors is not transparent, competitive, or fair. Here too, however, things are changing. We are leading the change.

Germany's first true tenure track, and more

TUM has introduced an end-to-end recruiting and career system that is consistent with best practices worldwide and remains – even as others begin to follow our lead – unique in Germany.

The difference can be seen particularly in terms of what TUM offers the world's most promising *young* researchers: real opportunities, based above all on performance, to achieve scientific independence and professional security. This system is flanked by policies and services that make it easier for international professors and their (often dual-career) families to make themselves at home in Munich — one of the world's best places to live and work, better still with a support network ready to welcome and assist newcomers.

The main thrust of this effort is the TUM Faculty Tenure Track System, launched in 2012 with a commitment to hire 100 new tenure track professors by 2020. With this TUM aims to force the transformation of the conventional German *appointment system*, a maze-like anachronism choked with obstacles, into an open, performance-oriented *career path*. This culture-changing enterprise is grounded in the recognition that the best young talents can only be recruited where they know they can advance within the system. Performance-based criteria — for the initial appointment of an *assistant professor* as well as for advancement to *associate professor* and *full professor* — are clearly defined and transparently implemented.

Our latest step in this direction offers the chance to win a joint appointment at TUM and one of the world's most prominent non-university research institutions, the Max Planck Society (MPG). A successful applicant to head a Max Planck or Minerva Research Group can simultaneously be appointed to a tenure track professorship at TUM. Thus together, MPG and TUM can offer a comprehensive package for promising young scientists — from first-class laboratory facilities to the right to confer doctorates and the option of further advancement as part of our faculty — that is (again) unique in Germany. MPG and TUM complement each other perfectly, offering both excellent working conditions and clear opportunities for career advancement right from the start.

TUM Faculty Tenure Track — together with initiatives such as senior-level professorships reserved for distinguished *women* in research, mechanisms to bring international scientists to Munich as postdocs or as visiting professors, and a suite of family-friendly support programs — should make TUM an increasingly attractive destination for top talent worldwide. This in turn will be a key to our university's continued scientific excellence and its effectiveness as a servant of society.

Make a difference in the world — *your way*

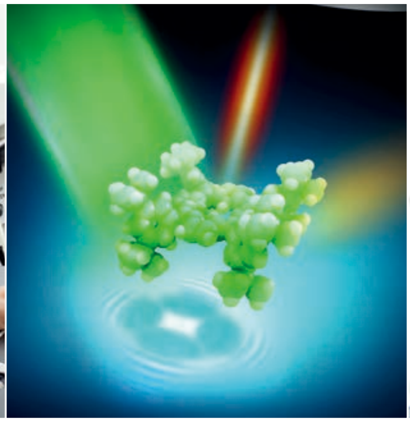
From students to senior researchers and industry partners, being part of TUM means having the chance and the means to make a difference in the world. Germany's technology-oriented universities have always had a core mission, dating back to the 1860s in our case, that is based on fundamental frontier research but strongly directed toward practical results. Basic insights spur innovations and new technologies enable discoveries, in an endlessly creative cycle.

Among the German technical universities, TUM commands the broadest portfolio of disciplines, covering natural and life sciences, engineering sciences, medicine, and economics. TUM fosters research and teaching at the highest level in all of these disciplines. We strongly promote interdisciplinary exploration, cultivate collaborations with industry and other partners, and actively prepare researchers for success in founding startup ventures.

In research, teaching, and partnerships as well as in public outreach and dialogue, today's TUM is oriented toward the major challenges facing society: energy, climate and environment, natural resources, health and nutrition, communication and information, mobility, and infrastructure. Addressing society's challenges requires interdisciplinary approaches that transcend boundaries of all kinds, now more than ever. That's the way we do it at today's TUM. If that works for you, think about joining us — take a closer look!

TUM. The Entrepreneurial University. Get to know us better at **www.tum.de**






THE UNIVERSITY OF SCIENCE AND TECHNOLOGY OF CHINA

PURSUING EXCELLENCE IN SCIENCE

The University of Science and Technology of China (USTC) is one of the most important innovation centres in the country, and is always ranked among its best universities. It is particularly strong in fields such as quantum manipulation, nanotechnology, high-temperature superconductivity, speech processing, fire science and life sciences.

The USTC takes the lead in many major science projects, such as quantum satellite research and dark-matter detection. It is also an active contributor to significant international projects, such as the International Thermonuclear Experimental Reactor (ITER) and the European Organization for Nuclear Research (CERN).

In 2013, the USTC won more than 20 renowned awards in science and technology. For example, a team of USTC physicists led by Professor Xianhui Chen received the first prize in Chinese Natural Science for their contributions to the field of superconducting materials; for the previous three years, there had been no recipients of this prize.

Some of the latest research highlights are described below.

PHYSICS AND CHEMISTRY

High-energy physics at the particle colliders

A team led by Professor Zhengguo Zhao in the School of Physical Sciences made weighty contributions to the study of diboson production, triple-gauge boson couplings and the discovery of Higgs particles via the ATLAS experiment at the Large Hadron Collider (LHC) of CERN. Zhao also greatly contributed to the observation of the Zc particles that were suggested to represent the charmed multiquark states, using the Beijing Spectrometer (BESIII) at the Beijing Electron Positron Collider (BEPCII), and, for the first time, observed over 10 new decay modes of the charmonium states cJ and c. As a result of these outstanding achievements, Zhao was elected as an academician of the Chinese Academy of Sciences (CAS), which is the highest academic honour in the country.

Inorganic solid-state chemistry

Professor Yi Xie and her group at the Hefei National Laboratory for Physical Sciences at the Microscale (HFNL) pioneered research into the design and synthesis of inorganic functional solids with efforts to modulate their electron and phonon structures. Xie established the methodology known as the "synergetic use of binary characteristic structures" for the synthesis and assembly of inorganic functional materials, proposed a strategy for modulating the electron and phonon transport properties with phase transitions at the nanoscale, developed new high-efficiency thermoelectric materials systems, and discovered the relationship between the fine/electronic structures and the thermoelectric/optoelectronic properties of two-dimensional semiconductor crystals. As a female scientist, Xie is the youngest academician of the CAS among those elected in 2013.

Carbon aerogels sop up hydrocarbons

A team led by Professor Shuhong Yu at the HFNL is pursuing carbon aerogel

中国科学技术大学
University of Science and Technology of China

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production from biomass. The team selected bacterial cellulose pellicles — a commonly used, inexpensive, nontoxic form of biomass consisting of a tangled network of cellulose nano fibres — as a precursor for the production of ultralight carbon nanofibre aerogels on a largescale. This biomass can easily be produced on an industrial scale through microbial fermentation.

QUANTUM INFORMATION AND QUANTUM TECHNOLOGY

The Synergetic Innovation Centre for Quantum Information and Quantum Physics (SIC–QIQP), head by Professor Jianwei Pan, was established and financially supported by the Chinese Ministry of Education. It focuses on bringing together teams of multi-disciplinary researchers to form a dynamic national network for developing scalable quantum technologies.

Foiling quantum hackers

A research team led by Professor Qiang Zhang and Professor Tengyun Chen at the SIC–QIQP successfully demonstrated the measurement-device-independent quantum key distribution by developing up-conversion single-photon detectors with high efficiency and low noise. The new quantum-encryption method provides the ultimate security against hackers in real-world cryptography applications, and greatly improves the security of quantum-encryption systems. This research was selected as one of the Highlights of the Year in *Physics* by the American Physical Society.

Guo Moruo Square. USTC was established by the Chinese Academy of Sciences (CAS) in 1958 in Beijing. The director of CAS, Mr. Guo Moruo was appointed the first president of USTC.

A milestone in satellite-based quantum communication

A collaborative team led by Professor Chengzhi Peng at the SIC–QIQP achieved comprehensive and direct verification of quantum communication between satellites and ground stations. This research lays the necessary technical foundations for a global quantum-communication network based on ground–satellite quantum communication by launching the quantum science experimental satellite of China.

Optical spectroscopy goes intramolecular

A team led by Professor Zhenchao Dong at the SIC–QIQP reported an optical spectroscopic-imaging approach that achieves subnanometre resolution and resolves the internal structure of single molecules. This development could lead to new techniques for probing and controlling nanoscale structure, dynamics, mechanics and chemistry. This research was listed among China's top 10 science news stories in 2013.

ENVIRONMENTAL AND EARTH SCIENCES

Penguins thrived in Antarctica during the Little Ice Age

New research led by Professor Liguang Sun in the School of Earth and Space Sciences showed that penguin populations in the Ross Sea of Antarctica spiked during the short cold period, called the Little Ice Age, which occurred between AD1500 and 1800. These results run contrary to previous studies that found increases in Antarctic penguin populations during warmer periods and decreases during colder periods, suggesting that populations living at different latitudes in the Antarctic might respond differently to climate change.

Uncovering the mystery of subduction zone earthquakes

Based on analytical data from four of the highest magnitude subduction zone megathrust earthquakes, the conclusion was drawn that low-frequency radiation is closer to the trench at shallower depths and high-frequency radiation is farther from the trench at greater depths, in general. This scientific breakthrough was achieved by a team led by Professor Huajian Yao.

LIFE SCIENCES

New evidence for curing type 2 diabetes

Research teams led by Professor Rongbin Zhou and Professor Zhigang Tian in the School of Life Sciences revealed a new mechanism through which omega-3 fatty acids inhibit inflammation and prevent type 2 diabetes. The research results were published in *Immunity* in June 2013 and highlighted in the same issue of the journal.

Identifying liver-resident natural-killer cells with immune memory

A team also led by Professor Zhigang Tian identified liver-resident natural-killer (NK) cells that possess unique immune memory characteristics absent from normal NK cells.

LincRNA-p21 as a novel key player in regulating the Warburg effect

A research team led by Professor Mian Wu and Professor Yide Mei, at HFNL and the School of Life Sciences, has revealed a novel mechanism whereby lincRNA-p21 regulates the Warburg effect under hypoxic conditions. They demonstrated, for the first time, that lincRNA-p21 is an important regulator of the Warburg effect, and also identify lincRNA-p21 as a valuable therapeutic target for cancer.




SUN YAT-SEN UNIVERSITY

CHALLENGING TRADITIONAL PARADIGMS

Sun Yat-sen University was founded in 1924 by Dr Sun Yat-sen, a great democratic revolutionary leader of the twentieth century. Its medical school was established even earlier in 1866. The four campuses of Sun Yat-sen University are situated in Guangzhou and Zhuhai, China by the Pearl River and the South China Sea. It is a leading, internationally renowned comprehensive university in China, which advocates a dedication to learning, seeks to imbue people with a passion for education and adopts the mentality that "the professors are the university". It has one of the most relaxed and unconstrained intellectual atmospheres of all the universities in China.

Sun Yat-sen University is active in a wide variety of academic disciplines, including the liberal arts, social sciences, sciences, engineering and medicine. According to the Essential Science Indicators, 16 academic disciplines at Sun Yat-sen University are ranked in the top 1 per cent worldwide; this number is the third highest for universities in China.

The university boasts eight affiliated hospitals that together treat more than 10 million patients each year. This represents a sophisticated network of medical services and provides a source of abundant first-hand clinical data. The academic strength, large size and high quality of the medical school contribute to it being ranked among the top universities in the country.

Sun Yat-sen University is conveniently located close to Hong Kong and Macau, and has strongly pursued collaborations in those regions. Moreover, the university has forged long-term strategic partnerships with institutions such as the Consortium Français de Formation d'Ingénieurs en Nucléaire Civil, Carnegie Mellon University and the Johns Hopkins School of Medicine. These collaborations have considerably extended the influence and enhanced the competitiveness of Sun Yat-sen University worldwide.

RESEARCH

Sun Yat-sen University enjoys excellent funding for scientific research, with annual government grants of over one billion RMB for longitudinal research for the past four years. Researchers have published thousands of high-quality articles in journals such as *Nature, Science, The Lancet* and *Cell* as well as their subsidiary journals. The university is ranked 12th in the Nature Index for China.

Achievements in academic research and consulting with government agencies have established the university's reputation both domestically and internationally. Globally influential research includes ecological studies where it was discovered that previous extinction rate estimates were overestimates — the actual rate of species extinction is roughly 40 per cent of previous estimates. This result was published in *Nature* in 2011 and overturned the former consensus in the scientific community regarding the species extinction rate. Another example of the university's groundbreaking research is the explanation of how the composition and structure of DNA in a cell affect spontaneous mutations. This research was published in *Science* in 2012 and provides important guidelines for understanding the genomic structure and evolution of eukaryotes. In 2014, it commissioned a supercomputer with the fastest computational speed in the world, Tianhe-2, which will provide powerful support for cutting-edge research.

Sun Yat-sen University is strong in both traditional and newly emerging disciplines, including the classic basic sciences, information technology, materials science, health sciences, humanities, business administration and social sciences, and it has developed long-term, ambitious goals for all these fields. It has also drafted ambitious institutional development strategies for establishing a platform to conduct world-class research, including both large-scale recruitment and cultivation of internationally outstanding scientists and scholars.

RECRUITMENT OF TALENTED RESEARCHERS

The recruitment of talented teachers and researchers is crucial to the development strategy of Sun Yat-sen University. The university is very inclusive when recruiting outstanding researchers from both China and overseas. The university has commenced the second phase of its 100 Top Talents Program and hopes to attract exceptional researchers by offering excellent starting conditions, salaries and benefits and a free intellectual environment as well as transparent and efficient recruiting procedures.

Sun Yat-sen University is an ideal environment for both work and life, choosing it will make your dreams come true.

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East & Southeast Asia

China, Japan, Singapore and South Korea vividly demonstrate how significant investment in science can help to fuel national economic growth.

ARTICLE COUNT (AC): 15,638
FRACTIONAL COUNT (FC): 11,449
WEIGHTED FRACTIONAL COUNT (WFC): 10,811

Nations across East and Southeast Asia have enjoyed success from implementing policies that increase research and development (R&D) budgets and stimulate scientific endeavours, says Tateo Arimoto, the director of Science, Technology and Innovation Policy Program at Japan's National Graduate Institute for Policy Studies. "A remarkable increase in scientific output in recent years reflects these efforts," he says. The region might be third overall by weighted fractional count (WFC), which gives a measure of the relative contribution to each paper; but three of its countries — China, Japan and South Korea — are in the top ten, led by China with a WFC of 5,206.

China and Japan, the world's second and third largest research spenders, are expected to jointly invest nearly 28% of the total US$1.6 trillion (valued in purchasing power parity) for R&D around the world in 2014, according to US thinktank the Battelle Institute. South Korea is expected to come fifth, with a US$63 billion research and development expenditure.

These countries are traditionally strong in physical science and chemistry — of China's total WFC of 5,206, for example, a WFC of 4,696 (or 90%) is from chemical and physical sciences. The Asian powers are spending heavily to maintain this lead, particularly in target areas such as nanoscale research. But, Buhm Soon Park, head of the Graduate School and of science and technology policy at Korea Advanced Institute of Science & Technology (KAIST), questions whether a narrow focus is the best way forward. He says this approach will "raise the real question of how far China and Korea can go with such intensive funding".

"IT IS VERY CLEAR THAT CHINESE SCIENTISTS ARE MAKING TREMENDOUS BREAKTHROUGHS."

Soon Park's worry is shared by Fengchao Liu, a professor of science policy at Dalian University of Technology (DUT) in China, who adds that the Asian countries lag behind the United States and much of Europe in terms of generating novel research.

CHINA, THE BIG SPENDER

There's no doubt that China has the greatest growth rate, both in terms of R&D investment and scientific outputs, of the region's countries. According to UNESCO, China's research spending passed 1 trillion yuan (US$163 billion) in 2012, or 1.98% of its GDP, surpassing the European Union's 1.96%. A decade previously, the country was investing only 1% of GDP.

From 2012 to 2013, China's WFC increased by 15% — even more impressive when compared to an increase of less than 1%, or even a decrease, for all other top-ten WFC countries.

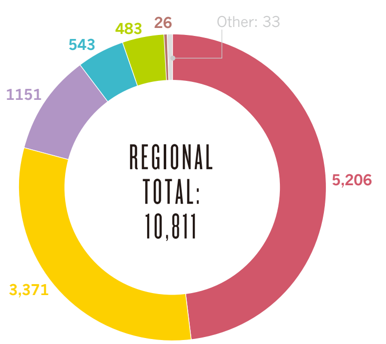
A recurring criticism is that this rise in quantity has not been matched with improved quality, but that might be changing. China also published more in *Nature* and *Science* in 2013 than in 2012, rising from a position of eight to five overall on this measure. And, says Zheng Liang of the China Institute for S&T Policy at Beijing's Tsinghua University, there's more to come. "It is very clear that Chinese scientists are making tremendous breakthroughs in areas like physical sciences," he says. "And China's capacity in technological development and engineering projects has dramatically grown."

In 2012 a Chinese paper made *Science* magazine's prestigious top-10 breakthroughs for the first time in the list's 18-year history. The study, by researchers with the Chinese Academy of Sciences (CAS) at the Daya Bay Nuclear Power Plant, measured the last unknown parameter needed to describe how neutrinos collide at near-light speed. Results are expected to help explain why the universe contains so much matter and so little antimatter.

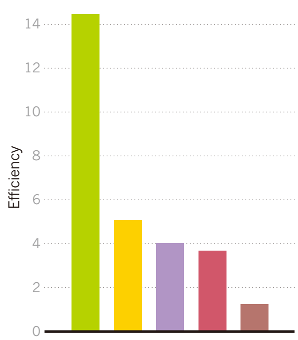
EAST & SOUTHEAST ASIA ANALYSIS

China | Japan | South Korea | Taiwan | Singapore | Thailand

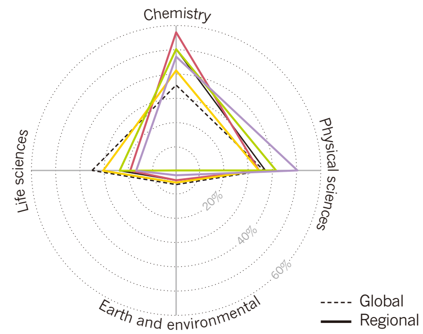
Countries' weighted fractional count (WFC)
Of the 15 countries in the region, three dominate the scientific output, led by China.



Researcher efficiency
WFC per 1,000 researchers[1].



Research strengths
Most countries focus on chemistry and physical sciences. Japan is strongest in the life sciences[2].



1. Source: UNESCO. 2. Subjects overlap, so the total for each country can be >100%.

SINGAPORE

Punching above its weight

A*STAR

A*STAR is one of three main institutions

Although Singapore is the smallest nation in Southeast Asia, in some respects it outperforms other countries in the region and further afield. For example, the Global Competitiveness Report 2014–2015 released by the World Economic Forum in early September 2014 endowed the silver medal of competitiveness to Singapore, second only to Switzerland. This measure aims to quantify a country's drivers of productivity and prosperity.

The Nature Index adds another credential to those plaudits, showing that the nation has world-class efficiency. The rate of WFC per 1,000 researchers is 14.2 — comparable to the Uinted States and ahead of most major European nations except Switzerland (see Researcher efficiency). According to Wong Poh-Kam, a professor of innovation policy at National University of Singapore (NUS), the city state's active international collaborations, particularly with China, contribute to its excellence.

There are three main players in Singapore: the Agency for Science, Technology and Research (A*STAR), Nanyang Technological University (NTU), and the NUS. Although chemistry is still the greatest strength for all three, there is a growing focus on government funding for life sciences.

Although China and its leading institutions are showcasing growth, its foundations could be a lot better, says Cong Cao, a leading China science policy expert at the United Kingdom's University of Nottingham, who has repeatedly urged an overhaul of China's science system. "Funding for basic research has been below 5% of total R&D spending for a long time, weakening China's innovation capacity," Cao says. Comparative figures for the United States and Japan are 19% and 12.5%, respectively. "In addition, funding is unevenly concentrated in some top academicians, resulting in reported misuses and insufficient resources for young scientists to develop."

NTU

One of Nanyang Technological University's schools

PEKING UNIVERSITY

CAS is the leading institution in the world in terms of overall publications in high-quality journals, with a WFC of 1,209 in the Nature Index and a size and stature to match: the Academy has 50,000 scientists at more than 100 research institutes. But China's leading single institution is Peking University (PKU). Like the country in general, PKU is strong in chemistry (see 'Institutional subject spread'), which chemist Song Gao, vice-president of the university, attributes partly to its strong collaborations with other institutions, such as the CAS and the University of California.

