Two studies published in the journal *Annals of the Brazilian Academy of Sciences* have sketched an unprecedented portrait of what Brazil has been producing of most relevance in the international scientific scene. Researchers Rogerio Meneghini and Abel Packer, from the Latin American and Caribbean Center on Health Sciences Information (Bireme), pored over the cream of the national academic production between 1994 and 2003: the set of 248 scientific articles cited over a hundred times in other publications connected to the Thomson-ISI (Institute for Scientific Information) database. This sample represents 0.23% of the 109,916 articles by Brazilians published in magazines indexed in the ISI in that period. The significance of a paper is usually measured by the number of mentions that it gets in other articles.

The next step was to try to group the 248 articles into areas of knowledge. It was possible to find common denominators in 114 of them, leading the authors to conclude that 25 Brazilian centers of excellence achieved special prominence in 11 different fields:

- Amongst the 12 articles on the Amazon Forest, the majority about the consequences of the exploitation of the forest, eight were connected to the National Institute of Amazon Research (INPA), based in Manaus. "It is a positive fact, because it shows the viability of producing high level research outside the big centers", Meneghini says. Its close
ness to the object of study does not explain the impact. "Many institutions from other countries also sponsor research in the Amazon", he says.
- Cardiovascular surgeries are the theme of 18 of the most cited articles. The majority of them are linked to large international research networks, and many have to do with the same subject: the effectiveness of techniques like angioplasty and the implantation of stents to unblock arteries, carried out at institutions in São Paulo like the Heart Institute (InCor) and the Dante Fazzanese Cardiology Institute. An innovative technique for reducing dilated left ventricles invented by surgeon Randas Batista, from Pará, was also significant.
- Twenty Brazilian groups that are studying the oxidative mechanism of cells produced ten articles that received over a hundred citations. Amongst the highlights were the five articles by the team of Aníbal Vercesi, a professor from the School of Medical Sciences of the State University of Campinas (Unicamp). Their papers helped to understand the relationship between the activities of the mitochondria and cell death. Another three papers are from the group of Ohara Augusto, at the Chemistry Institute, the University of São Paulo (USP), in partnership with Rafael Radi, a Uruguayan. The articles resulted from a research that reported the formation of a carbonate radical, a compound hitherto unknown in living organisms.
- Seven articles about chemical catalysis evidence the success of the research coordinated by Jairton Dupont and Roberto F. de Souza, professors from the Federal University of Rio Grande do Sul (UFRGS). In 1992, they developed new molten salts, liquid at room temperature and highly stable, which have found a wide application in the chemical industry. The group managed to produce various ionic liquids, ensuring applications in various fields of science. The work was done in partnership with Petrobras.
- Genetic sequencing was responsible for three Brazilian articles of great significance. The main one was the sequencing of the *Xylella fastidiosa* phytopathogen, which merited the cover of the *Nature* journal on July 13, 2000. *Xylella* is responsible for the agricultural “yellowing” scourge. The sequencing was fostered by a program coordinatted by FAPESP, which organized the network connecting institutions in São Paulo. "It’s too early to conclude whether that is the best way to attain excellence in molecular biology", says Meneghini. “But there was a fundamental gain in our capacity to organize research networks at a national level.”
- Brazilian research in neurosciences produced 16 high impact articles. One of the groups that stood out, in the field of experimental pharmacology, is led by Frederico Graeff, from the School of Philosophy, Sciences and Literature of USP in Ribeirão Preto, and it seeks to understand the effect of drugs that relieve or produce anxiety in rats. The team with the most articles is led by Iván Izquierdo, then of the Federal University of Rio Grande do Sul, which investigates the mechanisms of the memory. Pharmacologist Xavier Albuquerque, from the Federal University of Rio de Janeiro (UFRJ) and the University of Maryland, in the United States, is researching the biophysical aspects of synaptic transmission in neurons. One of the articles in neurosciences has a Brazilian author, Luis Antônio Bacalá, from USP, but the work was conducted in a laboratory at Duke University, in the United States, commanded by Brazilian Miguel Nicolelis, known for his work with sensorimotor connections. Meneghini and Packer observe that both Xavier Albuquerque and Miguel Nicolelis were students of César Timo-Iaria, a researcher...
from USP and a pioneer in neurosciences in Brazil, who died in 2005.

- Particle physics was responsible for 13 articles, thanks, in good measure, to collections of data carried out by two research networks, one linked to USP’s Physics Institute, and another connected to the Brazilian Center for Research in Physics. The laurels are diluted: each one of the articles has an average of 154 authors from a dozen different countries.

- Quantum physics is the theme of seven articles, divided into two categories. One of them, more inclined to the theoretical field, is captained by Constantino Tsallis, of the Brazilian Center for Research in Physics – responsible for concepts that took his name, such as the Tsallis entropy. The other, in experimental physics, is led by Luiz Davidovich, from UFRJ.

- Fourteen articles deal with human genetics, the highlights being the studies by Mayana Zatz and Maria Rita Passos Bueno, from USP, who identified the genes involved in human muscular dystrophy. The Genetic Endocrinology Unit of USP’s School of Medicine also contributed with two articles about a genetic disease, a type of pseudohermaphroditism.

- Research into infectious diseases, such as toxoplasmosis, Aids and Chagas’s disease, accounted for 14 articles highlighting three institutions: the Federal University of Minas Gerais, the Oswaldo Cruz Foundation, and USP’s School of Medicine in Ribeirão Preto.

- Finally, three articles on the use of oral contraceptives and their effects on vascular ailments revealed the participation of the Federal University of São Paulo (Unifesp) in studies with major international research networks.

