EDITORIAL

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Year's comments for 2013

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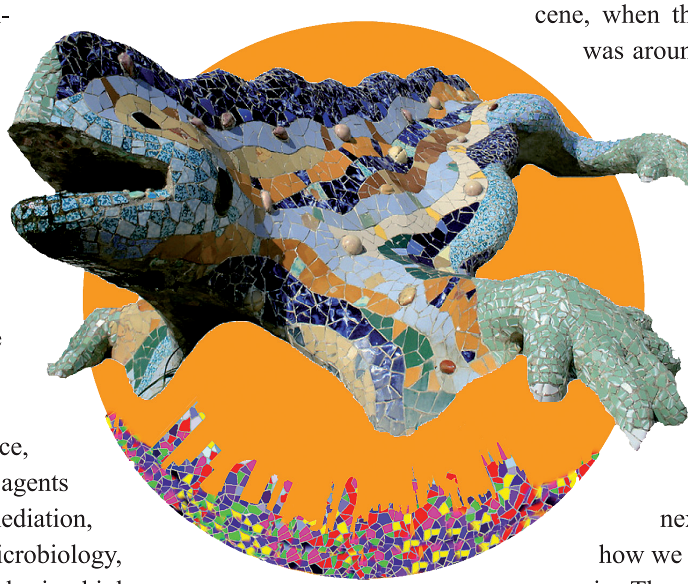
As we approach the end of 2013, it is a good exercise for every microbiologist to look back and select the year's main findings and events related to microbiology, and to note the contributions of the Spanish Society for Microbiology (SEM). The 24th Congress of the SEM was held July 10 through 13, at the Bellvitge Campus of the University of Barcelona, in L'Hospitalet de Llobregat, and on the premises of the University of Barcelona (Paranimph, or Ceremonial Main Hall) and those of the Institute for Catalan Studies, in the center of the city (Fig. 1). Our biennial meeting gathered 618 microbiologists from Spanish universities and research centers as well as researchers from 24 countries. The main topics discussed in the Congress were new frontiers in research on the molecular basis of pathogenicity and bacterial resistance, fungal virulence, antimicrobial agents in biodegradation and bioremediation, "-omic" techniques in food microbiology, and bacteriophages in industrial microbiology. Two *in memoriam* symposia were held, one as a tribute to the American microbiologist Lynn Margulis (1938–2011) and the other to Miquel Regué (1953–2012), professor at the University of Barcelona. The dissemination of microbiology in society and how microbiology can take advantage of social networks were also discussed. [5].



Fig, 1. Gaudi's dragon (Python, Gaia's son, spelled oracles, symbol of the communication of knowledge) at the entrance of Park Güell, Barcelona. Artistic representative of the 24th Congress of the Spanish Society for Microbiology (SEM), that was held in L'Hospitalet de Llobregat and in Barcelona, under the presidency of Prof. Miquel Viñas.

The year 2013 marked the occurrence of a further rise in the concentration of carbon dioxide (CO_2) in the Earth's atmosphere, with the level reaching the symbolic record of 400 ppm (Mauna Loa, 10 May 2013), an amount that has not been reached in the last 5 to 3 million years, as far back as the Pliocene, when the average global temperature was around 4 °C higher than it is today. Symptoms of warming are everywhere; for example, a report published in 2013 concluded that the present temperatures in the Eastern Canadian Arctic are the highest since the beginning of the last ice age, 120,000 years ago [9]. Most theoretical models suggest that global warming is today an unavoidable future for the next 50 to 100 years, and somehow we humans will have to adapt to it again. There is broad consensus that only the use of renewable energies, rather than fossil fuels, will be able to reverse this process in the long term. Indeed, several reports have discussed recent developments in the use of biofuels and hydrogen-producing microbes [11,14].