However, when it comes to publishing in *Science* and *Nature*, PKU is on a par with CAS — but Gao feels that its scientists could do better (see 'Nature and Science split'). Gao says the university concentrates too much on sluggish research fields, and suffers from a paucity of long-term systematic studies and inadequate funding. Targeting the crossover area of chemical biology could help to boost higher-profile results, he says.

Yi Rao, former dean of the Peking University College of Life Science, agrees that PKU's life science is weak. Other universities have much bigger budgets and a longer track record in life science, he says. However, PKU has recently hired at least 30 new junior faculty members to boost research in this area. "Once our newly recruited faculty members grow up, things will change," Rao predicts.

JAPAN, PULLING OUT OF STAGNATION

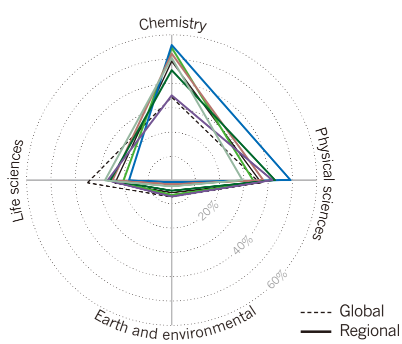
Home to the top two universities in the region, the universities of Tokyo and Kyoto, Japan also enjoys a higher ratio of publications in top journals *Nature* and *Science* than other countries in the region — although at 1.9% this is still below the global average of 3.1%. Japan is also much stronger in life sciences than China and South Korea. Since 2000, 14 Japanese scientists have been awarded Nobel Prizes. The most recent Japanese-born laureates, who jointly collected the 2014 prize in physics, are Isamu Akasaki, Hiroshi Amano and Shuji Nakamura (now a US citizen) for their invention of efficient blue light-emitting diodes that enabled bright and energy-saving white light sources.

Greater funding for basic science also distinguishes Japan from China and South Korea, says KAIST's Soon Park. He says that science in these latter two countries is often perceived in "utilitarian terms" — that is, as a necessary step in the production of technology.

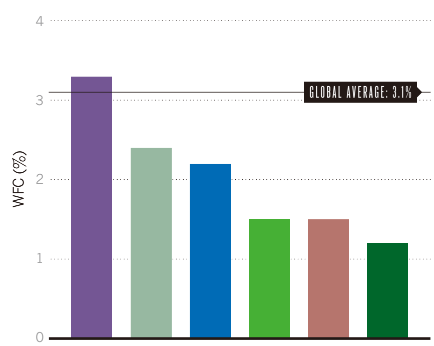
After years of stagnation, Japan's R&D expenditure started to grow again in 2012, rising 1.6% over the previous year to 17.4 trillion

Chinese Academy of Sciences (CAS) | Korea Advanced Institute of Science and Technology (KAIST) | Kyoto University | Peking University (PKU) | Seoul National University (SNU) | The University of Tokyo

Institutional subject spread
Leading institutions in each country focus heavily on chemistry and physical sciences[1].



***Nature* and *Science* split**
Within the region, only The University of Tokyo publishes above the global average.



1. Some subjects overlap, so total can be >100%.

yen (US$165 billion). In 2013, the Council for Science and Technology Policy, chaired by Prime Minister Shinzo Abe, called for a dramatic increase in the numbers of female and

KAIST has strong international links

KAIST

foreign researchers at Japanese research institutes from 3.9% to 20% by 2020. It also called for total government R&D investment to be secured at 1% of GDP.

This national ambition is expected to benefit top universities like the University of Tokyo, which is the region's biggest producer of papers in *Science* and *Nature* (making up 3.3% of its overall output in the index). One *Nature* paper, on which four out of five authors were from the University of Tokyo, considered the quantum teleportation of information or qubits, which scored well in the online and social media-focused altmetrics system (see The University of Tokyo's online visibility).

The University of Tokyo is stronger in life science than many other institutions in the region, with 27% of its papers in this field. In the index, the university's recent highlights include a paper in *Nature* about a revolutionary method to probe molecular structure using 'crystalline sponges', and one in the *Journal of Clinical Investigation* presenting evidence that RNA splicing is involved in certain types of cancer that affect blood cell production. Such successes are proving alluring. "Promising young researchers have been moving from physics and chemistry to medical and biological sciences," says Arimoto.

"AN EXPERIMENTAL SPIRIT IS FIRMLY INGRAINED IN KAIST, SOUTH KOREA'S ELITE SCHOOL."

But, says Masatoshi Tagawa, a molecular biologist at Japan's Chiba University, the University of Tokyo, and Japan in general, risks losing its edge unless it collaborates more. In the index, Japan has one of the lowest rates of collaboration in the region (see 'Collaborative potential'). Liu of DUT agrees: "Japanese industries have rapidly expanded their collaborations with worldwide academics, but their universities are relatively conservative in both international collaborations and welcoming foreign researchers."

IMPORTANCE OF IMPACT

Although South Korea is perhaps best known for the commercial products pumped out by Samsung or Hyundai (both of which appear in the index), its basic research output is also strong. The country has 1,953 papers in the Nature Index in 2013, with a WFC of 1,151 placing it tenth worldwide.

Across most research fields, Seoul National University (SNU) and the Korea Advanced Institute of Science and Technology (KAIST) have the country's leading WFCs, with Samsung Electronics achieving the third highest output in physical sciences. Both South Korean institutions have seen a decrease in their output of high quality science since 2012, dropping in WFC terms by 11% for SNU and 18% for KAIST.

As the country's top research university, SNU has a long and prestigious history with a strong tradition of physical sciences research, borne out by the Nature Index showing 42% of its output is in this field. Nevertheless it is growing its capacity in the life sciences, and at 26% has the highest proportional output in South Korea – despite a setback when, in 2006, stem-cell researcher Woo Suk Hwang was discredited for fabricating data on cloned human embryos.

SNU has an AC twice that of KAIST, and a WFC that is 50% higher, but KAIST's researchers have a greater percentage of papers in *Nature* and *Science*: 2.2% of all output compared to 1.2% for SNU.

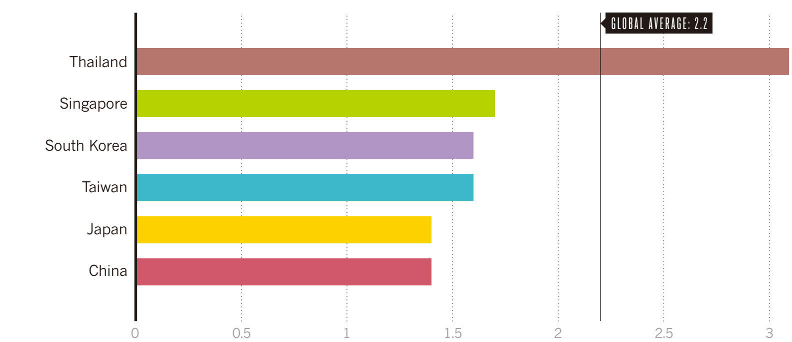
The two institutions are very different. KAIST was created in 1971 as an elite graduate school focused on research, under the Ministry of Science and Technology instead of the Ministry of Education. Its academics are better paid and have greater autonomy than at other South Korean universities, including the ability to waive tuition fees, exempt KAIST students from military service, hire new faculty members and create (or close) new academic programmes. "The experimental spirit is firmly ingrained in the school," says KAIST's Soon Park.

Sung-Mo Kang, President of KAIST, thinks international links have played a key role in its success. "Out of KAIST's total 877 faculty members recruited between 1971 and 2014, 617 professors received their doctoral degrees in the US," he says. ■

China | Japan | South Korea | Taiwan | Singapore | Thailand

Collaborative potential

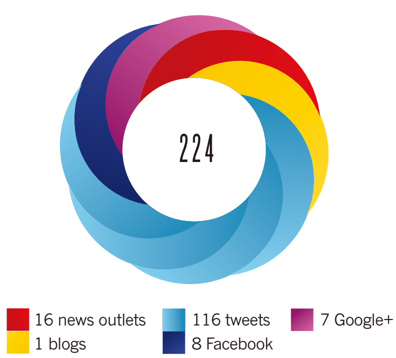
Only Thailand is above the global average for international co-authors per paper.



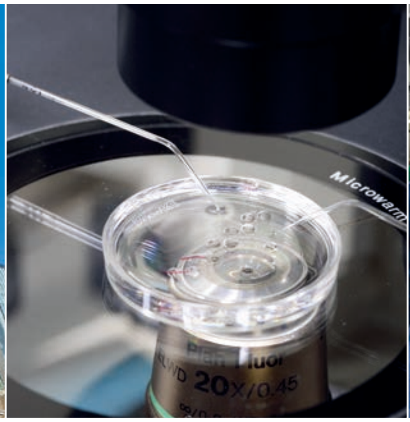
1. DOI: 10.1038/nature12366. Data from altmetric.com, 22 September 2014.

The University of Tokyo's online visibility

Strong coverage for its paper[1] on the quantum teleportation of information, or qubits.








MEIJI UNIVERSITY

NEW MODELS FOR ORGAN PRODUCTION AND TRANSPLANTATION

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Meiji University was founded in 1881 during the Meiji era in Japan, when the country was going through major political and economic changes, transforming from a feudal society to a modern industrial state. The university was originally named the Meiji Law School, specializing in the instruction of French law to Japanese students with the idea of building a free society founded on individual rights. In 1903, the school was renamed to its current title to reflect its expansion into other areas of study in the humanities as well as the natural sciences. Today, Meiji University has 10 undergraduate schools, 15 graduate schools and 28 departments that cover a comprehensive range of fields, from political science to agriculture, science and technology.

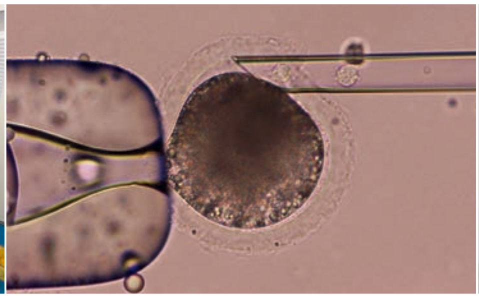
Meiji University has made great strides in research, thanks to the strategic vision of the Organization for the Strategic Coordination of Research and Intellectual Properties established in 2005 to ensure that the university delivers world-class research. The organization consists of two key branches working in close collaboration — the Research Planning and Promotion Headquarters, responsible for the planning, preparation and implementation of university research policy; and the Research Extension and Intellectual Property Headquarters, tasked with promoting collaborative projects involving industry, academia and the government. Both branches also develop strategies for ensuring a conducive environment for international research at the university.

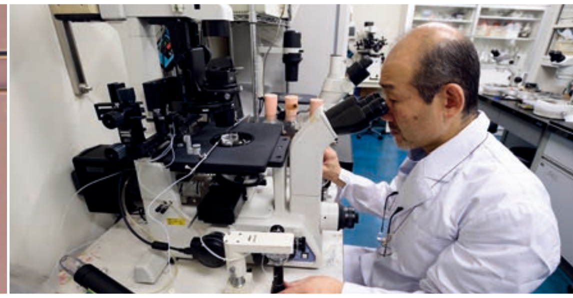
AGRICULTURE AND MEDICINE

A key institute conducting globally recognized research at Meiji University is the Meiji University International Institute for Bio-Resource Research (MUIIBR). Established in 2011, MUIIBR is comprised of a network of universities, research institutes and companies in Japan and overseas, and has been awarded several research grants from the Japan Science and Technology Agency, including from the Exploratory Research for Advanced Technology (ERATO) and Core Research for Evolutionary Science and Technology (CREST) funding programmes.

> **"In agriculture, the concepts of enhancing system efficiency and protecting genetic resources so that they can be passed on to the next generation are very important."**

Hiroshi Nagashima is the director of MUIIBR, as well as general manager at the Research Extension and Intellectual Property Headquarters and a professor at Meiji University's School of Agriculture. "In agriculture, the concepts of enhancing system efficiency and protecting genetic resources so that they can be passed on to the next generation are very important," says Nagashima. MUIIBR integrates these agricultural principles and animal





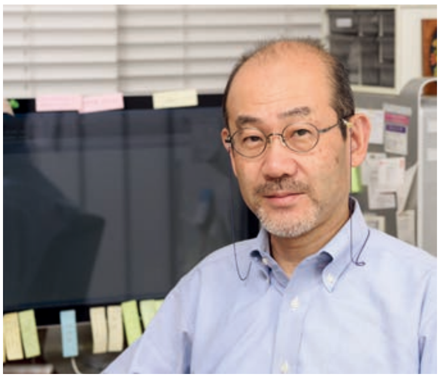
biotechnology methods in the development of new techniques for regenerative medicine and therapies for rare human diseases. To achieve this, MUIIBR relies on the creation, maintenance and utilization of biological resources, with a specific focus on genetically engineered pigs.

TRANSLATIONAL RESEARCH

Translational research creates an important bridge between basic biological and medical investigations using model organisms such as mice and clinical research that can contribute to advances in human well-being. The general consensus within the medical community is that pigs are a useful model in preclinical research because of their physiological and anatomical similarities to humans. MUIIBR therefore focuses on developing pig models for translational research.

In the area of regenerative medicine, MUIIBR uses genetically engineered and cloned pigs to create organs for transplantation. Organ transplantation is the only therapeutic option available for end-stage organ failure, but the procedure is severely limited by shortages in organ availability. The use of induced pluripotent stem (iPS) cells and embryonic stem (ES) cells to generate organs for transplantation offers huge potential for addressing the problem, but difficulties in growing organs derived from iPS and ES cells in cell culture have limited their clinical applicability. Nagashima and his colleagues therefore decided to use pig models to grow organs for transplant surgery.

To fulfil their goal, the researchers first used gene manipulation techniques to create pig models lacking specific organs. They then injected embryonic cells known as blastomeres into the empty space or 'niche' where the original organ would have been to generate an entirely new and viable organ in the vacant niche. In 2010, a team of researchers at the University of Tokyo succeeded in generating a functional pancreas derived entirely from rat iPS cells in a mouse model. Following this, MUIIBR succeeded in taking cells derived from one pig to grow a pancreas in another pig that originally lacked the organ. Researchers at the institute plan to continue these *in vivo* experiments in organ production using different cross-species combinations of model organisms and cells derived from pigs, sheep, cows and even humans.



Hiroshi Nagashima, director of the Meiji University International Institute for Bio-Resource Research, is leading research at the confluence of agriculture and medicine.

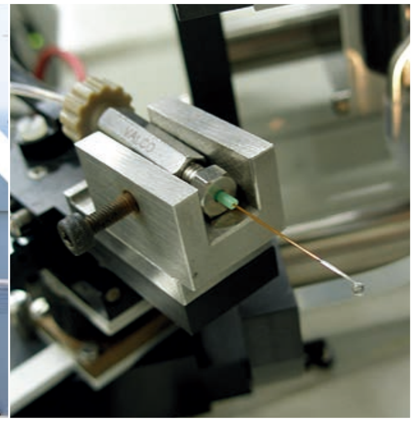
In addition to cross-species organ growth, researchers at MUIIBR are also investigating "xenotransplantation", in which pig organs are transplanted to humans. The biggest challenge in applying this method is the potential for the recipient's immune system to reject the foreign organ. One form of rejection known as hyperacute rejection can occur within minutes of transplantation. A key factor in activating hyperacute rejection in pig-to-human transplantation is the presence of natural antibodies in humans against galactose epitopes, which are synthesized on the surfaces of pig cells by the enzyme α1,3-galactosyltransferase. Researchers at MUIIBR therefore developed pig models in which the gene encoding α1,3-galactosyltransferase expression was removed, or knocked out. Only a few researchers in the world have been able to develop α1,3-galactosyltransferase-defficient pig models, and the MUIIBR team was the first to do so in Japan.

NEW MODELS FOR HUMAN DISEASE

Another major project at MUIIBR is the development of pig models for human disease. While many researchers have created mouse models for human disease, the observable characteristics of a mouse model can differ from those phenotypes observed in humans with the same disease. Pigs, on the other hand, are often characterized as having symptoms that more closely resemble those observed in humans. To date, MUIIBR has created pig models for Marfan syndrome, a genetic disorder that affects the connective tissue in the body. The gene expressing for the disorder is dominant, meaning that it is expressed even if only one copy is inherited. Approximately 1 in 5,000–10,000 individuals worldwide have inherited the disease.

Ultimately, the clinical application of MUIIBR's research will depend on the type of organ or disease targeted for research. One prime candidate for clinical application is the transplantation of insulin-producing cells in the pancreas known as the islets of Langerhans. These islet cells deteriorate as soon as the pancreas is damaged. Given the shortage of organ donors, the techniques of growing organs in animal models and transplanting animal organs into patients could offer a temporary solution until clinically applicable methods of pancreas organogenesis from patient-derived iPS cells are developed.

MUIIBR's holistic approach to xenoregeneration-based organ transplantation therapy — from bio-resource development to organ growth and eventual transplantation — has defined its success in the field. Of particular advantage has been the advanced cryopreservation technology established at the institute for safely storing frozen pancreatic islet cells and fertilized eggs. "We are probably the only institute in the world taking such an integrated approach," says Nagashima.



TOKYO UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

GLOBAL INNOVATION RESEARCH ORGANIZATION FOCUSES ON THE AREAS OF FOOD, ENERGY AND LIFE SCIENCE

Tokyo University of Agriculture and Technology (TUAT) has a long history of improving human society through advances in agricultural science and engineering. Ever since its beginnings in the 1870s as two government departments that merged in 1949 to form a university, TUAT has placed a strong emphasis on improving the lives of people in Japan and beyond.

That emphasis received an international twist this year with the launch of the Global Innovation Research Organization, which will bring together TUAT researchers and leading international professors to tackle global problems in the areas of food and energy. Measures include increasing crop yields to combat global food shortages, monitoring air pollution in East Asia and safeguarding the world's energy supply.

The creation of the Global Innovation Research Organization was the brainchild of the University's president, Professor Tadashi Matsunaga, and it was supported by priority allocation from the national universities' budget. It promises to transform the way research is undertaken at TUAT. The initiative will increase connections with international partners and provide novel management training opportunities for young researchers in the areas of food and energy.

Led by the vice president of TUAT, Professor Chisato Miyaura, the Global Innovation Research Organization will focus on three critical priority areas: food, energy and life science. These areas reflect TUAT's focus on addressing the most immediate problems facing humanity. Each area will have three teams, which will be led by a TUAT researcher teamed with a distinguished international professor. The international professors will be invited to participate in the organization as recognition of their high standing in the global scientific community, and they will visit TUAT for one to three months to focus solely on research.

FEEDING THE WORLD

Food shortage is a devastating global issue, affecting 842 million people, 66% of whom are in the Asia-Pacific region. Hence, food is one of the research priority areas of the Global Innovation Research Organization. These research programmes have the potential to positively impact our food supply, health and the environment.

> "In these collaborations with distinguished professors from around the world, the Global Innovation Research Organization will foster such abilities in young researchers."

The first team in the food group is led by Professor Tadashi Hirasawa, who, in collaboration with a distinguished professor from the USA, will focus on using genome information to increase the production yield of a variety of crops. Hirasawa's team will identify which genes in plants facilitate photosynthesis

Tokyo University of Agriculture and Technology

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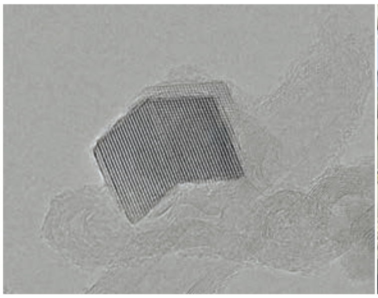
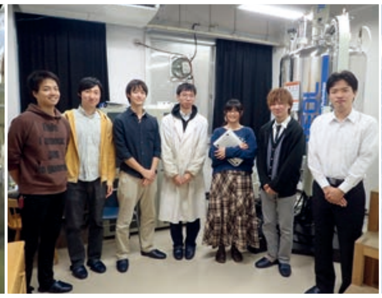
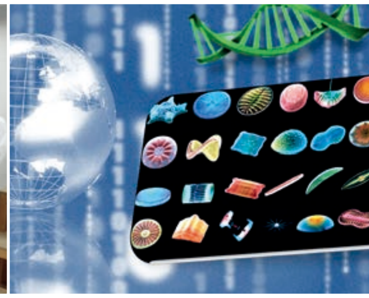






and then use this knowledge to propose a selection process designed to enhance crop yield. Professor Nobuhiro Takahashi leads the second team, which will focus on studying the turnover and physiological function of RNA in animal cells. "The insights gained from this work have the potential to provide novel targets for the early diagnosis and treatment of severe neurodegenerative diseases," he says. Meanwhile, Professor Shiro Hatakeyama's team, which consists of a network of collaborators in Japan, Korea, Taiwan and Hong Kong, will study transboundary air pollution in East Asia. The collaboration with the distinguished international professors will assist the research teams in understanding how air pollutants are distributed and transformed across the East Asia region and clarify how specific emission sources contribute to air pollution.