The survey is useful for showing the international face of Brazilian research, but the authors warn that the data has to be contextualized. The predominance of articles in the area of medicine and biomedicine (108 of the 248 articles) is not explained just by the performance of the scientists, but also by the fact that, all over the world, this field is particularly productive. Meneghini and Packer did another study, not yet published, in which they looked at articles that had received at least 50 citations. In this universe, there emerged groups of excellence in areas like mathematics, computing sciences, anthropology, engineering, veterinary medicine and biophysics. In some of these areas, the world academic production is lower, which explains the lower number of citations. Brazilian research in humanities is less significant due to the fact that they deal with regional subjects, which do not arouse international interest.

The survey brings various findings that inspire reflection. One of them is the considerable prevalence of studies done by large international networks, in the areas of medicine, particle physics and astronomy. They are articles about the incidence of diseases or the effectiveness of drugs, or that depend on the collection of data by means of accelerators or telescopes. Amongst the 37 articles most cited, each of which received as many as 250 citations, 18 are of this kind. On average, each one of these articles has 21 authors from 9.4 different countries per article from the set of papers studied. “They are important researches, but some have an almost bureaucratic scope, in which the participation of the researchers is limited to supplying large quantities of data”, Meneghini says.

What also called attention was the fact that only four of the 37 articles are the exclusive responsibility of Brazilian authors, a demonstration of the importance of international cooperation, which inspired the researchers to write a second article, specific to the theme.
Brazilian studies were these? The rank-
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Who produces most in health and biology

The University of São Paulo (USP) is the
leader in the production of ar-
ticles on health and biology. Between
2001 and 2003, it published 5,696
articles indexed in the database of
the ISI (Institute for Scientific Infor-
mation) and 6,368 on the Medline
database. This leadership is recorded
in a study published in the Brazilian
Journal of Medical and Biological Re-
search, which presented a ranking of
the 20 most productive Brazilian
universities in this field, responsible for 78.7% of the some 25 thousand
papers published between 2001 and
2003. The main author of the study
is journalist Ricardo Zorzetto, the sci-
ence editor of Pesquisa FAPESP and
a researcher in Jair Marí’s group, a
professor from the Psychiatry De-
artment of the Federal University of
São Paulo (Unifesp). Production is
concentrated in institutions from the
Southeast of the country. The second
place went to the Federal University
of Rio de Janeiro, with 2,476 arti-
cles in the ISI and 2,318 in Medline,
followed by Unifesp, USP in Ribeirão
Preto and the State University of
Campinas (Unicamp). Also featuring in
the ranking are the Oswaldo Cruz
Foundation, the Federal Universities
of Minas Gerais, Rio Grande do Sul,
Paraná, Pernambuco, Santa Catarina,
Bahia, Ceará and Pará, three units of
the São Paulo State University (Unesp), the Rio de Janeiro State Uni-
versity, the campus of Unicamp in
Piracicaba, and the University of
Brasilia (UnB).

Planning the future - The idea of do-
ing a survey arose in 2004, when
Britain’s David King, scientific advisor
to the government of the United King-
dom, did a study about the 1% most
quoted articles in the world between
1993 and 2001 and published an arti-
cle in Nature magazine, showing the
ranking of the 31 countries that produce
the most significant research on the
planet. In it, Brazil appears in an hon-
orable 23rd place. The study showed that the country published 27,874 ar-
ticles in the Thomson ISI database, be-
tween 1993 and 1997 (0.84% of the to-
tal), and 43,971 articles from 1997 to
2001 (1.21% of the total). But what
Brazilian studies were these? The rank-
ing did not set out to answer this, the
reason Meneghini and Packer decided
to investigate the data.

Knowing the weak points and the
strong points is essential for planning
the future and stepping up the perfor-
mance of research. In the opinion of
Eduardo Krieger, the 11 areas of great-
est impact can help the government to
target investments, but it would be a
mistake to bet exaggeratedly on areas
with practical applications, leaving aside
basic research. “The areas of excellence
have to be expanded, but it cannot be
forgotten that each one of them was
constructed on a solid base of uncom-
mitted science”, he says.

Science, let it be said, is not produced
by spontaneous generation. Jairton
Dupont, a professor from UFRGS and
the leader of the group that became
prominent in chemical catalysis, reminds
us that the advances in their field of
knowledge result from investments made
from 1980 onwards, by force of the first
Scientific and Technological Develop-
ment Support Program (PADCT), of the
federal government. “Chemistry was a
sort of poor cousin of the science and
technology system, but it has managed to
make a lot of headway in the last 20
years”, Dupont says. For him, his group
was successful because it was always ready
for the unexpected – the innovative pro-
cess of chemical catalysis was driven by
the difficulty of importing reagents.

Aníbal Vercesi, who is responsible for
prominence in the area of oxidative stress,
notes that the recognition of his field of
research comes from the great populari-
ty that it won abroad in the last few years.
“There are no secrets. Everything depends
on a lot of work and on having the back-
ing of good students and good collabo-
ators, besides seeking interaction with
other researchers. I visit various foreign
laboratories and I always leave the doors
open for those who want to get to know
our work”, says Vercesi, although for-
eigners only contributed to one of his five
articles, with over a hundred citations.

For Eduardo Krieger, the challenge is
to set aside resources capable of guaran-
teeing an annual growth of 8% in the ar-
ticles published, as has been happening
in the last 20 years, although the econ-
omy is advancing at a far slower pace.
“Our research system is young and has
evolved a lot. We have to help the coun-
try to develop and root for the growth of
the economy to allow Brazilian science
to take further leaps forward.”