Despite the carbon dioxide increase and the present economic crisis, significant scientific breakthroughs were made in 2013 that bring hope for the future of humankind. The journal *Science* chose cancer immunotherapy as the main scien-

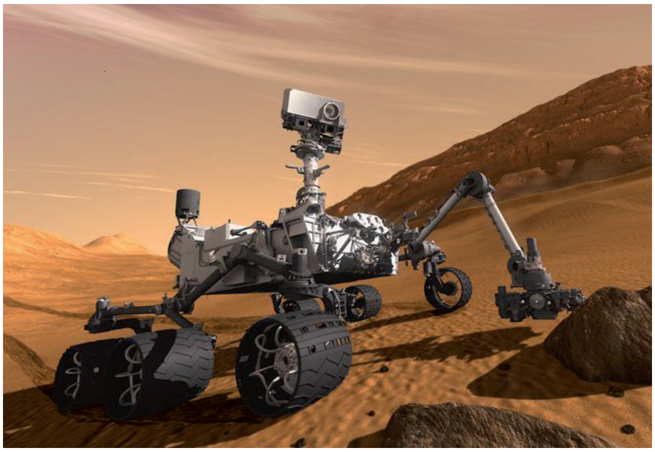


Fig. 2. Rover *Curiosity* (NASA photograph recreation)

tific breakthrough of the year, based on the increased number of successful treatments. There is now hope that antibodies and selected T-cells can be used to treat patients with what previously were otherwise untreatable cancers [4]. In regenerative medicine, the development of in-vitro-grown organs and other body parts from stem cells of different kinds (livers, teeth, blood vessels and even rudimentary brain) constitutes an impressive step toward the in vitro synthesis of compatible organs for transplantations. Also, there were important reports describing successful gene therapy treatments, not only in animal models but also in humans with extremely disabling diseases [2,3].

Although apparently unrelated fields, gene therapy is only possible with the aid of microbiology, as it relies on the use of enzymes and vectors derived from microorganisms (usually bacteria and viruses). In fact, a major milestone in the genetic editing of eukaryotic genomes takes advantage of a RNA–DNA interference system derived from the type-II CRISPR-Cas system of *Streptococcus pyogenes*. This method, known as Cas9-edition, allows simultaneous mutations to be made in several genes of mammalian embryonic cells by using RNA oligonucleotides as guides. Cas9-edition is superior to methods based on zinc-finger nucleases and transcription activator-like effector nucleases (TALENs), and it has been immediately adopted for eukaryotic genome editing by many researchers throughout the world [7].

Two other hallmarks in human genetics and evolution reported in 2013 were the completion of the sequence of a Neanderthal individual, from a tiny toe bone found in a cave in Siberia [13], and, at the end of the year, the mitochondrial sequence from a 400,000-year-old hominid discovered in Atapuerca, in northern Spain [8]. In the former, the ancient DNA matched that of the Denisovans, a Neanderthal-related hominid whose remains were found in the same cave from which the Neanderthal genome was obtained. As above, the extraction and amplification of very fragmented (<50 bp) DNA is possible only through the use of microbial enzymes.

In the space-related sciences, the major findings of 2013 included the discovery of hundreds of Earth-like exoplanets (featured in a *Science* special issue in May 2013) that provide the basis for long-dreamed habitable worlds and give strong support to astrobiology. Closer to the Earth, 2013 brought news of the success of the *Curiosity* rover in its journey on the surface of Mars (Fig. 2). Reports compiled from this micro-laboratory with drilling capability provide lend credence to the hypothesis that Mars was once suitable for microbial life. Analysis of several Martian rocks with names such as “John Klein,” “Tintina,” “Sutton Inlier” (area), “Knorr,” and “Wernecke” in the Gale Crater revealed the presence of water, carbon dioxide, oxygen, sulfur dioxide, hydrogen sulfide, chloromethane, dichloromethane, and calcium sulfate. In addition, the *Curiosity*’s instruments provided evidence for the presence of subsurface water in amounts as high as 4 %, down to a depth of 60 cm, suggesting that subsurface conditions still harbor water and mineral sources with enough energy to sustain living subterranean microbiota, such as those in the deep subsurface of our planet [21].

New frontiers of life were explored also on Earth. A group led by Scott O. Rogers, from Bowling Green State University, Ohio, published metagenomic data from the accretion ice of Lake Vostok, at a depth of more than 3700 m in the Antarctic [18]. This ice, which formed when the overlying glacial ice moved over the surface of the lake, contains an astonishing diversity of Bacteria, with minor representations of Eukarya and Archaea, all apparently thriving in a buried lake similar to the ice-covered seas of Europa and Enceladous, Jupiter and Saturn’s moons, respectively. Another hallmark was the finding of large populations of bacteria at the bottom of the Mariana Trench, the deepest part of the Earth’s surface. There were also reports on microbes living inside rocks buried deep below the sea floor.