ENERGIZING THE GLOBE

Energy production and storage are becoming increasingly important topics, with world energy consumption predicted to increase by 56% between 2010 and 2040. Hence, the second priority area of the Global Innovation Research Organization is energy. Professor Hiroyuki Ohno leads the first team, which will use ionic liquids to develop novel energy conversion technologies in collaboration with a distinguished professor from Italy. "We will focus specifically on improving the performance of batteries, fuel cells, biorefinery processes and novel refrigeration processes," he says. Taking another approach, Professor Yoshinao Kumagai leads the second team, which will seek to develop materials for low-loss and high-power electrical devices. In collaboration with a distinguished professor from Sweden, Kumagai's team will concentrate on developing high-quality, crystalline group-III (for example, metals such as aluminium, gallium and indium) nitride semiconductors. Advanced supercapacitors is the topic of choice for Professor Katsuhiko Naoi and the third team in the energy group. These researchers, which include a distinguished professor from France, have proposed a new supercapacitor system, dubbed the 'nano-hybrid capacitor', so called because it is based on a combination of carbon nanofibres and nanocrystalline lithium titanate. "We believe that the nano-hybrid capacitor could help meet the energy and power demands for a variety of applications, including microelectronic devices and electrical vehicles; it has the potential to be a breakthrough improvement," Professor Naoi says.

INVESTIGATING NATURAL SYSTEMS

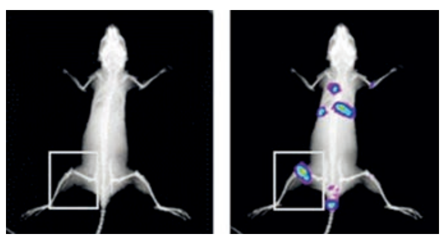
The life science priority area brings together three very different but thematically linked investigations. The first team is led by Associate Professor Masaki Inada who has teamed up with collaborators from Spain, the UK and Germany. This team will utilize the respective expertise of Inada and the distinguished professors to develop biomedical applications for treating diseases such as cancer based on complexes of collagen molecules. The second team, led by Professor Kazuhiro Chiba with a distinguished professor from Finland will focus on developing nanoparticle drug delivery systems, combining the preparation of a range of nanoparticles and biologically active complexes to develop nano-sized drugs capable of being absorbed through the skin. The third team, led by Associate Professor Tsuyoshi Tanaka with input from distinguished professors from France and the USA will establish a new research group of excellence for 'marine-omics'. This field combines data from genomics, environmental microbiology, geochemistry and molecular biology to provide rich insights into marine microalgae and how they may be used to address current issues in food, energy and health research.

TRAINING THE NEXT GENERATION OF RESEARCHERS

In addition to tackling challenging scientific problems, the Global Innovation Research Organization aims to help scientists, especially early career researchers, become literate in management principles. "It is unusual to find young researchers in Japan who have an appreciation of both scientific techniques and management skills," remarks Professor Miyaura, the head of the organization. "In these collaborations with distinguished professors from around the world, the Global Innovation Research Organization will foster such abilities in young researchers." In this way, TUAT aims to promote the globalization of research in its focus areas, especially among young researchers.

Genetic analyses in plants facilitate photosynthesis to enhance crop yield.

Growth reactors of new single crystals for low-loss and high-power electrical devices



Bio-imaging analyses for medical application of diseases such as cancer.

:insideview
profile feature

Professor Yonghua Song, Executive Vice-President, Zhejiang University, Hangzhou, China

Located in the historical and picturesque city of Hangzhou, Zhejiang University is perfectly positioned to be an innovative, comprehensive research university with world-class standing. Throughout its 117-year history, Zhejiang University has maintained a commitment towards cultivating talent, with the primary goals of pursuing excellence, advancing science and technology, developing society and promoting culture. This spirit is manifested in the university motto "Seeking the Truth and Pioneering New Trails". Zhejiang University is a comprehensive research university with national and international reach. Research at Zhejiang University spans 12 academic disciplines, including philosophy, economics, law, education, literature, history, art, science, engineering, agriculture, medicine and management. In 2013, the research fund at Zhejiang University totalled 3 billion RMB. Moreover, 116 research projects have each secured a grant of more than 10 million RMB.

Q: What are Zhejiang University's goals?

Zhejiang University is the first university in China solely founded by Chinese nationals. From its inception, Zhejiang University's pedagogical approach was characterized by practical application and societal impact. In the past 20 years, Zhejiang University has aimed to become a world-class university, taking the lead among universities in China to explore and exercise a training system for top-level innovative talents in the establishment of a research university.

We select only the best students from across the country for freshman class. We are also the most selective graduate school in China. We want every Zhejiang University professor to be able to create innovative knowledge and train students to create such knowledge, laying the groundwork for every graduate to demonstrate leadership qualities and make a positive impact on society. This is the most fundamental mission of Zhejiang University.

Q: What are Zhejiang University's key strengths?

Zhejiang University covers the most diverse areas of study of all universities in China and is ranked number 159 in academic influence by the Essential Science Indicator (ESI) ranking of September 2014. With 17 areas of study ranked in the top 1% in the ESI, Zhejiang University is the most rapidly improving university in China. Upside potential of zhejiang university is not only because of the China's rapid economic development, but also because the Zhejiang province is a highly innovative and economically dynamic region with an annual GDP of 3.75 trillion RMB (612 billion USD).

Hangzhou, the capital of Zhejiang Province, is a cultural and scenic city, described by the Italian explorer Marco Polo as "the most beautiful and most attractive town". Alibaba, a world-renowned Chinese enterprise is headquartered in Hangzhou. These geographic advantages also contribute to the growing potential of Zhejiang University.

Q: What qualities does Zhejiang University look for when hiring researchers?

Each year, well-known scholars from academic institutions around the world choose Zhejiang University as a home where they can express their strong academic creativity. We hope that the most competent young scholars from a range of research fields will join Zhejiang University, leading their research teams to produce internationally competitive academic achievements, and using their charm and ability to influence and train young students.

Q: What does Zhejiang University do to attract top academic talent?

In recent years, Zhejiang University has been committed to building an academic environment designed to attract talent. These commitments have involved developing our policy and funding programmes. We have been able to provide a high standard of living and international academic research conditions for outstanding academics.

The University has set aside 1.8 billion RMB to invest in its high-level faculty team over the next 4 years, which is very rare among Chinese universities. Zhejiang University has implemented the tenure track system to provide young researchers with quality academic conditions and wages. We are hoping that this will significantly enhance the development of Zhejiang University.

"Hangzhou, the capital of Zhejiang Province, is a cultural and scenic city, described by the Italian explorer Marco Polo as "the most beautiful and most attractive town"

Q: What do you consider to be the main challenges for Zhejiang University to become a world-class university?

I studied and worked in the UK for 18 years, prior to which I had gained 20 years of research experience in China. These experiences were important for my personal growth as well as my academic and administrative capacity; they also allow me to view different academic and educational institutions objectively. I believe the key to building a world-class university is to gather a team of international faculty.

But by "international" I do not mean that the focus has to be on the actual nationalities of the faculty members; instead it refers to an open mind and the ability to communicate with the world.

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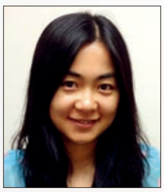
Zhejiang University

SEEKING THE TRUTH AND PIONEERING NEW TRAILS

As a national university, Zhejiang University is building itself into an innovative and comprehensive research institution of world class standing. Zhejiang University adheres to the spirit of seeking the truth and pioneering new trails, dedicating itself to creating and disseminating knowledge, inheriting and advancing civilization, serving and leading society, and promoting national prosperity, social development and human progress.

Why did you choose Zhejiang University?



"Zhejiang University acts as a bridge to the exciting and fast-growing Chinese market. It allows researchers to harvest real-life problems and provides abundant opportunities for applying research outcomes to real systems. Besides providing opportunities to work with the best students in China, Zhejiang also has an excellent research environment that nurtures world-class research."

Professor Wenyuan Xu, College of Electrical Engineering

"For a young researcher, China is a fascinating country to begin an independent career. The creativity and pace of modernization will impress everyone who visits, and having a position here gives you the opportunity to focus on what really matters: research and the education of a new generation of scientists. Zhejiang University is one of the top universities in China and provides starting faculty with excellent working conditions.

The Department of Chemistry supports its young professors wherever it can, gives them much freedom and welcomes interdisciplinary collaboration. I am happy to have brilliant and helpful colleagues as well as smart, hard-working students."

Research Professor Simon Duttwyler, Department of Chemistry

"As a former PhD student at Zhejiang University, I have always valued its strong support network, so after doing two postdoc programmes here, when the opportunity came for me to stay and teach, I took it without hesitation. I am proud to be on the faculty of the College of Agriculture and Biotechnology and I feel like I can never repay my alma mater for transforming me from a young boy into the quality teacher that I am today."

Lecturer Imran Haider Shamsi (Ying Lan), Department of Agronomy

"I decided to return to China in 2009 after working abroad for 15 years as I believe that China is the best place to find sustainable development solutions to address our planet's limited resources. Indeed, the Yangtze River Delta, where Zhejiang University is located, is an area that has prospered continuously for thousands of years without major environmental decay. In particular, I enjoy the freedom to pursue my area of interest as a researcher and the open-minded atmosphere at Zhejiang University."

Professor Xiaogang Peng, Department of Chemistry

"Although I officially joined Zhejiang University in 2011, I have been collaborating with researchers at Zhejiang University since 2002. I have found it to be a place with great academic freedom, and I believe that's the reason why Zhejiang University is one the best universities in China. In addition, I am grateful to be able to work in the beautiful city of Hangzhou, where I grew up. Zhejiang University is also strong in engineering, which provides a fantastic platform for physical science research and interdisciplinary collaboration — activities that are of particular importance to me."

Professor Fuchun Zhang, Department of Physics

"Zhejiang University's location in the economically dynamic region of the Yangtze River Delta provided much opportunity for translational research and a large patient base for biomedical research."

Professor Lanjuan Li, Director of the State Key Laboratory for Infectious Diseases Diagnosis and Treatment

浙江大學
ZHEJIANG UNIVERSITY

Central, East & South Europe

Countries in the region are pushing to adopt a broader research base, along with updated institutional organizations. But for the most part it is the physical sciences that remain strongest.

ARTICLE COUNT: 3,351
FRACTIONAL COUNT (FC): 1,321
WEIGHTED FRACTIONAL COUNT (WFC): 1,048

One of the most striking findings about this region is the subject distribution of its research footprint.

Globally, subject areas for papers in the Nature Index are fairly evenly split among the life sciences, chemistry and physical sciences, with each commanding approximately one third of the share (with earth and environment papers making up 6% of the total). In Central, East and South Europe, however, there is nearly double the output in physical sciences. To some extent, this reflects history. Science in countries in the former USSR and Eastern Bloc was affected by communist ideology: fields held to showcase the best of the Soviet system, such as space science, were favoured, while others that contradicted ideology, such as genetics, were suppressed.

As the largest country in this region, with almost 143 million people, Russia produces the most high-quality science — and, as expected, is focused mainly on the physical sciences. Its world-leading centre for nuclear physics, the Joint Institute for Nuclear Research (JINR — set up as a Soviet response to the European Organisation for Nuclear Research, also known as CERN in the 1950s) has seen its budget swell from US$37 million in 2005 to more than $100 million in 2010. The institute, renowned for its work on the synthesis of new superheavy elements, has built new facilities and upgraded its existing ones. In the index, the JINR contributes to 3% of Russia's physical sciences weighted fractional count (WFC), a measure of the relative contribution of an institution to each paper.

Russia's 290-year-old Academy of Sciences (RAS) is the top institution in the region by article count (AC) and WFC. However, RAS is undergoing a painful overhaul. In 2013, president Vladimir Putin's administration passed laws forcing the RAS to merge with its two sister academies, which focus on medical and agricultural research. It is also downsizing, with its 483 institutes facing staff cuts. The turmoil at RAS is not the only blight on the Russian research landscape. Earlier this year, NATO and NASA cut ties with Russia in response to the situation in the Ukraine, threatening the future of its international collaborations, which within the index, at least, are greater than the global average.

REGIONAL REGENERATION

With the collapse of communism in the early 1990s came turmoil, followed by regeneration and change. In central Europe, former Eastern Bloc countries such as Poland, Hungary and the Czech Republic have since been reforming their infrastructures to make them more merit-based.

Poland is second in the region with a WFC of 216 (sandwiched globally between Brazil and Finland). The country, which joined the European Union (EU) in 2004, has been pursuing policies to modernise the traditional, hierarchical structure of its research institutions. In 2010, new government moves to make the funding of Polish science more competitive included establishing a new funding agency, the National Science Centre, and reforming the existing National Centre for Research and Development. "This is the biggest achievement," says Maciej Żylicz, president of the Foundation for Polish Science (FNP), an NGO that supports scientific research in Poland. About a decade ago, only 13% of government funding was in the form of competitive grants, he says. Today that figure is about 50%. "This is a big change, not only physically, but psychologically."

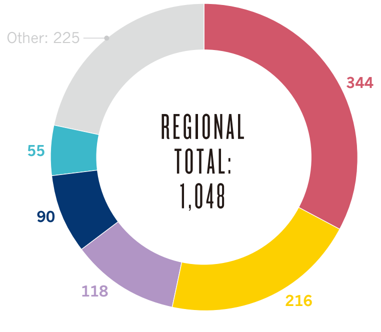
Poland has also undertaken a number of initiatives to support the life sciences. One notable example is the International Institute of Molecular and Cell Biology (IIMCB) in Warsaw, founded following a 1995 agreement between the Polish government and UNESCO. "This international umbrella helped us to build a structure that is totally different from the structures of the institutes of the Polish Academy of Sciences or universities," says Żylicz, who also heads the Department of Molecular Biology at the IIMCB.

The IIMCB has an international advisory board, which helps select principle investigators. Scientists do not have tenure, but are evaluated every four years and dismissed if they are not up to scratch. "In normal Polish institutes, there is no way to fire professors," says Żylicz.

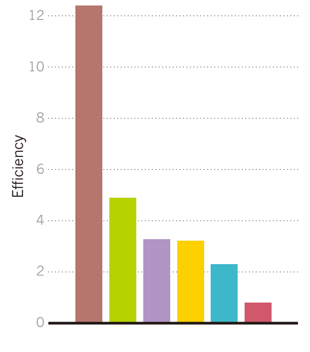
CENTRAL, EAST & SOUTH EUROPE ANALYSIS

Russia | Poland | Czech Republic | Greece | Hungary | Slovenia | Cyprus

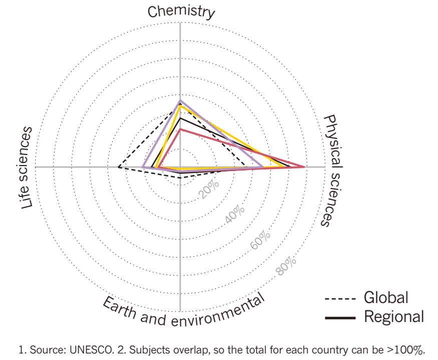
Countries' weighted fractional count (WFC)
Of the 22 countries in this region, Russia and Poland produce more than half of the high-quality science.



Researcher efficiency
WFC per 1,000 researchers[1].



Research strengths
The whole region is heavily skewed towards the physical sciences[2].



1. Source: UNESCO. 2. Subjects overlap, so the total for each country can be >100%.

Cyprus may have a population of 866,000 people and a WFC of only 10.9, but it tops the region in terms of its researcher efficiency, or WFC per 1,000 researchers, rivalling that of western European countries such as the United Kingdom and Germany. This might seem surprising given that, unlike these countries, Cyprus' research history is short: its first public university, the University of Cyprus, was only established in 1989; and its first research institute, the Cyprus Institute of Neurology and Genetics, opened in 1990. But, says Vassilis Tsakalos, Director General of the Research Promotion Foundation (RPF), an NGO that supports scientific and technological research, youth is a virtue. "It's a new system," he says. "The institutions were created with the latest ideas in mind. So they are very dynamic."

Although funding in Cyprus suffered as a result of the global financial crisis, scientists are hopeful that spending will now remain stable, says Tsakalos. The RPF gets most of its funding from the government, which spent about half a per cent of GDP on R&D per annum between 2010 and 2012. Recently, the Cypriot government appointed a committee to recommend on the governance of research and innovation.

UNIVERSITY CHALLENGE

Science in this region is dominated by national academies of science, which are conglomerates of tens or hundreds of smaller, dedicated research institutes. To allow for comparison, the index can focus on universities only, which for the top three countries include the University of Warsaw, Charles University in Prague and Lomonosov Moscow State University (MSU). The universities are all of comparable size: Warsaw has around 7,000 staff, and the same number of PhD and postdoc students; Charles University has more than 7,900 staff, including 4,500 academic and research staff; MSU has 10,000 faculty including 5,000 researchers.

Publications from all three are heavily dominated by the physical sciences (see 'Institutional subjects'). Yet while Warsaw is proportionally the most focused on physics, its WFC for this subject is 21, whereas MSU produces the most physics output in absolute terms with a WFC of 24.

Warsaw is involved in several large international physics collaborations. One to which its researchers contribute particular expertise, says Warsaw's Rector Professor Marcin Pałys, is the Compact Muon Solenoid (CMS) collaboration at CERN. Another strength is the university's highly regarded astronomical observatory, which in 2013 made a major contribution to a *Nature* paper that more precisely measured the distance to the Large Magellanic Cloud — an important cosmic yardstick. The paper created a stir internationally, earning the university one of its highest scores on altmetric.com, which tracks media outlets (see 'Online visibility').

Charles University, too, has been successful with international physics projects including the High Energy Stereoscopic System (HESS) Collaboration and the PHENIX Experiment at Brookhaven National Laboratory, as well as projects at CERN. "These collaborations have been very productive," says Jan Konvalinka, vice-rector of Charles University. MSU, likewise, has published extensively as part of the LHCb, CMS and ATLAS collaborations at CERN.

Of the three institutions, Charles University produces the largest fraction (18%) of output in the life sciences. Key to this success are the university's links with the European Molecular Biology Organisation and other EU initiatives, and offers of support to attract foreign scientists.

In terms of publications in *Nature* and *Science*, Charles University lags behind Warsaw and MSU with only 0.3% of its WFC from these journals. Konvalinka expects this to change. As well as investment in facilities, changes in the way the university and government rate papers should increase quality. Previously, the Czech government's science funding schemes valued only the quantity of papers produced, an issue that Konvalinka and several leading Czech scientists have criticized. "Now we need to see to it that not only the quantity of research papers but also the quality of original scientific contributions is increased substantially," says Konvalinka. ■

HUNGARY

Academy of Sciences

HUNGARIAN ACADEMY OF SCIENCES

The beautiful Hungarian Academy of Sciences

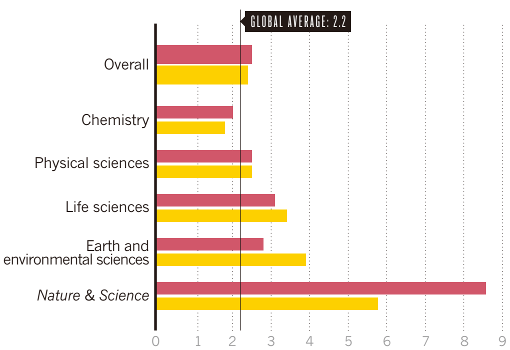
Hungary, like many other countries in central and eastern Europe, has an Academy of Sciences (HAS) as its top institution. But unlike the academies of Russia, the Czech Republic or Poland, for example, HAS has a much stronger record in the life sciences, which comprise more than a third of its output. The academy has a long history in this area: the Biological Research Centre in Szeged and the Institute of Experimental Medicine in Budapest are regarded as leading institutions in the country. The latter contributed to almost half of the academy's WFC in the life sciences.

However, in terms of publications in *Nature and Science* HAS is far less productive than the academies of neighbouring countries. It is looking to change this and in 2009 launched its Momentum programme, with Ft2.5 billion (US$10 million) of government funding, to encourage outstanding young Hungarian researchers to remain in or return to the country. HAS received a further boost in 2012, when the government increased its overall funding by 20% to Ft35 billion (US$142 million). HAS expects this to translate into a significant increase in publications in the most prestigious journals over the longer term, an academy spokesperson told *Nature*.

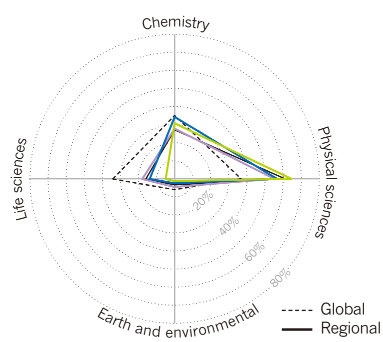
Russia Poland

Lomonosov Moscow State University (MSU) University of Warsaw Charles University in Prague

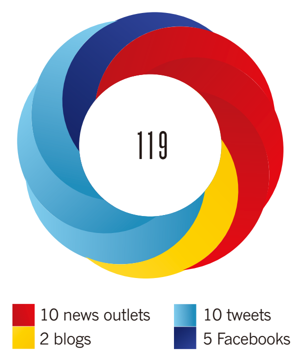
Collaboration rate
Dividing AC by FC gives a proxy for average number of collaborators per paper from outside the country.



Institutional subjects
Warsaw is most skewed towards physics, but MSU has higher actual output[1].



University of Warsaw's online visibility
A paper involving the astronomical observatory helped refine an important cosmic yardstick[2].



1. Some subjects overlap, so total can be >100%. 2. DOI: 10.1038nature11878 data from altmetric.com, 22 September 2014.

Australasia & Pacific Islands

The research landscape could not be more disparate between Australia and New Zealand. Strong Australian results are undermined by recent budget cuts, while New Zealand's output has fallen despite science spending boosts.

ARTICLE COUNT: 2,782
FRACTIONAL COUNT (FC): 1,270
WEIGHTED FRACTIONAL COUNT (WFC): 1,064

Australia's weighted fractional count (WFC) of 944 in the Nature Index for 2013 is up from 865 in 2012. Although this keeps it in twelfth place globally, it is one of the few countries that improved its WFC. On the policy front, however, a pall has descended across research this year. When the current conservative coalition government — facing a budget deficit of AU$41.8 billion (US$36.5 billion) when it was elected in September 2013 — delivered its first budget in May, there were swingeing cuts across the board in the AU$9 billion research budget.

Twelve industry innovation programmes, worth AU$846 million (US$740 million), were abolished. Another AU$378 million was lopped from six organizations, including the Australian Research Council, which funds much basic research, and the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the country's largest scientific agency. CSIRO is seventh in the country by WFC in the Nature Index. These cuts meant the loss of several hundred jobs and a decline in output. Environmental and climate science were particularly hard hit – an area of traditional strength for Australia. In the Nature Index, this research accounts for 12% of Australia's output, which is double the global average.

The cuts, along with the government's failure to appoint a science minister, indicated to many in the science community that research is undervalued. Pre-budget rumours of widespread cuts led Melbourne's *Sunday Age* to warn in an editorial, "this is the era of technology, and to throttle back on funding is more than merely stupid or blinkered; it is vandalism."

"EXPENDITURE IN NEW ZEALAND IS STILL WELL BELOW THE OECD AVERAGE."

The new government did announce the creation of AU$1 billion dollar Medical Research Future Fund, which it plans to grow to AU$20 billion by 2020. But this has stalled in the Senate, largely because its funding relies on an unpopular policy to make people pay AU$7 towards general practitioner visits — the first such fee in the national health scheme.

And more recently, in a statement on 14 October, 2014, the Prime Minister reiterated his view that science matters can be handled by the Minister for Industry. Indeed, the government is attempting to forge closer ties between science and commerce, announcing an AU$400 million "Industry, Innovation and Competitiveness Agenda" to fund industry-led non-profit growth centres. Companies may also have a greater role in the school system.

AUSTRALIAN INSTITUTIONS TIED

The index shows that there's little to separate the country's institutions: by article count (AC), the University of Sydney and the Australian National University are the top institutions, having contributed to 474 and 424 papers respectively. WFC gives a measure of the relative contribution of an institution to each paper; using this metric shuffles the order so that the University of Queensland is strongest with a WFC of 95.89, but the University of Sydney (95.07), Monash University (94.69) and the Australian National University (94.09) are close behind.

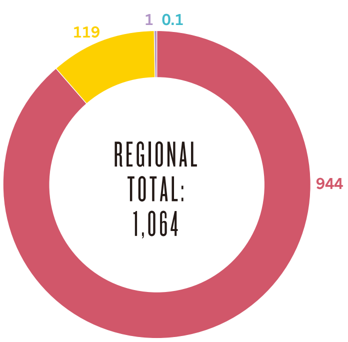
Focusing on output by subject area reveals further jostling among institutions, with some smaller facilities moving into the top ten in a single subject area, for example Swinburne University of Technology for physical sciences, and the Walter and Eliza Hall Institute of Medical Research in life sciences.

University of Queensland president Peter Høj says the institution's highlights in 2013 included a paper in *Science*, in collaboration with researchers from Massachusetts Institute of Technology, exploring a boson-based

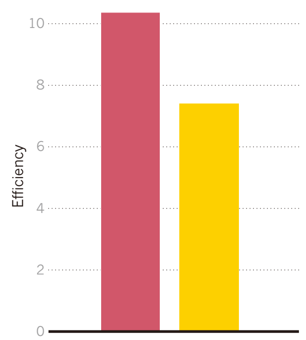
AUSTRALASIA & PACIFIC ISLANDS ANALYSIS

Australia | New Zealand | Papua New Guinea | Fiji

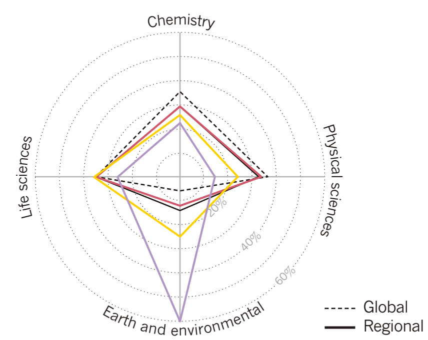
Countries' weighted fractional count (WFC)
Australia accounts for the lion's share of high-quality research.



Researcher efficiency
WFC per 1,000 researchers[1].



Research strengths
Smaller countries focus more on earth and environmental sciences[2].



1. Source: UNESCO (Papua New Guinea and Fiji data not available). 2. Subjects overlap, so the total for each country can be >100%.

alternative to quantum computing, which has potential for the future of quantum devices and supercomputers. This paper was widely shared on social media. Høj adds that such papers illustrate the ability of the university's researchers to participate in "projects with great potential for people worldwide".

Meanwhile, Monash University in Melbourne shows particular strength in the fields of chemistry and life sciences, which heavily overlap. The university is home, for example, to the development of the influenza treatment zanamivir, a neuraminidase inhibitor sold by GlaxoSmithKline under the trade name Relenza. Monash is also strong when it comes to publications in *Nature* and *Science*. A little over 5% of its WFC came from papers in these two journals, which is notably higher than the global average. Its researchers contributed to a total of 15 *Science* or *Nature* papers in 2013, including a report in *Science* on a technique for using graphene as a material for compact energy storage, for which all contributors were from Monash. However, leading the charge on this metric is CSIRO, with 5.5% of its output, or 14 papers, in *Nature* or *Science* (see 'Nature and Science output'). All of these were collaborative works.

NEW ZEALAND BOOSTS ITS BUDGET

Politically, New Zealand is a much different story from Australia. Two days after its neighbour received its bleak science funding news, the New Zealand government revealed a surprise surplus of NZ$372 million (US$292 million) in its 2014 budget, and announced an extra NZ$57 million of science funding in the form of competitive grants as well as NZ$58 million of increased tax deductions for research and development.

Another NZ$53 million over four years was allocated to its Centres of Research Excellence programme, and an 8.5% increase – or another NZ$67.9 million — for university science education.

Nicola Gaston, president of the New Zealand Association of Scientists, welcomed the boost in funding, but said it was more indicative of the government's shift in focus: the vast majority of competitive grants now require co-funding from industry. Given the nature of the country's industries — largely focused on tourism and primary industries with only a small manufacturing sector, "this has led to serious distortions in the overall balance of science," she said. "Science expenditure in New Zealand is still well below the OECD average, as it has been for some time," she added.

Such a funding deficit is taking its toll. In the Nature Index, New Zealand has a WFC in 2013 of 119, a decrease from its 127 in 2012 (although it retained 28th place).

The University of Auckland contributed to the largest number of papers, with an AC of 123, but on the basis of WFC, the University of Otago topped it. Based in Dunedin and with campuses in Christchurch and the capital Wellington, Otago is the country's oldest university with a good record in the biomedical sciences. Indeed, more than half of the university's WFC comes from the life sciences, with only 13% from the physical sciences (see 'Institutional subject spread').

Richard Blaikie, Otago's deputy vice-chancellor for research, is reluctant to name standouts among the university's 1,100 researchers. But, when pressed, he highlights the university's leadership in an international consortium that identified a new set of genes that instruct stem cells in the human brain how to increase in number and take up position *in utero*. This was one of seven papers the university published in *Nature Genetics*.

The index additionally shows Otago's strength in neuroscience: out of seven papers it contributed to in the *Journal of Neuroscience* in 2013, five were wholly authored by Otago researchers.

Otago's ratio of AC to FC (a proxy for level of collaboration) of 3.0 is above the average for New Zealand of 2.4. Blaikie says this shows that "our staff are engaged in fruitful international collaborations at the forefront of scientific progress across many areas of enquiry." Some papers also score highly in terms of online visibility as measured by altmetrics.com. Otago researchers were part, for example, of a large global team that published a paper in *Science* detailing how slippery clay was responsible for the 2011 Tohoku earthquake, which was widely picked up by news outlets (see 'Otago's online visibility'). ■

PAPUA NEW GUINEA

Pacific positivity

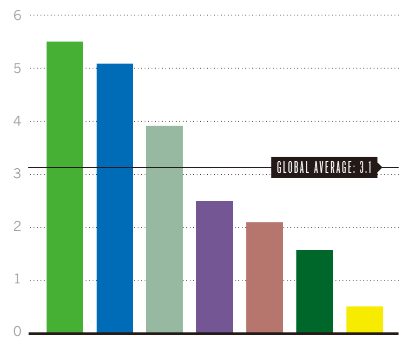
Although Australia and New Zealand dominate the region's science output, the Nature Index also lists papers from the Pacific Island nations. These include one from the Secretariat of the Pacific Community, based in New Caledonia, and five from institutions based in Papua New Guinea, which appears at number 92 on the global list by WFC.

Papua New Guinea's publications in the index focus heavily on environmental science. They include a study from The Nature Conservancy on grouper larvae in coral reefs, and one from Ok Tedi Mining Limited on the effect of the Madden-Julian Oscillation, the largest atmospheric factor in tropical rainfall cycles, on rainfall in the Fly River system in Papua New Guinea. This river system is the wettest place on Earth, and sustained heavy damage from the 1984 OK Tedi Mining disaster — one of the worst environmental disasters ever caused by humans.

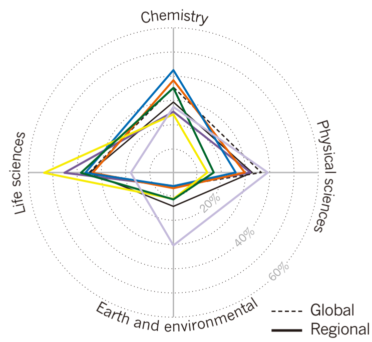
The funding outlook for science in Papua New Guinea is positive, with increases for the Institute of Medical Research and the National Agriculture Research Institute, and a call by the Research, Science & Technology Council for 5% of GDP to be spent on R&D as part of a government-wide National Vision 2050 plan.

CSIRO | Monash University | The University of Melbourne | The University of Queensland (UQ) | Australian National University (ANU) | University of Auckland | University of Otago | The University of Sydney | Victoria University of Wellington

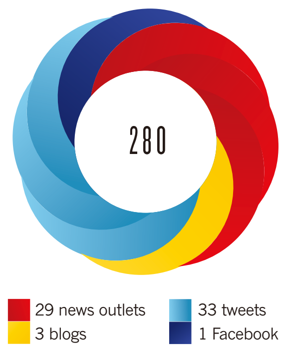
Nature and Science output
Governmental research agency CSIRO* has the largest proportion of its WFC in these two journals.



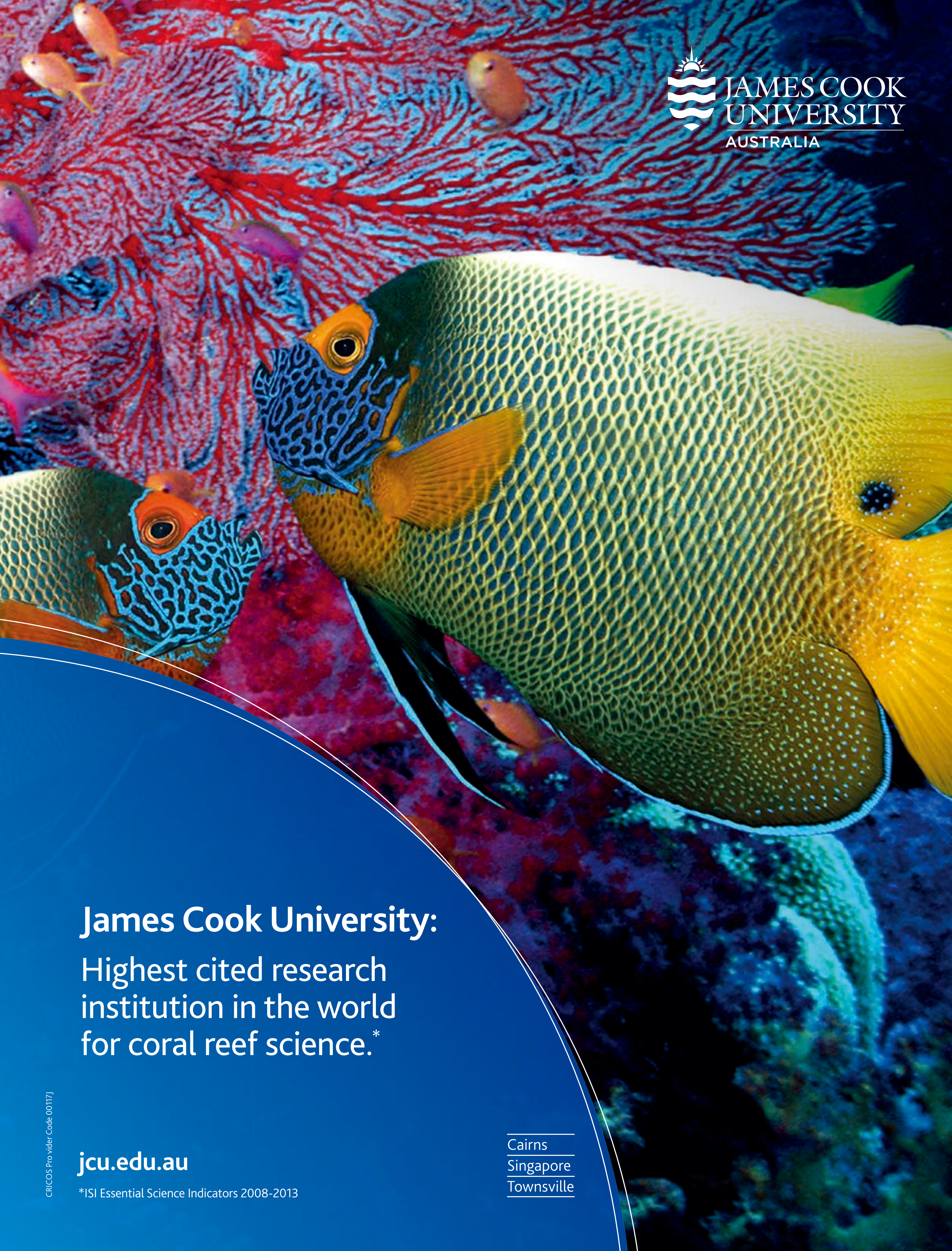
Institutional subject spread
Biomedical sciences are strong for University of Otago, whereas Australian institutions tend to have a more even distribution[1].



Otago's online visibility
Researchers helped reveal how slippery clay was responsible for the 2011 Tohoku earthquake[2].



*The Commonwealth Scientific and Industrial Research Organisation. 1. Subjects overlap, so the total for each country can be >100%. 2. DOI: 101126science.1238041. Data from altmetrics.com, taken 22 Sept. 2014.


JAMES COOK UNIVERSITY
AUSTRALIA
James Cook University:
Highest cited research institution in the world for coral reef science.*
jcu.edu.au
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West Asia

Almost all countries in the region endured upheaval in 2013. Despite unsettled times the biggest research players continued to prioritize science and discovery and push for breakthroughs across the disciplines.

ARTICLE COUNT (AC): 1,920
FRACTIONAL COUNT (FC): 785
WEIGHTED FRACTIONAL COUNT (WFC): 696

The news from West Asia is often about conflict. Hostilities are played out across borders and within countries. But the picture painted by data in the Nature Index of the regional science landscape shows a dynamic, yet far more collaborative scene.

Israel is the leading science powerhouse in West Asia (see 'Countries' weighted fractional count'). With an article count (AC) over 1,000, its institutions have published more papers in the index than all other regional countries combined. Its research profile is comparable to those of Western countries, for example its publishing record in *Science* and *Nature* is similar to Canada and Australia. It has the highest ratio of researchers to population in the region, and the index reveals that Israel's scientists are amongst the most efficient in terms of weighted fractional count (WFC) per researcher (see 'Researcher efficiency').

In 2012, Israel spent 3.9% of GDP on research and development (R&D), a higher percentage than any other country in the region and among the top five globally. Benjamin Geiger, chair of the Israel Science Foundation (ISF), which supports academic research in Israel, notes that this percentage has declined from a high of 4.2% in 2009. This is not a real decrease in funding but the result of vigorous economic growth: Israel's GDP his risen by 41% since 2009. Manuel Trajtenberg, chair of Israel's planning and budgeting committee, says this increase is seen in all areas of science spending, "The higher education budget was US$1.8 billion in 2010, it is now US$2.6 billion; adjusting for wage inflation, it would be an increase in real terms of 33% in four years." Geiger adds that, during this time, the ISF budget has also increased, from US$80.2 million to US$138.3 million.

"WE DO NOT KNOW THE NEXT BIG THING IN SCIENCE, BUT WE CAN KNOW THE OUTSTANDING SCIENTISTS."

Despite its sophisticated output, Israel's scientific growth may have stalled: its WFC in the index is unchanged since 2012, and it has contributed fewer articles in total. Saudi Arabia, by contrast, is a distant second in terms of numbers, but is ramping up its high-quality scientific output. The wealthiest country in the region, Saudi Arabia is increasing its proportional R&D spend too – now approaching 1% of GDP, up from just 0.07% five years ago. And according to the index data, Saudi Arabia is one of the most efficient countries at getting high-quality science returns for its R&D spend (Overview, page S56).

Some institutes in Saudi Arabia improve their publishing figures by offering attractive packages to overseas researchers, who spend a few weeks or months in the kingdom and add a local affiliation to their papers. This practice shows up in the Nature Index as an unusually high ratio of AC to WFC, because of the higher number of joint affiliations each researcher has. King Abdulaziz University of Science and Technology (KAUST), for example, has an AC of 121 but a WFC of 9.96; other institutions in the index from across the world with the same AC typically have WFCs three-times higher.

KEEPING IT PHYSICAL

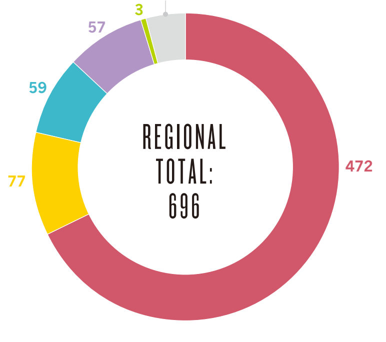
Saudi Arabia's institution with the highest WFC is KAUST, a graduate level university specialising in science and engineering. Located by the Red Sea, KAUST boasts some of the best equipped laboratories and facilities in the region, including one of the fastest supercomputers in West Asia.

KAUST has been actively recruiting top researchers. At its inauguration in 2009, KAUST had 65 faculty hired from different universities around the world, mostly at the assistant professor level; today there are 136. "We are hiring people who are higher calibre.