All of these extreme environments offer further evidence that microbial life requires very little in the way of nutrients to exist, and support the search for extraterrestrial life. Reports on the survival of microbes in outer space and the strong reminder of the effects of ancestral collisions with objects from space—provided by the explosion over Chelyabinsk, Russia, of the most significant meteor since the 1908 Tunguska event, in Siberia—are additional, potent arguments to study outer space as a major shaper of life on Earth.

Fig. 3. Christian de Duve (1917–2013), Frederick Sanger (1918–2013), and François Jacob (1920–2013).

Also in 2013, a relevant advancement in our understanding of microbial evolution was achieved through the sequencing of the single-cell genomes of 201 uncultured Bacteria and Archaea [16]. In addition to being an impressive technical goal, the work revealed spectacular cases of lateral gene transfer and modifications of the genetic code, both of which expand our understanding of the evolution of prokaryotes since the origin of life on Earth. In related news, the discovery of some of the oldest fossils on Earth, in the Dresser sandstone formation in Western Australia, which has been dated back to almost 3500 million-years ago, was reported [10]. The fossils represent microbial mats and demonstrate the existence of phototrophic metabolism very early in evolution.

In present earth-bound microbiology, the relationship between microbiota and health was a major topic in 2013. After the description, in 2012, of the human microbiome by an international consortium ("Human Microbiome Project"), a series of fascinating articles were published that related human health and sickness to the presence of specific microbiotal patterns. Equally fascinating were reports on the effects of the transplantation of microbiota from healthy individuals ("healthy microbiota") to those with specific disorders. Papers published in *Science* in February and September, by a group directed by Jeffrey I. Gordon, from Washington University, St. Louis, Missouri, a world leader in gut microbiome research, described the transfer by fecal microbiota from twins discordant for obesity of obese or lean phenotypes, when the microbes were transplanted into mice [15]. These studies evidence the crucial role of gut microbes in maintaining health independently of genetic inheritance. Another article, published in *Cell* by the end of the year [6], showed that, in mice models, certain types of autism in animals that also have gastrointestinal disorders can be ameliorated by oral treatment with gut microbes such as *Bacteroides fragilis*. This unexpected connection between microbiota and the brain points to a putative probiotic therapy for certain types of autism.

Other major announcements in 2013 were related to the development of vaccines or improved treatments against major pathogens. In HIV therapy, the news of a "cure" of a 30-month-old child who had received antiretroviral therapy in the first 18 months of life [12] had a major impact in medical microbiology and in society. In fact, it is the first case in which the HIV virus has been eradicated from an infected infant. In addition, successful phase I clinical trials of an HIV vaccine offer new hopes in the fight against this devastating virus in developing countries, where present therapies are not affordable. A major step against malaria was also announced, when a new intravenous vaccine made of whole sporozoites was shown to be highly effective and safe [17]. These successes in the fight against infectious diseases were, however, accompanied by disappointments, especially the failure in human trials of a much anticipated new vaccine against tuberculosis [20].

In the 2012 comments of the year, we noted the death of Carl Woese, who had a major influence on our concept of life, by defining three domains based on the analysis of 16S–18S RNA as a molecular clock. Nowadays, this approach is a routine tool to establish the phylogenetic relationships and taxonomy of every new organism isolated. In 2013, we note the deaths of three other important scientists who also very significantly contributed to our understanding of how life functions and evolves. On April 19, François Jacob (b. 1920) passed away in Paris. As co-discoverer of the mechanism underlying the regulation of gene expression in bacteria (the "operon model"), he was a seminal figure in the development of modern microbiology and contributed to what became the era of molecular biology, in the years following the publication of the structure of DNA. For this work he shared the 1965 Nobel Prize in Physiology or Medicine with Jacques Monod and André Lwoff. On May 4, Christian de Duve (b. 1917) died at his home in Belgium. He discovered lysosomes, an essential organelle in both the structure and function of the eukaryotic cell. He shared the 1974 Prize in Physiology or Medicine with Albert Claude and George E. Palade. On November 19, Frederick Sanger (b. 1918) died in Cambridge, UK, at the age of 95. Sanger was an exceptional scientist and was twice awarded the Nobel Prize in Chemistry, the first time (1958) for his work on the development of methods for sequencing proteins (Sanger's method of peptide end-group analysis), with his groundbreaking work on the sequence of bovine insulin. The second time (1980), he shared the prize with Walter Gilbert, for the development of a sequencing method, in this case for DNA. Sanger's method was based on the use of specific dideoxy-nucleotides as DNA strand terminators by DNA polymerases and their subsequent separation by size. This method is still in use, with some modifications, and has allowed the sequencing of whole genomes, including the human genome, and has paved the way to the present genomic era. The work of de Duve, Sanger, and Jacob forms a cornerstone in modern biology and will continue to guide and inspire all researchers involved in the biological sciences (Fig. 3).