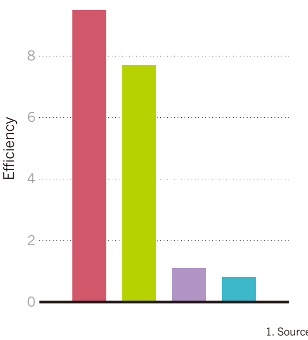
WEST ASIA ANALYSIS

Israel | Saudi Arabia | Turkey | Iran | Kuwait

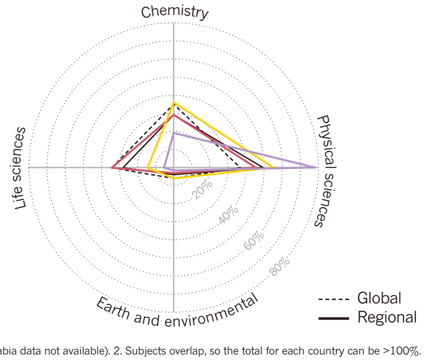
Countries' weighted fractional count (WFC)
Israel accounts for three-quarters of the region's output in the Nature Index.



Researcher efficiency
WFC per 1,000 researchers[1].



Research strengths
Emerging scientific countries focus more on physical sciences[2].



1. Source: UNESCO (Saudi Arabia data not available). 2. Subjects overlap, so the total for each country can be >100%.

We are still in a growth phase and we are very careful not to grow too fast," says Jean Frechet, vice president for research at KAUST. "We want to grow in quality before quantity, and we want to do it right."

Frechet himself was recruited from the University of California, Berkeley. When he was approached in 2009, he refused an offer because he had never heard of KAUST.

But he changed his mind after visiting the university, seeing the facilities and meeting other faculty members. "It was very exciting", he recalls. "Sometimes you get the opportunity to do something that you will not get again."

The region's institute with the highest WFC is the Weizmann Institute of Science in Rehovot, Israel.

"SAUDI ARABIA IS CHARACTERIZED BY MATERIAL SCIENCE RESOURCES."

Notably, it has published 12 papers in *Nature* and *Science,* more than all other institutes in the region, and papers in these journals comprise 4.4% of its output, compared to 0.6% for KAUST. Such a record is the result of progressive hiring policies, says Daniel Zajfman, president of the Weizmann Institute. "We do not know what the next important thing in science is, but we can know who are the outstanding scientists."

KAUST and Weizmann have very different research profiles. Life sciences research at KAUST is scant, as it is across Saudi Arabia (see 'Research strengths'), whereas the Israeli institute has a more even split between chemistry and life and physical sciences. "Saudi Arabia is very much characterized by material science due to its natural resources," explains Frechet, adding that KAUST modelled itself on the California Institute of Technology (Caltech), which is also heavily focused on physical sciences.

The Weizmann Institute's science is also much more visible on social media, with five papers (four in the life sciences) receiving a score on altmetrics.com — a new measure of a paper's impact, determined by article views, downloads and references in social media and news sources — in excess of 100. Its top article was a *Nature* paper authored by three Weizmann researchers collaborating with six researchers from the University of Cambridge and the United Kingdom's Babraham Institute. This paper challenged previous views about the shape of chromosomes. In contrast, KAUST's highest paper achieved a score of 47 for describing a new material for scrubbing carbon dioxide from the air. ■

IRAN

Institute for Research in Fundamental Sciences

Located in the Farmanieh district in northern Tehran, the Institute for Research in Fundamental Sciences (IPM) is Iran's leading institution in the index. It is one of the few top 10 institutes in the region that isn't in Israel or Saudi Arabia. IPM, credited with bringing the internet to Iran, is almost completely focused on physical sciences research, particularly involving the Large Hadron Collider at CERN (nearly half its papers are in the *Journal of High Energy Physics*).

Seventeen IPM researchers participate in various particle physics experiments, mainly at CERN's Hadron Calorimeter. Such collaborative work is seen in its high ratio of article count (AC) to weigh fractional count (WFC).

IPM is also trying to engage and stimulate local research through various projects with Iranian universities and research centres. One example is the Iranian Light Source Facility in the northwest Qazvin province, which will house a dedicated synchrotron accelerator once it is complete in late 2018.

Central & South Asia

Asia's traditional strengths in chemistry and physical sciences continue to power scientific pursuits and collaborations in Central and South Asian countries.

ARTICLE COUNT (AC): 1,574
FRACTIONAL COUNT (FC): 986
WEIGHTED FRACTIONAL COUNT (WFC): 879

Asia's historic love affair with chemistry and physics is noteworthy. So much so that the topic is a common conversation starter when international scientists meet at a conference dinner.

So it's not surprising that, in sharp contrast with global publication trends in the Nature Index, 2013 papers from the Central and South Asian region slant steeply toward chemistry and the physical sciences (see 'Research strengths'). The scientific output of the region is dominated by India — with a population of 1.3 billion and growing — towering over the region's second-highest performing country and her politically volatile neighbour, Pakistan.

Transitioning from a developing country to an emerging economic superpower, India is experiencing an attendant surge in its share of the world's scientific publications. The recovery is largely the result of liberalization, part of the country's rapid economic growth post-2000. Though allocated funds for science and technology have stagnated at around 1% of GDP over the last two decades, the economic boom means that the absolute amount of money available for scientific research and development has increased. In the 2014 annual budget, India announced a 4% hike in allocations to science-related ministries setting aside 362.69 billion rupees (US$6 billion) for research.

Nandula Raghuram, a keen metrics watcher and professor at New Delhi-based Guru Govind Singh Indraprastha University, says, "In many consecutive meetings of the Indian Science Congress, our prime ministers have expressed the need to double the investment for science and technology and bring it to 2% of GDP. It is shameful that this has never happened."

The Indian government has been urging the private sector to invest more in science but Raghuram says private investment should not be relied on to substitute government funding, which accounts for the lion's share of science capital in India.

Pakistan, which began its life as an independent country a day before India in August 1947, did not have many scientific institutions when it struck out alone. Despite years of instability and political turmoil it now has a handful of credible scientific institutions. The country spends 0.59% of GDP on science and technology (S&T)

and is aiming to ramp that up to 2%, by 2020. The country's new science and technology policy tries to connect science with socio-economic development, primarily concentrating on demand-driven research that might help the economy, and through international partnerships. It has some way to go: although India and Pakistan both have roughly the same number of researchers per capita (about 150–160 per million of population), India's scientists are more efficient, producing more than four times as many papers each (see 'Researcher efficiency').

ART DIRECTORS & TRIP/ALAMY

"PAKISTAN'S POLITICS ECLIPSE DEVELOPMENTAL ENDEAVOURS."

Pakistan's political uncertainties continue to eclipse all its developmental endeavours. In a national science and technology policy released in 2012, then science minister Mir Changez Khan Jamali conceded that these exigencies have relegated S&T efforts to the back burner. In the baby steps that Pakistan is taking to shape its research efforts, the focus is on using science to boost the economy through technology transfer projects in metrology, environment, health, energy, biotechnology, agriculture, genetic engineering, electronics and nanotechnology.

Pakistan's Quaid-i-Azam University has an article count (AC) of 52 in the index, the vast majority in the physical sciences (86.1%). The success stems mostly from its natural science faculty, a central part of the university since its foundation. Faculty dean, Mohammed Zakaullah, says most of its research is highly applied.

Two papers in the journal *Applied Physics Letters* that best show the university's strength, wholly authored by its researchers, detail behaviours of "relaxors" – a class of materials that change shape when an electric field is applied — both of which have immediate applications.

SUCCESS STORY

The Indian success story contains highlights of scientific brilliance in recent years, especially in material science, nanosciences and astrophysics, at its many Indian Institutes of Technology (IITs). These technology schools have the highest WFC, which gives a measure of the relative contribution of an institution to each paper, in the region, followed by the government-funded laboratories of the Council of Scientific and Industrial Research and the Indian Institutes of Science Education and Research (IISER). Researchers from the IISERs contributed to three papers in *Nature* and *Science* in 2013, the highest contribution for any Indian institution; the country as a whole only managed 11 papers.

IITs and IISERs are conglomerates or groups of institutes. The standalone institute that shines through is the Indian Institute of Science (IISc) with its formidable chemistry and physical sciences departments producing the highest WFC (83) of the country's individual centres. Institute director Anurag Kumar attributes this success to the fact that new faculty members are provided with start-up research funding, "so that they can get their research programmes off the ground without having to wait for their first grants." IISc also has an ongoing programme that provides seed grants to groups, which most often go on to win large value grants. Of the institution's 132 articles, 60 were wholly authored in-house (an FC of 1), an impressive display of independence. Five of these were in *Physical Review Letters*, including a paper that upped the theoretical mass limit for a star to turn into a type 1a supernova, which did particularly well on Twitter, according to altmetrics.com data.

In the field of physical science, meanwhile, the Tata Institute of Fundamental Research out-produced IISc in 2013, with a WFC second only to the combined IITs. With its stronghold — fundamental research in particle physics and astrophysics — Tata scientists made a mark with their contribution to the CERN experiments that led to the discovery of the Higgs-boson particle. ■

KAZAKHSTAN

L N Gumilyov Eurasian National University

Kazakhstan, a seat of learning in medieval times

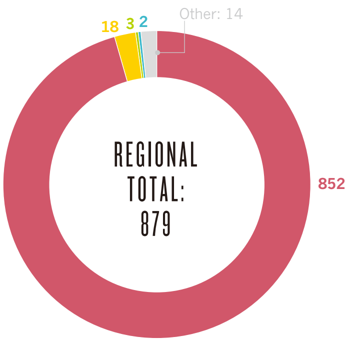
Named after Eurasian scientist Lev Nikolayevich Gumilyov, this national university focuses on the integration of science, education and industry. A former Soviet republic, oil-rich Kazakhstan was considered a major seat of scientific learning in the region in medieval times. Recently, in just a few years, Kazakhstan has more than doubled its science spending from KZT20 billion (US$109 million) in 2010 to KTZ53 billion ($290 million) in 2013, or around 1% of the country's GDP. The university is also expected to benefit from Kazakh science minister Aslan Sarinzhipov's recent announcement of increasing science spending to 3% of GDP by 2050.

The university might only have six papers in this year's Nature Index, but it is tackling difficult and eclectic areas of physics. Its top paper, authored by three researchers (one with a joint affiliation) from Gumilyov, concerns new exact solutions for static wormholes.

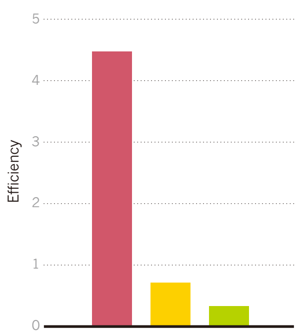
CENTRAL & SOUTH ASIA ANALYSIS

India | Pakistan | Kazakhstan | Bangladesh

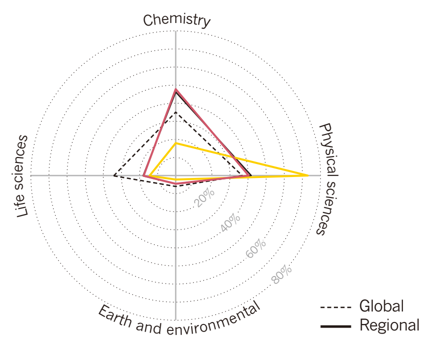
Countries' weighted fractional count (WFC)
Nine countries in this region appear in the index, with India dominating.



Researcher efficiency
WFC per 1,000 researchers[1].



Research strengths
India and Pakistan have vastly different priorities for their research[2].



1. Source: UNESCO. 2. Subjects overlap, so the total for each country can be >100%.

Middle & South America

Scientists in Middle and South America are striving for excellence and reaching out for international collaborations, while contending with comparatively low spending levels.

ARTICLE COUNT (AC): 1,968
FRACTIONAL COUNT (FC): 804
WEIGHTED FRACTIONAL COUNT (WFC): 530

Given that more than 92% of the total science and technology investment in Middle and South America goes to Brazil, Argentina and Mexico, it is no surprise that these three countries usually top the regional science output rankings and figure more prominently in the Nature Index than their neighbours. Researchers from this region contributed to 1,968 papers in Nature Index journals in 2013, with a total weighted fractional count (WFC) of 530 — more than three-quarters of which came from these three.

Despite steady growth in the number of peer-reviewed papers published by regional scientists over the past decade, Middle and South America is still far from being a major global player, says Rodolfo Barrere, an Argentinian science metrics specialist who coordinates Ricyt, a survey network compiling data on science policy across all Latin American countries. "The combined effort of all Latin-American countries in the global expenditure in science and technology is between 2% and 3%", he notes.

Overall, the region's WFC in Nature Index journals leans towards the physical sciences, boosted by observatories based in Chile, arguably the best country in the world for astronomy.

Argentina has a traditional focus on physical sciences, whereas in Brazil, the discipline absorbs more attention than it would otherwise because the bureaucracy surrounding life sciences makes it hard to conduct medical research.

At first glance there appears little to distinguish between the three top countries in the region: Brazil's WFC of 223 places it 23rd globally, Argentina's 105 puts it at 31st place, and Mexico's 77 takes the 34th slot (Top 100, page S98). All three countries fit the general profile of an emerging nation with aspirations of becoming a big league player in science. Yet there are notable differences in terms of how each funds scientific endeavours, and the frequency with which their scientists are published in high-profile journals such as those considered by the Nature Index.

> "IN BRAZIL, A SCHOLAR WHO FAILS TO OBTAIN GRANTS STILL HAS HIS WAGE GUARANTEED."

Brazil, where 70% of Latin-American science and technology investments are concentrated, is the only country in the region where more than 1% of GDP is invested in research and development (R&D). The most recent data compiled by Ricyt, from 2011, showed the country allocating 1.20% of GDP to R&D, followed by Argentina (0.65%), Mexico (0.45%) and Chile (0.44%).

BRAZIL STRIVING TO STIMULATE EXCELLENCE

In Brazil, the University of São Paulo (USP) outstrips other institutions by some margin for article numbers in the Nature Index. It is a huge institution, employing around 6,000 faculty and has around 100,000 graduate and undergraduate students.

USP receives precisely 5.5% of the total commercial tax revenue, (US$2.2 billion or R$5 billion) which is the main tributary tool (90%) in São Paulo state. And its researchers are typically awarded half of the US$500 million in grants offered by Fapesp (São Paulo's science funding agency).

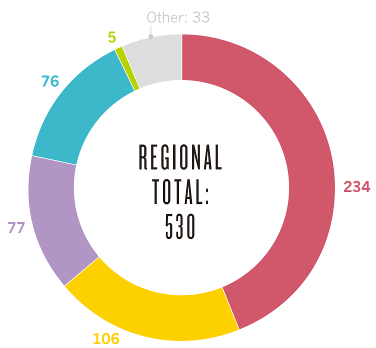
The steady flow of cash in Brazil guarantees resources for scientists, but does not create the most conducive environment to stimulate excellence of quality, according to Jose Eduardo Krieger, deputy dean for research at USP, who compared the system unfavourably to that in the US.

"In the US funding model, the quality assessment of research is embedded in the system," says Krieger. While a United States researcher's

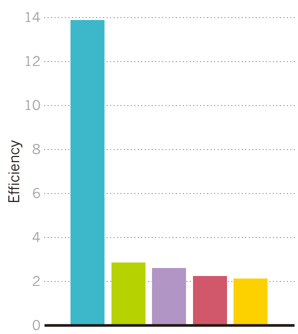
MIDDLE & SOUTH AMERICA ANALYSIS

Brazil | Argentina | Mexico | Chile | Uruguay

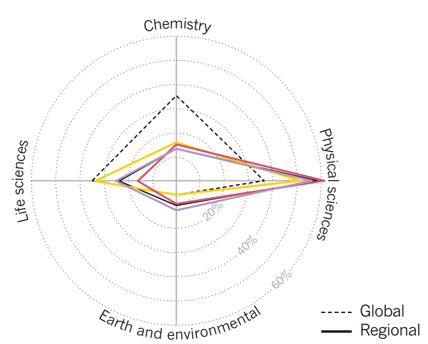
Countries' weighted fractional count (WFC)
Brazil, Argentina, Mexico and Chile share more than 90% of the regional WFC.



Researcher efficiency
WFC per 1,000 researchers[1].



Research strengths
Only Argentina matches the global average output in life sciences[2].



1. Source: UNESCO. 2. Subjects overlap, so the total for each country can be >100%.

income is closely tied to competitive funding, he says, in Brazil, a scholar who fails to obtain grants still has his wage guaranteed.

Within the index, Brazil also has a relatively low rate of international collaboration compared with other Latin-American countries: 2.2 compared to 2.7 for Mexico and 4.3 for Chile.

In order to promote collaboration, the federal government established Science without Borders, a programme under which young academics, mostly undergraduates, go abroad to study.

However Rogério Meneghini, a Brazilian science metrics specialist who directs SciELO, a database of open access journals, questions the value of the project, saying there is no way to be sure these students will continue with a career in science when they return.

RAISING FUNDING TARGETS IN ARGENTINA

The research funding system in Argentina is quite different from Brazil's. The University of Buenos Aires (UBA) is typical of the country's institutions in that it doesn't have a tenure system, explains Alberto Barbieri, the dean of UBA.

He says the work of UBA professors is evaluated every seven years and retaining their chair depends on performance in scientific production, teaching and formation of human resources.

The major challenge in Argentina now seems to be raising overall funding for R&D. In 2013, the government launched a programme with a target of raising R&D expenditure from 0.65% to 1.65% of GDP, by attracting more private money for science through new public–private projects.

Some researchers are optimistic that this appears to be making Argentina more attractive place to work than flocking to greener pastures abroad. "There are a remarkable number of scientists returning to the country," says Barbieri. Argentina now brags about its academic population, with three researchers per thousand people in the economically active population, twice as many as those doing science in Brazil.

Argentina's leading scientific institution in the index is its National Scientific and Technical Research Council (Conicet), with a WFC of 34. Conicet is a funding body that also has its own labs, and it is these that the Nature Index records.

Conicet and UBA have a similar profile in terms of subject spread, both with a reliance on physical sciences.

However it is third placed National University of La Plata that is the strongest in this field, with nearly four-fifths of research in physics. Part of the reason are the university's two flagship institutes — of Physics and Astrophysics — that are highly collaborative, the former being a part of the ATLAS collaboration at CERN. ■

CHILE

Global connections

DORLING KINDERSLEY LTD/ALAMY

The University of Chile stands apart in the region. The university can boast more than 700 international agreements for joint research projects. Many of them are in astronomy, a subject where the university publishes heavily: 94 of its 128 papers are in astrophysics journals.

The University of Chile has a healthy level of collaboration in the index: its ratio of article count to franctional count is 4.8, compared to a global average of 2.2. These collaborations help to leverage the university's 2,500 salaried academics, says Flavio Salazar, deputy rector for research and development. He says the university's scientists are highly productive and their work has significant impact, but are few in number.

Africa

Efforts to boost domestic science spending have yet to reach their goal, but are having an effect in Africa. Researchers, however, still rely heavily on funds and collaborators from richer nations.

ARTICLE COUNT (AC): 743
FRACTIONAL COUNT (FC): 159
WEIGHTED FRACTIONAL COUNT (WFC): 120

Africa is paying attention to science. In 2005 and again in 2014, the continent's leaders met to agree on strategies for investment in science and technology to solve Africa's myriad problems, including ill-health, poverty and political instability. Strategies included funding regional networks in key research areas, such as biosciences and water, and a continental target of countries spending 1% of their GDP on science and technology.

But despite these agreements, no African countries have reached the 1% goal. Today, support for science in Africa varies widely, with countries contributing between less than 0.1% (for Angola) and 0.98% (for Kenya), compared to a world average of 1.7%. Many African scientists still depend partly or wholly on foreign funding to keep their labs running. As a result, international funders have a strong influence on Africa's research agenda, for example prioritizing advanced vaccine development over low-tech, local health interventions.

The continent's top performing countries in science have long been South Africa followed by Egypt, with Kenya coming in third place. This pattern is reaffirmed by the Nature Index, with South Africa contributing to 441 papers, Egypt 80 and Kenya 24. Strong performances are notable in geology, astronomy and palaeontology; fields in which Africa has geographic advantages such as rich fossil sites or unique geological features.

Patchy funding leads many scientists to collaborate with colleagues from richer continents. As seen in the ratio of article count (AC) to fractional count (FC), Africa is the most collaborative region (Global Overview, page S56), and all African countries have a collaboration score well above the global mean of 2.2.

Aside from financial concerns, many Egyptian scientists have difficulty obtaining the chemicals and equipment they need, explains Ramy Aziz, a microbiologist/immunologist at Cairo University. Some collaborate internationally to get what they need; others emigrate and then work with colleagues back home on research projects.

It is slow and costly to import materials and instruments into Egypt, Aziz says — a problem that worsened during the 2011 revolution. It is usual practice to travel to finish off work. For instance, Aziz spent last summer at the University of California, San Diego, in order to finish six projects that were easier to do there than in Egypt. In the United States, he says, the primers (small pieces of DNA) that he uses for gene amplification can be ordered overnight. In Cairo, it takes up to four weeks to receive them, and costs a lot more.

But, Aziz thinks things are looking up for Egyptian science. The country's government recently increased funds, although in 2012 the science ministry reportedly struggled to spend its enlarged budget due to inefficiencies in the ministry. Egyptian universities and research institutes are also increasingly giving financial incentives for publishing in high-ranking journals. However, change will take time, Aziz says. "Look for the impact of the 2011 revolution in terms of publications by 2020."

BOOSTING RESEARCH QUALITY

The two top-performing African universities in the Nature Index are both South African: the University of the Witwatersrand in Johannesburg and the University of Cape Town (UCT). Both have benefited greatly from two initiatives launched in the last ten years to boost research quality at the country's universities: the South African Research Chairs initiative and the Centres of Excellence scheme. Both have provided quality supervisors for young researchers. To date 15 Centres of Excellence across the country each receive up to R10 million (US$900,000) per year (a sizeable investment for these institutions), and more than 150 research chairs have been set up with multi-million rand grants attached to them. UCT alone is home to 33 such research chairs.

UCT makes a strong showing in the Nature Index in astronomy and high-energy physics, with more than 70 papers, and does well in many other subjects. Papers in which at least half of the authors are from UCT range from a study contentiously showing that Marine Protected Areas — underwater nature reserves — can improve fishing yields without harming fisheries, to a report that fledgling birds 'blackmail' their parents into feeding them.

UCT's performance in these fields is not a coincidence, says Marilet Sienaert, executive director of UCT research. Three of the university's government-funded research chairs are in astrophysics, astronomy and marine ecology. It also hosts a government-funded Centre of Excellence looking at birds and biodiversity.

Meanwhile 'Wits', as the University of the Witwatersrand is known, makes a big showing in palaeosciences. It is also head and shoulders over UCT in terms of its publications in *Nature* or *Science*, having 9 articles — accounting for just over 15% of its WFC — in these journals. However, most of these articles come from a special issue of *Science* focusing on *Australopithecus sediba*, an early human ancestor identified from a 2-million year old fossil, discovered by Wits researchers in 2008 at the 'Cradle of Humankind' world heritage site outside Johannesburg.

MANY AFRICAN SCIENTISTS STILL DEPEND PARTLY OR WHOLLY ON FOREIGN FUNDING.

"The special issue on *Australopithecus sediba* has certainly made a significant difference to the count of papers in *Nature* and *Science*," says Robin Drennan, director of research development at Wits. The university was awarded a Centre of Excellence for palaeosciences in 2013. In tandem, the government launched a national palaeosciences strategy providing safe storage facilities for fossils and equipment for casting fossil replicas.

The sediba discovery opened up a new series of caves, all of which show potential for further discoveries, Drennan says. "Our expectation is that a rich and long series of knowledge will flow from this globally unique site." ■

ETHIOPIA

Addis Ababa University

HEMIS/ALAMY

Addis Ababa University has grand ambitions

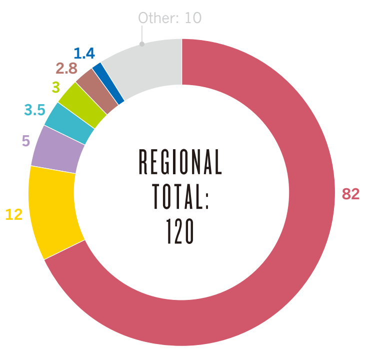
Addis Ababa University (AAU) is Ethiopia's largest and oldest research institution. AAU has only eight articles in the Nature Index, but because one was in *Nature* it has a strong ratio in the *Nature* and *Science* measure. The university is strongest in the earth and environmental sciences; five of its articles are on magma upwelling in the country's Afar Depression — the only place on Earth where continental plates are at an advanced stage of separation, giving scientists a first-hand look at how oceans form.

In the Nature Index, AAU is currently 18th overall in Africa. However, it is looking to improve that standing, and has started rewarding staff that bring in external research grants or publish in international journals, says Tassew Woldehanna, vice president for research and technology transfer at AAU. "Our vision is to be one of the top five research universities in Africa," he says.

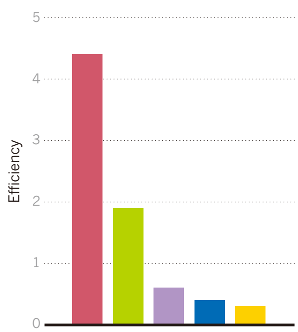
AFRICA ANALYSIS

South Africa | Egypt | Kenya | Morocco | Tanzania | Tunisia | Ethiopia

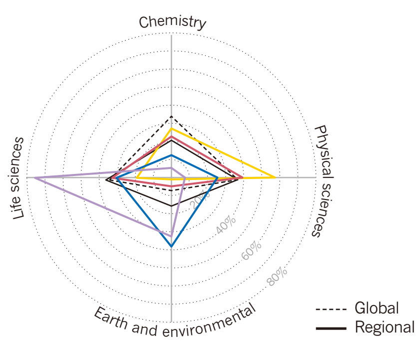
Countries' weighted fractional count (WFC)
Of the 35 African countries in the index, only 9 have a WFC above 1.



Researcher efficiency
WFC per 1,000 researchers[1].



Research strengths
Africa's natural geology and long human history provide rich sources for the earth and environmental sciences[2].



1. Source: UNESCO. 2. Subjects overlap, so the total for each country can be >100%.

A guide to the Nature Index

A description of the terminology and methodology used in this supplement, and a guide to the functionality available online at natureindex.com.

The Nature Index is a database of author affiliations and institutional relationships, used to track contributions to articles published in a small group of highly selective journals that have been chosen by an independent group of working scientists.

Data in the Nature Index are updated monthly, with the most recent 12 months of data available under a Creative Commons licence at natureindex.com. The database is compiled by Nature Publishing Group (NPG) in collaboration with sister company Digital Science.

NATURE INDEX METRICS

There are three measures provided by the Nature Index to track affiliation data. The simplest is the article count (AC). A country or institution is given an AC of 1 for each article that has at least one author from that country or institution. This is the case whether an article has one or a hundred authors, and it means that the same article can contribute to the AC of multiple countries or institutions.

To get a better sense of a country or institution's contribution to an article, and to remove the issue of double-counting of articles, the Nature Index uses the fractional count (FC). FC takes into account the relative contribution of each author to an article. The total FC available per paper is 1, and this is shared between all authors under the assumption that each contributed equally. For instance, a paper with 10 authors means that each author receives an FC of 0.1. For authors with joint affiliations, the individual FC is then split equally between each affiliation.

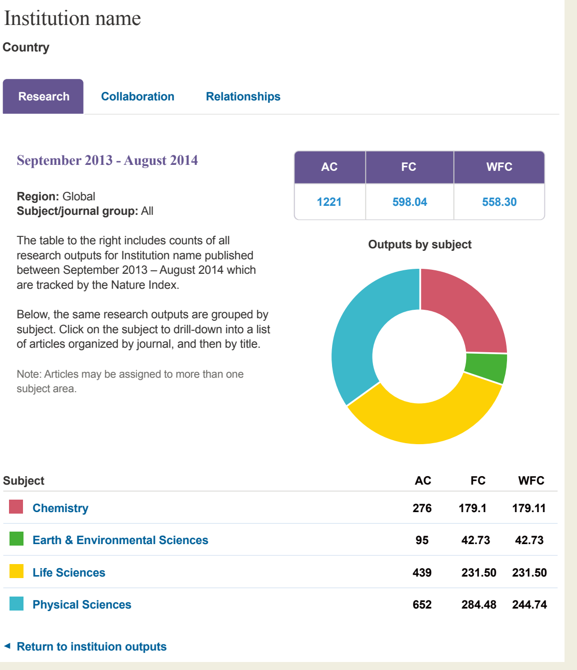
The third measure is the weighted fractional count (WFC), which applies a weighting to the FC in order to adjust for the over-representation of papers from astronomy and astrophysics. The four journals in these disciplines publish about 50% of all papers in international journals in this field — approximately five-times the equivalent figures for other fields. Therefore, although the data for astronomy and astrophysics are compiled in exactly the same way as for all other disciplines, articles from these journals are assigned one-fifth the weight of other articles (i.e. the FC is multiplied by 0.2 to derive the WFC).

NATUREINDEX.COM

A global indicator of high-quality research

Users of natureindex.com can search for specific institutions or countries and generate their own reports, ordered by article count (AC), fractional count (FC) or weighted fractional count (WFC).

Each query will return a profile page that lists the country or institution's recent research outputs, from which it is possible to drill down for more information. For example, articles can be displayed by journal, and then by article title. As in the supplement, research outputs are organized by subject area. The profile page also lists the institution or country's top collaborators, as well as its relationship with other research organizations.



The total FC or WFC for an institution is derived by summing the FC or WFC for individual authors. The process is similar for countries, although complicated by the fact that some institutions have overseas labs that will be counted towards the host country totals. What's more, there is great variability in the way authors present their affiliations. Every effort is made to count affiliations consistently, making reasonable assumptions. For more information on how the affiliation information is processed, please see the frequently asked questions at natureindex.com.

THE SUPPLEMENT

Nature Index 2014 Global is based on a snapshot of data from natureindex.com, covering articles published between 1 January and 31 December, 2013.

Most analyses within the Nature Index 2014 Global supplement use the WFC as the primary metric, as it provides a more even basis for comparison across multiple disciplines, and in determining the relative contribution of each country/institution.

Additional layers of information concerning funding levels, numbers of researchers, size of population and so on, are taken from publicly available sources. In several places, we use altmetrics as a supporting data source. Altmetrics is an alternative way to measure the impact of a paper by tracking different online sources (newspaper stories, tweets, blog posts, comments) that mention the paper. The altmetric score for an article gives an idea of the attention that it has received. Our data are from altmetric.com, provided by the start-up company Altmetric — which is supported by Digital Science. To see more about how this score is calculated, please visit support.altmetric.com. ■

OKAYAMA UNIVERSITY

FIGHTING VIRAL INFECTIONS FOR AGRICULTURE AND MEDICINE

Okayama University was established as a national comprehensive university in 1949 and is located in western Japan, midway between Osaka and Hiroshima on Japan's main island. With 1,600 faculty and more than 13,000 students, the university has grown considerably from a small institute called the Medical Training Place founded in 1870.

The university has a long history of conducting research in the areas of plant and medical science. In 2013 and 2014, it won several highly competitive government grants, including assistance under three high-profile programmes of the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), namely the Program for Promoting the Enhancement of Research Universities, the Translational Research Network Program and the Top Global University Project. This funding will support more international travel among students and researchers and enhance the international profile of the university by improving its research development.

STRONG BINDING

Professor Takashi Sera from Okayama University's Department of Bioscience and Biotechnology is building on the university's dynamic history through his work on fighting viral infections. As the recent Ebola outbreak has so shockingly demonstrated, viruses can have a devastating impact on human health. They also cause widespread damage to crops and livestock. What makes them so difficult to combat, is the fact that they are moving targets — an antiviral drug can be developed for a specific virus, but the virus may later mutate into a form that is resistant to that drug. Thus, the war against viruses becomes an endless cat-and-mouse game.

> "If we could make cassava, one of the main crops in Africa, resistant to viral infection, we could save people living in Africa from food crises."

Sera is optimistic about a strategy that has the potential to break this cycle. His new approach seeks to prevent viruses from proliferating after an infection occurs. It is an ingenuous strategy involving the creation of an artificial DNA-binding protein that attaches to a virus more strongly than the virus's own replication protein.

Sera hopes to use these artificial DNA-binding proteins to produce agricultural crops with greater resistance to viruses and to develop effective antiviral drugs that are side-effect free. He has demonstrated the effectiveness of this technique in both plants and animals. In particular, he has used it with success against the beet severe curly top virus, which is spread through the beet leafhopper and affects hundreds of plant species primarily in the western United States.

NO SIDE EFFECTS

Sera has also used the power of this technique to fight viruses that afflict humans. Specifically, he has developed antiviral drugs for human papillomavirus, which is implicated in cervical cancer. While vaccines for cervical cancer have already been developed, they have subsequently been reported to have various side effects. Sera is confident that his antiviral drugs will be side-effect free, as they are made of only slightly modified versions of proteins that are naturally found in meat and many vegetables.

The potential of this method is huge, he says. Its benefits could include almost total prevention of viral proliferation with a low probability of creating resistant viruses. Looking to the future, Sera is excited about the possibilities. "If we could make cassava, one of the main crops in Africa, resistant to viral infection, we could save people living in Africa from food crises," he explains. "And if we could create drugs for bird flu or foot-and-mouth disease, we could prevent these infections from spreading to livestock in surrounding areas." The economic benefits of such breakthroughs would be enormous.

"Conducting research at Okayama University has been important for me," Sera says. "The university's long history of promoting a culture of interdisciplinary research as well as its excellent facilities have been vital." As Sera's research demonstrates, this combination of culture and facilities promises to yield great results in the future.

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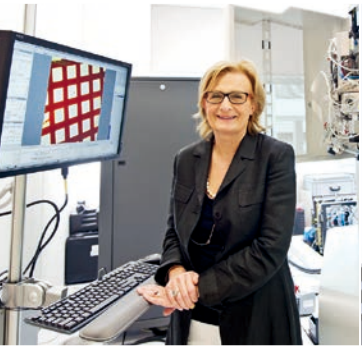


NANYANG TECHNOLOGICAL UNIVERSITY

RISING UP THE RANKS

Nanyang Technological University (NTU Singapore) is a young, research-intensive university that is rising in global rankings. Ranked first among top Asian universities in terms of the Normalised Citation Impact (Thomson Reuters InCites 2014) and also in field-weighted citation impact (Elsevier SciVal 2014), NTU has firmly established itself as a powerhouse of research and innovation. It also made a significant leap from 35th place in 2012 to 12th in 2013 in the *Nature Publishing Index Asia-Pacific* ratings, which are based on the number of primary research articles published in Nature-branded journals. This impressive performance is largely due to NTU attracting both ambitious young researchers and established, high-profile scientists.

HOT RESEARCH

Among the top names at NTU Singapore is Professor Zhang Hua (pictured above second from right), an expert in synthesising and fabricating nanomaterials and carbon sheets such as graphene for use in biosensing, clean energy, water treatment and a host of other applications. With a consistent record of highly cited research over the last decade, Zhang received special mention as one of the world's top 17 scientists in the Thomson Reuters 2014 report on *The World's Most Influential Scientific Minds 2014*. "These individuals," the report states, "are influencing the future direction of their fields, and of the world." In 2013 alone, Zhang authored 16 of the highest cited papers in the field of materials science.

Zhang is one in a long list of superstar scientists at NTU. Led by world-renowned scientist and NTU President Bertil Andersson, winner of the prestigious Wilhelm Exner Medal, NTU's stellar faculty includes NTU Provost Freddy Boey, inventor of innovative biomedical devices; geneticist Stephan Schuster, who co-led the Mammoth Genome Project to sequence the genome of an extinct animal for the first time; Nikolay Zheludev, nanophotonics and metamaterials expert; structural biologist Daniela Rhodes FRS (pictured above far left), distinguished for her research on the structure of chromosomes; geologist and seismologist Kerry Sieh, who has studied earthquakes in the United States, Taiwan and Myanmar, and is addressing the possibility of another devastating quake in Indonesia. Since 2008, Sieh has headed the Earth Observatory of Singapore (EOS), one of two Research Centres of Excellence at NTU.

MANY FACETS OF SCIENCE

Singapore's National Research Foundation and Ministry of Education established the Research Centres of Excellence programme in 2007 to attract leading researchers, boost graduate education and generate new knowledge in specific fields. Fulfilling this mission, the EOS is conducting fundamental research on the interrelated challenges of climate, governance and natural hazards associated with earthquakes and volcanoes. One more national Research Centre of Excellence based at NTU, the Singapore Centre on Environmental Life Sciences Engineering, is researching microbial biofilms with the goal of improving environmental and public health.

These centres draw on NTU's strengths in interdisciplinary research, with specific capabilities in sustainability, engineering and the life sciences. NTU is ranked 9th in the world for Engineering and Technology (QS World University Rankings 2014), and since 2005 the university has won SGD 1.3 billion in funding to address many facets of global sustainability, including water, energy, climate and public health.

NTU Singapore partnered with Imperial College London to set up the Lee Kong Chian School of Medicine, which welcomed its first cohort in 2013. This was Imperial's first overseas foray. An important pillar of NTU's life sciences cluster, the NTU medical school received SGD 400 million in philanthropic support at its inception. It complements the university's strengths in environmental life sciences engineering, biological sciences and structural biology. Scientists affiliated with the school's laboratories are studying the complex factors associated with metabolic, infectious, neurological and skin-related diseases.

In addition, strong links with companies such as BMW, Johnson Matthey, Rolls-Royce and Lockheed Martin ensure that NTU's excellence in basic and applied research translates into highly relevant industry applications. With its well-established track record in working with the industry, NTU was ranked joint No. 1 globally in Industry Income: Innovation by Times Higher Education in the last two years.

NANYANG TECHNOLOGICAL UNIVERSITY

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Nature Index tables

The world's leading countries and institutions for high–quality science, ordered by weighted fractional count (WFC) for 2013. Also shown are the total number of articles, and the change in WFC from 2012. Articles are from the 68 natural science journals that comprise the Nature Index (see Guide to the Nature Index, page S94.)

TOP 100 COUNTRIES

2013	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
1	United States	18,642.88	27,355	18,786.65	–0.8%
2	China	5,205.60	7,637	4,528.97	14.9%
3	Germany	4,076.97	8,669	4,038.30	1.0%
4	Japan	3,370.85	5,102	3,451.26	–2.3%
5	United Kingdom	3,290.35	7,373	3,259.46	0.9%
6	France	2,237.92	5,246	2,343.02	–4.5%
7	Canada	1,483.10	3,220	1,534.98	–3.4%
8	Spain	1,180.25	2,975	1,197.46	–1.4%
9	Switzerland	1,175.18	2,552	1,177.46	–0.2%
10	South Korea	1,150.52	1,953	1,193.02	–3.6%
11	Italy	1,075.12	3,089	1,084.27	–0.8%
12	Australia	943.94	2,448	864.60	9.2%
13	India	851.76	1,380	737.31	15.5%
14	Netherlands	763.24	2,221	765.03	–0.2%
15	Taiwan	543.18	937	595.99	–8.9%
16	Sweden	502.00	1,304	476.73	5.3%
17	Singapore	483.20	833	464.72	4.0%
18	Israel	472.35	1,008	520.05	–9.2%
19	Russia	344.26	1,058	298.26	15.4%
20	Belgium	327.25	1,019	347.22	–5.8%
21	Denmark	298.21	934	301.77	–1.2%
22	Austria	280.61	797	268.85	4.4%
23	Brazil	233.81	670	199.31	17.3%
24	Poland	216.35	689	176.78	22.4%
25	Finland	193.37	586	189.15	2.2%
26	Portugal	124.87	419	114.68	8.9%
27	Norway	123.62	371	142.00	–12.9%
28	New Zealand	118.93	307	127.84	–7.0%
29	Czech Republic	118.43	378	117.83	0.5%
30	Ireland	117.72	336	167.46	–29.7%
31	Argentina	105.66	304	93.08	13.5%
32	Greece	90.15	337	107.55	–16.2%
33	South Africa	81.81	441	58.02	41.0%
34	Mexico	77.08	362	73.52	4.8%
35	Saudi Arabia	76.64	288	52.52	45.9%
36	Chile	75.52	717	71.96	5.0%
37	Iran	58.55	121	71.45	–18.1%
38	Turkey	57.07	202	58.79	–2.9%
39	Hungary	54.92	228	78.88	–30.4%
40	Slovenia	43.20	118	34.85	24.0%
41	Ukraine	28.58	158	35.57	–19.7%
42	Thailand	25.89	89	25.51	1.5%

2013	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
43	Croatia	22.86	105	25.97	–12.0%
44	Pakistan	18.03	63	20.61	–12.5%
45	Romania	17.47	75	21.31	–18.0%
46	Malaysia	14.14	56	5.83	142.7%
47	Serbia	13.95	59	14.84	–6.0%
48	Iceland	13.90	85	15.74	–11.7%
49	Estonia	13.27	68	16.78	–20.9%
50	Slovakia	12.57	65	16.13	–22.0%
51	Egypt	12.04	80	7.32	64.6%
52	Lithuania	11.26	36	7.94	41.7%
53	Cyprus	10.90	25	12.89	–15.5%
54	Luxembourg	10.55	31	5.16	104.5%
55	Colombia	9.62	48	5.84	64.6%
56	Bulgaria	9.49	69	7.30	30.0%
57	Vietnam	8.23	41	6.85	20.1%
58	Armenia	7.98	39	7.30	9.3%
59	United Arab Emirates	7.08	27	2.56	176.7%
60	Panama	6.75	29	8.42	–19.8%
61	Kenya	5.36	24	5.13	4.4%
62	Uruguay	5.21	15	2.93	77.7%
63	Cuba	4.86	16	7.26	–33.0%
64	Indonesia	4.28	22	5.39	–20.6%
65	Peru	4.22	21	3.75	12.5%
66	Qatar	3.96	41	4.01	–1.3%
67	Belarus	3.95	23	6.05	–34.8%
68	Morocco	3.46	21	2.97	16.5%
69	Moldova	3.35	12	3.19	4.8%
70	Lebanon	3.34	17	3.26	2.6%
71	Philippines	3.33	19	2.70	23.5%
72	Latvia	3.18	11	4.04	–21.3%
73	Kuwait	3.17	9	0.43	634.9%
74	Tanzania	3.07	15	0.88	247.5%
75	Kazakhstan	2.85	9	7.20	–60.5%
76	Tunisia	2.84	16	4.52	–37.2%
77	Ecuador	2.48	15	3.29	–24.6%
78	Georgia	2.45	33	3.57	–31.4%
79	Bangladesh	2.28	11	1.23	84.8%
80	Venezuela	1.83	21	4.70	–61.1%
81	Costa Rica	1.49	9	2.11	–29.4%
82	Ethiopia	1.44	10	1.09	32.5%
83	Oman	1.29	6	1.72	–25.1%
84	Tajikistan	1.23	6	0.13	821.6%
85	Greenland	1.22	9	0.12	942.4%
86	Cambodia	1.16	5	0.69	67.4%
87	Algeria	1.10	7	3.51	–68.7%
88	Monaco	1.00	1	1.79	–44.2%
89	Nigeria	0.97	10	0.57	70.7%
90	Barbados	0.92	6	0.00	30144.8%
91	Papua New Guinea	0.91	5	1.04	–12.2%
92	Nepal	0.82	5	1.07	–23.4%
93	Congo	0.82	7	0.12	585.5%
94	Kyrgyzstan	0.81	4	–	–
95	Cameroon	0.81	10	0.60	35.4%
96	Iraq	0.74	9	1.70	–56.5%
97	Botswana	0.71	5	0.38	85.2%
98	Sri Lanka	0.70	7	1.51	–53.6%
99	Mongolia	0.62	7	0.94	–33.4%
100	Jordan	0.60	4	1.58	–61.8%

TOP 200 INSTITUTIONS

2013	INSTITUTION	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
1	Chinese Academy of Sciences (CAS)	China	1,209.46	2,661	1,119.75	8.0%
2	Harvard University	United States	852.12	2,555	904.46	–5.8%
3	Max Planck Society	Germany	728.64	3,023	678.20	7.4%
4	French National Centre for Scientific Research (CNRS)	France	720.62	4,585	718.24	0.3%
5	Stanford University	United States	552.93	1,253	516.78	7.0%
6	Massachusetts Institute of Technology (MIT)	United States	509.49	1,442	486.85	4.7%
7	The University of Tokyo	Japan	474.65	1,293	491.82	–3.5%
8	Helmholtz Association of German Research Centres	Germany	422.47	1,484	393.74	7.3%
9	University of Cambridge	United Kingdom	400.78	1,265	425.47	–5.8%
10	National Institutes of Health (NIH)	United States	390.96	801	386.30	1.2%
11	University of Oxford	United Kingdom	384.03	1,190	339.81	13.0%
12	University of California Berkeley (UC Berkeley)	United States	362.32	1,155	360.74	0.4%
13	University of California, San Diego (UC San Diego)	United States	345.50	873	342.81	0.8%
14	University of Michigan	United States	345.20	905	291.82	18.3%
15	Kyoto University	Japan	313.71	742	312.95	0.2%
16	Northwestern University	United States	298.02	609	294.36	1.2%
17	University of Pennsylvania	United States	296.19	671	241.87	22.5%
18	Yale University	United States	290.60	789	297.67	–2.4%
19	University of California Los Angeles (UCLA)	United States	286.59	768	318.68	–10.1%
20	California Institute of Technology (Caltech)	United States	281.90	1,216	269.89	4.5%
21	Swiss Federal Institute of Technology Zurich (ETH Zurich)	Switzerland	278.42	847	307.71	–9.5%
22	Peking University (PKU)	China	275.53	743	209.58	31.5%
23	Columbia University in the City of New York	United States	258.74	744	259.25	–0.2%
24	University of Washington	United States	254.74	692	299.79	–15.0%
25	University of Wisconsin-Madison	United States	251.46	652	263.40	–4.5%
26	The University of Texas at Austin (UT Austin)	United States	246.85	595	237.69	3.9%
27	Cornell University	United States	246.17	641	248.14	–0.8%
28	University of Toronto	Canada	242.41	736	262.52	–7.7%
29	Princeton University	United States	232.62	712	223.88	3.9%
30	University of Illinois at Urbana–Champaign	United States	228.61	507	229.51	–0.4%
31	The Johns Hopkins University (JHU)	United States	224.07	753	241.11	–7.1%
32	University of California San Francisco (UCSF)	United States	222.20	474	218.70	1.6%
33	Spanish National Research Council (CSIC)	Spain	220.63	1,553	230.82	–4.4%
34	Osaka University	Japan	219.88	534	261.31	–15.9%
35	Swiss Federal Institute of Technology in Lausanne (EPFL)	Switzerland	207.99	665	186.65	11.4%
36	University of California Santa Barbara (UCSB)	United States	196.36	537	227.84	–13.8%
37	Tsinghua University	China	194.87	474	177.74	9.6%
38	Nanjing University	China	194.57	391	168.10	15.7%
39	National University of Singapore (NUS)	Singapore	191.72	425	186.53	2.8%
40	The University of Chicago (UChicago)	United States	190.55	632	165.48	15.1%
41	Tohoku University	Japan	189.37	455	184.94	2.4%
42	Nanyang Technological University (NTU)	Singapore	187.38	336	178.16	5.2%
43	The Pennsylvania State University (Penn State)	United States	187.20	565	168.05	11.4%
44	Imperial College London	United Kingdom	185.60	668	165.14	12.4%
45	University College London (UCL)	United Kingdom	184.31	738	186.11	–1.0%
46	University of California Davis (UC Davis)	United States	183.99	492	168.74	9.0%
47	University of Minnesota	United States	178.83	449	193.68	–7.7%
48	The Scripps Research Institute (TSRI)	United States	178.38	328	193.05	–7.6%
49	University of Science and Technology of China (USTC)	China	175.73	427	147.75	18.9%

2013	INSTITUTION	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
50	Duke University	United States	174.18	453	162.44	7.2%
51	Washington University in St. Louis (WUSTL)	United States	174.02	376	190.52	–8.7%
52	University of North Carolina at Chapel Hill (UNC)	United States	171.18	373	178.88	–4.3%
53	Russian Academy of Sciences (RAS)	Russia	167.66	879	158.29	5.9%
54	Institute of Physical and Chemical Research (RIKEN)	Japan	165.95	522	144.52	14.8%
55	University of Maryland, College Park (UMCP)	United States	159.00	675	161.42	–1.5%
56	Seoul National University (SNU)	South Korea	158.24	432	178.36	–11.3%
57	Ludwig Maximilian University of Munich (LMU)	Germany	154.14	571	147.63	4.4%
58	Rutgers, The State University of New Jersey	United States	153.88	454	158.52	–2.9%
59	University of Colorado Boulder (CU-Boulder)	United States	152.21	589	147.72	3.0%
60	Lawrence Berkeley National Laboratory (LBNL)	United States	151.89	705	149.60	1.5%
61	Weizmann Institute of Science	Israel	150.96	315	162.04	–6.8%
62	Zhejiang University (ZJU)	China	150.42	289	123.20	22.1%
63	National Research Council (CNR)	Italy	149.79	538	142.41	5.2%
64	University of Pittsburgh	United States	148.19	396	130.26	13.8%
65	Texas A&M University (TAMU)	United States	148.12	414	127.40	16.3%
66	University of California Irvine (UCI)	United States	147.86	452	141.49	4.5%
67	The Ohio State University (OSU)	United States	142.91	553	141.39	1.1%
68	New York University (NYU)	United States	140.07	402	147.54	–5.1%
69	Atomic Energy and Alternative Energies Commission (CEA)	France	138.77	1,088	152.50	–9.0%
70	McGill University	Canada	137.85	459	142.97	–3.6%
71	Georgia Institute of Technology	United States	137.43	293	146.77	–6.4%
72	Nagoya University	Japan	132.96	404	138.68	–4.1%
73	The University of British Columbia (UBC)	Canada	131.61	419	133.51	–1.4%
74	Fudan University	China	129.23	255	121.36	6.5%
75	Indian Institutes of Technology (IITs)	India	128.53	241	125.16	2.7%
76	University of Southern California (USC)	United States	127.44	277	127.69	–0.2%
77	Technical University Munich (TUM)	Germany	125.23	475	130.25	–3.9%
78	The University of Manchester	United Kingdom	124.80	494	117.89	5.9%
79	The University of Texas Southwestern Medical Center at Dallas	United States	124.11	233	126.26	–1.7%
80	University of Copenhagen (UCPH)	Denmark	117.29	547	25.39	361.9%
81	Los Alamos National Laboratory (LANL)	United States	116.13	382	131.73	–11.8%
82	Council of Scientific and Industrial Research (CSIR)	India	115.24	179	107.50	7.2%
83	Nankai University	China	113.77	190	85.85	32.5%
84	Argonne National Laboratory	United States	113.72	450	98.48	15.5%
85	University of Utah	United States	113.04	284	109.78	3.0%
86	Purdue University	United States	112.70	323	141.43	–20.3%
87	Leibniz Association	Germany	112.10	456	120.59	–7.0%
88	University of Bristol	United Kingdom	111.64	378	122.41	–8.8%
89	Utrecht University	Netherlands	109.83	464	109.99	–0.2%
90	The University of Edinburgh	United Kingdom	109.40	641	127.08	–13.9%
91	University of Geneva (UNIGE)	Switzerland	108.05	403	114.75	–5.8%
92	Emory University	United States	107.91	215	102.57	5.2%
93	Hokkaido University	Japan	105.93	240	113.38	–6.6%
94	Tokyo Institute of Technology	Japan	105.72	283	112.64	–6.1%
95	Heidelberg University	Germany	105.61	606	109.59	–3.6%
96	University of Florida (UF)	United States	105.48	415	136.74	–22.9%
97	University of Rochester	United States	104.57	289	87.30	19.8%
98	University of Zurich (UZH)	Switzerland	104.35	426	93.46	11.7%
99	Korea Advanced Institute of Science and Technology (KAIST)	South Korea	103.03	210	126.30	–18.4%
100	Vanderbilt University	United States	101.80	326	136.16	–25.2%

2013	INSTITUTION	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
101	University of Alberta	Canada	101.29	252	99.24	2.1%
102	National Taiwan University (NTU)	Taiwan	101.23	291	96.64	4.8%
103	Boston University	United States	99.30	370	113.82	–12.8%
104	University of Göttingen	Germany	98.99	364	100.98	–2.0%
105	Wuhan University	China	98.80	154	74.27	33.0%
106	Jilin University	China	97.90	179	65.76	48.9%
107	National Aeronautics and Space Administration (NASA)	United States	97.17	978	84.62	14.8%
108	University of Münster (WWU)	Germany	96.69	213	87.80	10.1%
109	Shanghai Jiao Tong University (SJTU)	China	95.99	247	80.03	19.9%
110	The University of Queensland (UQ)	Australia	95.89	308	83.44	14.9%
111	Pierre and Marie Curie University (Paris 6)	France	95.28	1319	91.00	4.7%
112	The University of Sydney	Australia	95.07	474	71.15	33.6%
113	University of Würzburg	Germany	95.02	254	102.53	–7.3%
114	Monash University	Australia	94.69	328	90.99	4.1%
115	Australian National University (ANU)	Australia	94.09	424	85.39	10.2%
116	National Institute of Standards and Technology (NIST)	United States	91.79	286	89.31	2.8%
117	University of Leuven (KU Leuven)	Belgium	91.46	340	98.49	–7.1%
118	The Hebrew University of Jerusalem	Israel	91.29	245	107.24	–14.9%
119	University of Basel	Switzerland	87.67	227	69.70	25.8%
120	Oak Ridge National Laboratory (ORNL)	United States	87.20	283	84.20	3.6%
121	RWTH Aachen University	Germany	87.16	271	83.88	3.9%
122	University of Southampton	United Kingdom	86.68	338	70.04	23.8%
123	University of Notre Dame	United States	86.37	262	88.86	–2.8%
124	The University of Melbourne	Australia	85.79	386	87.15	–1.6%
125	Kyushu University	Japan	84.62	221	107.95	–21.6%
126	University of Erlangen-Nuremberg	Germany	84.58	248	77.00	9.8%
127	Indian Institute of Science (IISC)	India	84.14	132	70.88	18.7%
128	Durham University	United Kingdom	84.05	361	93.87	–10.5%
129	University of Hamburg	Germany	83.31	365	89.25	–6.7%
130	The Rockefeller University	United States	82.62	231	74.49	10.9%
131	Rice University	United States	82.53	227	96.48	–14.5%
132	National Institute for Material Science (NIMS)	Japan	81.79	182	92.60	–11.7%
133	Agency for Science, Technology and Research (A*STAR)	Singapore	81.62	240	86.25	–5.4%
134	Arizona State University	United States	81.20	216	80.87	0.4%
135	Uppsala University	Sweden	80.13	310	87.90	–8.8%
136	Academia Sinica	Taiwan	79.84	394	80.58	–0.9%
137	National Institute of Advanced Industrial Science and Technology (AIST)	Japan	79.53	203	105.78	–24.8%
138	Sun Yat-sen University	China	79.41	158	80.04	–0.8%
139	Iowa State University	United States	78.90	213	87.57	–9.9%
140	Stony Brook University	United States	78.90	284	86.44	–8.7%
141	The University of Arizona (UA)	United States	78.28	550	85.74	–8.7%
142	Aarhus University (AU)	Denmark	78.17	258	82.84	–5.6%
143	University of Bonn (Uni Bonn)	Germany	78.04	426	85.19	–8.4%
144	Tel Aviv University (TAU)	Israel	77.93	289	95.61	–18.5%
145	University of Virginia	United States	77.71	309	82.09	-5.3%
146	University of California Riverside (UCR)	United States	77.58	242	89.77	–13.6%
147	University of Tübingen	Germany	77.39	257	62.15	24.5%
148	Sichuan University	China	76.82	130	44.88	71.2%
149	Case Western Reserve University (CWRU)	United States	76.23	188	91.33	–16.5%
150	Baylor College of Medicine (BCM)	United States	76.10	187	66.26	14.8%

2013	INSTITUTION	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
151	Xiamen University	China	76.02	142	77.84	–2.3%
152	University of Groningen	Netherlands	75.31	375	92.76	–18.8%
153	Memorial Sloan-Kettering Cancer Center (MSKCC)	United States	75.27	184	83.74	–10.1%
154	Pacific Northwest National Laboratory (PNNL)	United States	74.62	178	62.75	18.9%
155	Lund University	Sweden	74.45	252	72.77	2.3%
156	North Carolina State University	United States	74.43	183	51.18	45.4%
157	The University of Nottingham	United Kingdom	74.25	235	77.84	–4.6%
158	Stockholm University	Sweden	73.61	375	57.22	28.7%
159	Leiden University	Netherlands	73.07	509	82.19	–11.1%
160	University of Freiburg	Germany	72.80	242	82.12	–11.4%
161	University of Paris Sud (Paris 11)	France	72.32	604	71.02	1.8%
162	Korea University	South Korea	72.01	220	67.89	6.1%
163	University of Massachusetts Medical School (UMMS)	United States	71.99	149	69.80	3.1%
164	Indiana University Bloomington	United States	71.45	214	68.86	3.8%
165	Brown University	United States	71.43	199	78.32	–8.8%
166	University of London - King's College London	United Kingdom	71.42	214	66.57	7.3%
167	University of Chinese Academy of Sciences (UCAS)	China	71.18	434	64.84	9.8%
168	The University of Hong Kong (HKU)	China	70.43	149	50.45	39.6%
169	The University of New South Wales (UNSW)	Australia	70.14	224	59.18	18.5%
170	The University of Iowa	United States	70.08	258	78.52	–10.8%
171	Pohang University of Science and Technology (POSTECH)	South Korea	70.00	147	84.98	–17.6%
172	Lanzhou University	China	69.99	123	67.58	3.6%
173	Joseph Fourier University (UJF)	France	69.85	596	76.56	–8.8%
174	Delft University of Technology (TU Delft)	Netherlands	69.28	160	64.70	7.1%
175	National Institute for Health and Medical Research (INSERM)	France	68.84	604	71.37	–3.6%
176	University of Barcelona (UB)	Spain	68.73	420	70.73	–2.8%
177	Florida State University (FSU)	United States	68.73	224	80.98	–15.1%
178	University of Calgary	Canada	68.36	147	60.35	13.3%
179	Autonomous University of Madrid (UAM)	Spain	68.16	361	66.86	1.9%
180	Goethe University Frankfurt am Main	Germany	68.14	202	68.20	–0.1%
181	Technion-Israel Institute of Technology	Israel	67.90	194	68.75	–1.2%
182	Brookhaven National Laboratory (BNL)	United States	67.83	268	68.46	–0.9%
183	The University of Sheffield	United Kingdom	67.61	231	70.94	–4.7%
184	University of Glasgow	United Kingdom	67.24	407	66.69	0.8%
185	National Oceanic and Atmospheric Administration (NOAA)	United States	66.86	229	63.25	5.7%
186	Albert Einstein College of Medicine of Yeshiva University	United States	66.10	152	53.18	24.3%
187	The University of Texas MD Anderson Cancer Center	United States	65.99	181	61.19	7.9%
188	East China Normal University (ECNU)	China	65.56	123	35.55	84.4%
189	Soochow University	China	65.30	128	55.27	18.1%
190	National Tsing Hua University	Taiwan	65.16	150	95.15	–31.5%
191	University of Illinois at Chicago	United States	64.44	170	68.23	–5.6%
192	Medical Research Council (MRC)	United Kingdom	64.27	139	60.84	5.6%
193	Radboud University Nijmegen	Netherlands	63.37	438	61.55	3.0%
194	National Chiao Tung University (NCTU)	Taiwan	63.32	124	65.22	–2.9%
195	Michigan State University	United States	62.99	272	73.77	–14.6%
196	University of Montreal	Canada	62.93	233	65.66	–4.2%
197	University of Leeds	United Kingdom	62.81	212	57.71	8.8%
198	IBM Corporation	United States	61.90	117	58.73	5.4%
199	U.S. Navy	United States	61.63	259	69.85	–11.8%
200	Yonsei University	South Korea	61.62	198	77.64	–20.6%

TOP INSTITUTIONS: LIFE SCIENCES

2013	INSTITUTION	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
1	Harvard University	United States	582.14	1,264	609.95	–4.6%
2	National Institutes of Health (NIH)	United States	366.19	755	360.57	1.6%
3	Stanford University	United States	244.26	464	226.04	8.1%
4	Chinese Academy of Sciences (CAS)	China	238.91	478	201.26	18.7%
5	Max Planck Society	Germany	209.85	585	220.13	–4.7%
6	University of California San Francisco (UCSF)	United States	205.95	436	206.55	–0.3%
7	Yale University	United States	190.09	370	178.69	6.4%
8	University of Pennsylvania	United States	187.98	387	165.47	13.6%
9	Massachusetts Institute of Technology (MIT)	United States	186.42	535	161.35	15.5%
10	University of California, San Diego (UC San Diego)	United States	177.45	398	183.78	–3.4%
11	French National Centre for Scientific Research (CNRS)	France	169.30	874	187.51	–9.7%
12	University of Cambridge	United Kingdom	150.50	363	147.77	1.8%
13	University of Michigan	United States	145.39	300	123.65	17.6%
14	The Johns Hopkins University (JHU)	United States	140.95	316	154.27	–8.6%
15	University of Oxford	United Kingdom	139.06	336	146.75	–5.2%
16	University of Washington	United States	138.26	333	161.40	–14.3%
17	Washington University in St. Louis (WUSTL)	United States	134.91	283	150.13	–10.1%
18	Cornell University	United States	134.60	303	117.69	14.4%
19	University of California Berkeley (UC Berkeley)	United States	127.05	268	121.10	4.9%
20	University of Toronto	Canada	126.95	304	145.67	–12.9%
21	The University of Tokyo	Japan	126.93	298	128.57	–1.3%
22	University of California Los Angeles (UCLA)	United States	124.95	285	157.03	–20.4%
23	Columbia University in the City of New York	United States	121.75	282	136.61	–10.9%
24	Duke University	United States	113.63	284	109.88	3.4%
25	University College London (UCL)	United Kingdom	113.22	304	123.73	–8.5%
26	The University of Texas Southwestern Medical Center at Dallas	United States	110.17	214	112.11	–1.7%
27	The Scripps Research Institute (TSRI)	United States	107.52	229	117.37	–8.4%
28	University of California Davis (UC Davis)	United States	96.79	204	76.38	26.7%
29	University of North Carolina at Chapel Hill (UNC)	United States	94.02	217	95.63	–1.7%
30	New York University (NYU)	United States	92.82	223	92.09	0.8%
31	The University of Chicago (UChicago)	United States	92.09	202	92.32	–0.2%
32	University of Wisconsin-Madison	United States	89.69	156	118.77	–24.5%
33	Kyoto University	Japan	88.62	208	76.16	16.4%
34	Northwestern University	United States	88.49	160	90.01	–1.7%
35	Helmholtz Association of German Research Centres	Germany	85.79	408	84.84	1.1%
36	University of Pittsburgh	United States	83.72	171	80.66	3.8%
37	McGill University	Canada	81.63	200	74.81	9.1%
38	Vanderbilt University	United States	74.78	190	93.81	–20.3%
39	Baylor College of Medicine (BCM)	United States	73.74	179	64.70	14.0%
40	Osaka University	Japan	72.73	160	80.62	–9.8%
41	The Rockefeller University	United States	72.41	153	65.70	10.2%
42	Emory University	United States	70.95	152	73.42	–3.4%
43	Institute of Physical and Chemical Research (RIKEN)	Japan	70.63	223	62.12	13.7%
44	University of Minnesota	United States	70.45	148	73.28	–3.9%
45	University of Massachusetts Medical School (UMMS)	United States	68.94	144	67.83	1.6%
46	Rutgers, The State University of New Jersey	United States	67.53	161	66.23	2.0%
47	Spanish National Research Council (CSIC)	Spain	65.91	247	68.06	–3.2%
48	Memorial Sloan-Kettering Cancer Center (MSKCC)	United States	65.88	163	68.89	–4.4%
49	Princeton University	United States	65.71	133	58.69	12.0%
50	University of Rochester	United States	64.85	125	39.37	64.7%

TOP INSTITUTIONS: EARTH AND ENVIRONMENTAL SCIENCES

2013	INSTITUTION	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
1	Chinese Academy of Sciences (CAS)	China	68.50	133	44.78	53.0%
2	Helmholtz Association of German Research Centres	Germany	57.18	143	51.67	10.7%
3	National Oceanic and Atmospheric Administration (NOAA)	United States	56.26	182	53.37	5.4%
4	National Aeronautics and Space Administration (NASA)	United States	51.29	169	43.81	17.1%
5	French National Centre for Scientific Research (CNRS)	France	47.74	295	51.24	–6.8%
6	California Institute of Technology (Caltech)	United States	41.29	116	40.98	0.8%
7	University of Colorado Boulder (CU–Boulder)	United States	37.92	129	39.89	–4.9%
8	University of California, San Diego (UC San Diego)	United States	36.60	85	35.67	2.6%
9	U.S. Geological Survey (USGS)	United States	36.30	99	32.76	10.8%
10	University of Washington	United States	33.87	73	29.14	16.3%
11	The University of Tokyo	Japan	32.72	77	25.19	29.9%
12	Swiss Federal Institute of Technology Zurich (ETH Zurich)	Switzerland	28.62	82	32.97	–13.2%
13	Columbia University in the City of New York	United States	28.56	81	25.14	13.6%
14	University of Oxford	United Kingdom	27.68	65	18.52	49.5%
15	Stanford University	United States	26.03	57	12.67	105.4%
16	Woods Hole Oceanographic Institution (WHOI)	United States	25.97	61	20.60	26.0%
17	Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	Japan	25.16	70	13.12	91.8%
18	National Center for Atmospheric Research (NCAR)	United States	23.95	82	22.45	6.7%
19	University of Wisconsin-Madison	United States	20.63	50	15.43	33.7%
20	University of Hawai'i at Mānoa (UH Mānoa)	United States	19.83	58	22.67	–12.5%
21	Texas A&M University (TAMU)	United States	19.22	47	13.66	40.6%
22	National Institute of Geophysics and Volcanology (INGV)	Italy	18.53	37	23.64	–21.6%
23	Utrecht University	Netherlands	17.54	46	13.25	32.4%
24	University of California Berkeley (UC Berkeley)	United States	17.47	53	20.22	–13.6%
25	The University of Texas at Austin (UT Austin)	United States	16.71	34	14.33	16.7%
26	Harvard University	United States	16.20	42	14.69	10.3%
27	University of Michigan	United States	16.14	37	13.41	20.3%
28	Colorado State University	United States	15.80	45	13.78	14.7%
29	Australian National University (ANU)	Australia	15.45	41	14.27	8.2%
30	Oregon State University (OSU)	United States	15.30	43	13.69	11.8%
31	Yale University	United States	15.02	28	10.90	37.8%
32	Spanish National Research Council (CSIC)	Spain	14.86	57	10.87	36.7%
33	University of California Santa Barbara (UCSB)	United States	14.52	35	7.90	83.8%
34	University of Cambridge	United Kingdom	14.46	31	23.28	–37.9%
35	The Pennsylvania State University (Penn State)	United States	14.45	40	22.55	–35.9%
36	University of California Davis (UC Davis)	United States	14.33	38	16.80	–14.7%
37	Max Planck Society	Germany	14.31	58	11.49	24.6%
38	The Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Australia	14.28	47	12.32	16.0%
39	University of Florida (UF)	United States	14.06	35	15.50	–9.3%
40	Pacific Northwest National Laboratory (PNNL)	United States	13.84	39	8.29	66.9%
41	Georgia Institute of Technology	United States	13.42	37	13.41	0.1%
42	University of California Los Angeles (UCLA)	United States	13.39	41	11.82	13.3%
43	Institute of Research for Development (IRD)	France	13.33	159	10.96	21.6%
44	Massachusetts Institute of Technology (MIT)	United States	12.99	44	12.61	2.9%
45	Met Office	United Kingdom	12.95	41	20.39	–36.5%
46	University of Maryland, College Park (UMCP)	United States	12.78	46	19.18	–33.4%
47	University of Leeds	United Kingdom	12.66	43	13.98	–9.4%
48	Imperial College London	United Kingdom	12.30	36	6.20	98.4%
49	University of Bristol	United Kingdom	12.25	40	16.63	–26.3%
50	Tohoku University	Japan	12.23	29	9.67	26.5%

TOP INSTITUTIONS: CHEMISTRY

2013	INSTITUTION	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
1	Chinese Academy of Sciences (CAS)	China	679.85	1,148	654.95	3.8%
2	French National Centre for Scientific Research (CNRS)	France	229.20	905	239.62	–4.3%
3	Max Planck Society	Germany	203.77	429	196.43	3.7%
4	Massachusetts Institute of Technology (MIT)	United States	165.70	268	175.91	–5.8%
5	The University of Tokyo	Japan	160.72	263	168.11	–4.4%
6	Kyoto University	Japan	157.00	246	181.97	–13.7%
7	Northwestern University	United States	153.92	236	176.29	–12.7%
8	Stanford University	United States	145.62	226	151.50	–3.9%
9	Harvard University	United States	145.32	249	173.11	–16.1%
10	Peking University (PKU)	China	142.80	268	113.77	25.5%
11	University of California Berkeley (UC Berkeley)	United States	131.34	233	132.02	–0.5%
12	Nanyang Technological University (NTU)	Singapore	123.40	179	127.49	–3.2%
13	University of Oxford	United Kingdom	119.36	197	122.72	–2.7%
14	University of Illinois at Urbana-Champaign	United States	115.67	163	107.03	8.1%
15	Nanjing University	China	115.65	160	97.50	18.6%
16	The University of Texas at Austin (UT Austin)	United States	109.97	151	119.76	–8.2%
17	California Institute of Technology (Caltech)	United States	107.42	145	89.20	20.4%
18	Osaka University	Japan	106.33	187	129.45	–17.9%
19	University of Cambridge	United Kingdom	106.16	182	118.49	–10.4%
20	University of Wisconsin-Madison	United States	104.82	140	110.24	–4.9%
21	Swiss Federal Institute of Technology Zurich (ETH Zurich)	Switzerland	103.59	197	112.50	–7.9%
22	The Scripps Research Institute (TSRI)	United States	102.50	146	111.01	–7.7%
23	University of Science and Technology of China (USTC)	China	93.78	150	82.17	14.1%
24	University of Michigan	United States	92.58	143	95.67	–3.2%
25	Tsinghua University	China	92.00	169	90.79	1.3%
26	Helmholtz Association of German Research Centres	Germany	91.96	254	74.01	24.2%
27	University of California Los Angeles (UCLA)	United States	87.47	142	106.94	–18.2%
28	Zhejiang University (ZJU)	China	86.42	133	69.32	24.7%
29	Nankai University	China	86.25	124	59.50	44.9%
30	University of Toronto	Canada	84.26	118	94.22	–10.6%
31	National University of Singapore (NUS)	Singapore	83.81	134	70.94	18.1%
32	Swiss Federal Institute of Technology in Lausanne (EPFL)	Switzerland	80.57	150	89.16	–9.6%
33	Fudan University	China	79.94	122	71.59	11.7%
34	University of Pennsylvania	United States	79.89	120	62.05	28.8%
35	University of California, San Diego (UC San Diego)	United States	79.51	141	83.01	–4.2%
36	Council of Scientific and Industrial Research (CSIR)	India	79.46	110	70.56	12.6%
37	University of North Carolina at Chapel Hill (UNC)	United States	75.09	109	83.97	–10.6%
38	Indian Institutes of Technology (IITs)	India	74.77	102	76.14	–1.8%
39	Lawrence Berkeley National Laboratory (LBNL)	United States	74.57	217	67.39	10.7%
40	Jilin University	China	74.06	129	40.87	81.2%
41	University of Minnesota	United States	71.49	98	62.26	14.8%
42	Spanish National Research Council (CSIC)	Spain	70.70	231	77.53	–8.8%
43	Seoul National University (SNU)	South Korea	70.70	121	69.85	1.2%
44	Georgia Institute of Technology	United States	69.30	115	80.59	–14.0%
45	Sichuan University	China	68.45	92	33.30	105.5%
46	University of California Davis (UC Davis)	United States	68.12	111	68.23	–0.2%
47	The Pennsylvania State University (Penn State)	United States	67.92	108	55.20	23.0%
48	Nagoya University	Japan	66.82	101	74.00	–9.7%
49	Texas A&M University (TAMU)	United States	64.05	93	62.87	1.9%
50	University of Washington	United States	63.40	93	77.77	–18.5%

TOP INSTITUTIONS: PHYSICAL SCIENCES

2013	INSTITUTION	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
1	Chinese Academy of Sciences (CAS)	China	412.33	1,234	399.92	3.1%
2	Max Planck Society	Germany	357.86	2,095	322.54	11.0%
3	French National Centre for Scientific Research (CNRS)	France	338.80	2,721	311.35	8.8%
4	Massachusetts Institute of Technology (MIT)	United States	228.44	741	216.24	5.6%
5	Helmholtz Association of German Research Centres	Germany	220.93	778	208.06	6.2%
6	Stanford University	United States	214.72	622	210.97	1.8%
7	The University of Tokyo	Japan	195.25	728	205.31	–4.9%
8	Harvard University	United States	195.03	1,144	223.46	–12.7%
9	University of Cambridge	United Kingdom	169.79	753	184.99	–8.2%
10	University of California Berkeley (UC Berkeley)	United States	139.93	692	151.20	–7.5%
11	Swiss Federal Institute of Technology Zurich (ETH Zurich)	Switzerland	133.54	496	141.69	–5.7%
12	University of Oxford	United Kingdom	125.31	634	92.75	35.1%
13	University of Michigan	United States	124.60	472	95.49	30.5%
14	Princeton University	United States	118.34	491	124.82	–5.2%
15	University of California Santa Barbara (UCSB)	United States	117.95	376	140.04	–15.8%
16	University of Illinois at Urbana-Champaign	United States	110.64	303	97.94	13.0%
17	Russian Academy of Sciences (RAS)	Russia	110.53	700	106.19	4.1%
18	Peking University (PKU)	China	105.35	388	86.35	22.0%
19	Swiss Federal Institute of Technology in Lausanne (EPFL)	Switzerland	103.24	440	93.83	10.0%
20	California Institute of Technology (Caltech)	United States	102.65	871	121.85	–15.8%
21	University of California Los Angeles (UCLA)	United States	100.93	363	97.65	3.4%
22	The University of Texas at Austin (UT Austin)	United States	100.49	359	99.60	0.9%
23	Tohoku University	Japan	96.67	259	94.84	1.9%
24	National Research Council (CNR)	Italy	93.39	327	89.99	3.8%
25	Atomic Energy and Alternative Energies Commission (CEA)	France	92.22	791	97.41	–5.3%
26	University of Maryland, College Park (UMCP)	United States	91.34	502	89.60	1.9%
27	Northwestern University	United States	90.80	278	88.16	3.0%
28	Kyoto University	Japan	90.46	306	83.76	8.0%
29	Spanish National Research Council (CSIC)	Spain	89.51	1089	100.59	–11.0%
30	Tsinghua University	China	88.12	262	87.16	1.1%
31	National University of Singapore (NUS)	Singapore	87.46	175	91.42	–4.3%
32	Los Alamos National Laboratory (LANL)	United States	84.90	287	96.15	–11.7%
33	Imperial College London	United Kingdom	79.10	365	63.01	25.5%
34	Columbia University in the City of New York	United States	78.16	319	65.23	19.8%
35	University of California, San Diego (UC San Diego)	United States	77.67	300	76.07	2.1%
36	The Pennsylvania State University (Penn State)	United States	77.16	348	64.52	19.6%
37	Lawrence Berkeley National Laboratory (LBNL)	United States	76.89	466	93.79	–18.0%
38	Cornell University	United States	74.62	264	96.13	–22.4%
39	Nanyang Technological University (NTU)	Singapore	72.04	140	69.62	3.5%
40	Georgia Institute of Technology	United States	71.81	155	76.58	–6.2%
41	University of Science and Technology of China (USTC)	China	71.66	242	63.63	12.6%
42	Argonne National Laboratory	United States	71.57	313	62.87	13.8%
43	National Institute of Standards and Technology (NIST)	United States	71.09	235	65.42	8.7%
44	University of Pennsylvania	United States	70.74	220	43.29	63.4%
45	University of Wisconsin-Madison	United States	66.95	351	64.69	3.5%
46	Seoul National University (SNU)	South Korea	66.32	248	75.07	–11.7%
47	Weizmann Institute of Science	Israel	65.64	174	76.86	–14.6%
48	Zhejiang University (ZJU)	China	65.02	136	44.46	46.2%
49	Nanjing University	China	64.94	193	68.24	–4.8%
50	Osaka University	Japan	62.47	222	77.35	–19.2%

TOP INSTITUTIONS IN *NATURE* AND *SCIENCE* JOURNALS

2013	INSTITUTION	COUNTRY	WFC	ARTICLE COUNT	2012 WFC	2012–2013 CHANGE IN WFC
1	Harvard University	United States	76.34	199	87.25	–12.5%
2	Massachusetts Institute of Technology (MIT)	United States	45.67	125	35.67	28.0%
3	Stanford University	United States	38.30	87	33.48	14.4%
4	Max Planck Society	Germany	32.86	116	36.51	–10.0%
5	National Institutes of Health (NIH)	United States	27.57	60	22.87	20.6%
6	University of California San Francisco (UCSF)	United States	23.83	45	19.86	20.0%
7	University of California Berkeley (UC Berkeley)	United States	21.54	72	23.13	–6.8%
8	University of Cambridge	United Kingdom	20.65	51	18.92	9.1%
9	Columbia University in the City of New York	United States	19.90	61	9.07	119.4%
10	Chinese Academy of Sciences (CAS)	China	18.64	54	6.26	197.5%
11	The Scripps Research Institute (TSRI)	United States	18.43	38	15.00	22.8%
12	University of California, San Diego (UC San Diego)	United States	17.79	53	23.41	–24.0%
13	Yale University	United States	17.04	43	29.05	–41.4%
14	The University of Tokyo	Japan	15.55	40	10.28	51.3%
15	French National Centre for Scientific Research (CNRS)	France	15.01	117	15.44	–2.8%
16	University of Washington	United States	14.64	38	21.37	–31.5%
17	Swiss Federal Institute of Technology Zurich (ETH Zurich)	Switzerland	13.98	40	18.95	–26.2%
18	Princeton University	United States	13.50	36	13.74	–1.7%
19	University of Toronto	Canada	13.31	34	10.96	21.4%
20	Cornell University	United States	13.11	40	11.26	16.4%
21	University of Oxford	United Kingdom	12.93	45	14.21	–9.0%
22	University of California Los Angeles (UCLA)	United States	12.75	39	13.05	–2.3%
23	California Institute of Technology (Caltech)	United States	12.73	60	17.07	–25.4%
24	The Johns Hopkins University (JHU)	United States	12.33	35	12.05	2.3%
25	The University of Texas Southwestern Medical Center at Dallas	United States	11.79	19	13.20	–10.7%
26	The University of Chicago (UChicago)	United States	11.75	33	11.56	1.7%
27	The Rockefeller University	United States	11.45	23	13.48	–15.0%
28	Helmholtz Association of German Research Centres	Germany	10.75	64	10.75	0.0%
29	New York University (NYU)	United States	10.54	26	10.26	2.8%
30	University of Pennsylvania	United States	10.23	29	7.69	33.0%
31	Institute of Physical and Chemical Research (RIKEN)	Japan	9.62	24	6.80	41.4%
32	University of Colorado Boulder (CU-Boulder)	United States	9.40	35	7.55	24.4%
33	University of Michigan	United States	9.36	40	9.08	3.1%
34	Medical Research Council (MRC)	United Kingdom	9.24	16	7.62	21.3%
35	Swiss Federal Institute of Technology in Lausanne (EPFL)	Switzerland	9.16	26	7.00	30.7%
36	European Molecular Biology Laboratory (EMBL)	Germany	9.05	28	4.02	125.0%
37	National Aeronautics and Space Administration (NASA)	United States	8.77	49	6.84	28.3%
38	Northwestern University	United States	8.61	22	10.24	–15.9%
39	Washington University in St. Louis (WUSTL)	United States	8.41	23	12.74	–34.0%
40	University of North Carolina at Chapel Hill (UNC)	United States	8.38	19	8.42	–0.4%
41	Ludwig Maximilian University of Munich (LMU)	Germany	8.25	24	5.56	48.4%
42	University of California Davis (UC Davis)	United States	8.06	27	5.27	53.0%
43	University College London (UCL)	United Kingdom	7.69	34	7.45	3.2%
44	Kyoto University	Japan	7.48	28	7.91	–5.3%
45	Duke University	United States	7.14	26	11.37	–37.3%
46	The Pennsylvania State University (Penn State)	United States	7.10	20	3.69	92.2%
47	University of Massachusetts Medical School (UMMS)	United States	6.87	14	3.43	100.3%
48	University of Illinois at Urbana-Champaign	United States	6.82	14	7.54	–9.5%
49	Weizmann Institute of Science	Israel	6.67	12	6.45	3.5%
50	University of Minnesota	United States	6.45	19	8.78	–26.5%

Weighted fractional count (WFC) for each institution is shown to two decimal places only. When two or more institutions have the same WFC, their positions are determined by the thousandth place (or beyond).

These results are based on the most recent data available as of 11 September 2014. Owing to continual refinements of the data, the figures in the database are liable to change and might differ to those printed in the supplements.