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The funding of science in Spain remains a serious problem. In addition to a tremendous decrease in the science budget since 2009, the delayed publication of the National Plan for Science, which was published in November 2013 instead of December 2012, will postpone, for at least 6 months, the starting period of 2014 projects. Consequently, many of the planned projects, involving around one third of Spanish academic groups, many of them highly competitive, have been left without funding for half a year. Some of these groups will have to drastically reduce their sizes and activities, with adverse effects on scientific production over the next 2–3 years. We must denounce the short-sightedness of our politicians while we try to adapt to the lack of funds by concentrating and coordinating our research through collaborative programs, such as the European Horizon 2020, which has its first call in April 2014.

On a more positive note, on December 19th, the last day of parliamentary activity in Spain for the year 2013, most of the parliamentary groups in Madrid signed an "agreement for research, development and innovation," promoted by COSCE, the Federation of Spanish Scientific Societies, with which SEM is affiliated. The signed agreement included four points: the recovery, in three years, of the 2009 levels of science funding and a progressive increase in the percentage of the national budget dedicated to science to reach the mean levels of the EU; the elimination of the 10 % limit on incorporating personnel in science; the avoidance of funding delays; and the creation of a State Agency of Research, as originally proposed in 2011. Despite our prudent skepticism regarding the promises of politicians, this agreement is a step forward in that it considers science as a matter of state, independent of the color of the government in turn. This should be also the case for education, but the needed level of maturity among our political parties has yet to be reached.

In the dissemination of science, the last few years have witnessed an increase in the number of open access publications, a process in which INTERNATIONAL MICROBIOLOGY is highly active, although the model is still a matter of controversy [1]. Both the European Union, in the Horizon 2020 program, and the Spanish National Plan for Science have explicitly specified that the research results of the projects they fund must be published in an open access format, and a specific budget to do so will be established. However, we are all aware of the high fees that major commercial scientific publishers charge for articles that will appear in their open access journals. Bearing in mind the decrease in public funding for science in Spain, such fees are clearly excessive and efforts at more reasonable fee structuring should be encouraged. For journals belonging to learned societies, including INTERNATIONAL MICROBIOLOGY, efforts are and will be made to keep open access publication fees as low as possible, ensuring that they will not be significantly more expensive than those charged by the printed forms of journals of reference in the field. In this context, I would like to call our readers attention to the controversy sparked by the 2013 winner of the Nobel Prize in Physiology or Medicine, Randy Schekman, who made note of the pernicious role played by what he calls "luxury journals" in the evaluation of scientific quality and of the need for a greater number of open access journals combined with IF-independent criteria to properly evaluate the quality of the scientific work [19].

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Perhaps as a reflection of our policy of keeping low publication fees combined with our commitment to maintaining high standards of quality, in 2013 INTERNATIONAL MICROBIOLOGY received 160 manuscripts from 40 countries. Of these, 28 articles were published in four issues after being accepted by peer reviewers. The diffusion of the digital version of the journal through the web of the Institute for Catalan Studies, our co-editor, has increased constantly since 2011, the first year that the journal was available on the IEC publication's portal; in 2011, there were 64,108 downloads; in 2012, 101,783; and in 2013, 173,822. The articles published in 2013 covered the great diversity of microbiology, from environmental biology and biodiversity to biodegradation and pathogenesis. From these pages we encourage all members of the SEM as well as microbiologists from Latin America to publish in International Microbiology.

In 2013, the four images featured as the central cover photo were: a leaf-cutter ant from Costa Rica (*Atta colombica*) (March), a marsh of the Lerma River in Mexico (June), the Gaudi's famous dragon in Barcelona (September), and a Chilean desert landscape (December). The four micrographs (representing viruses, bacteria, protists, and fungi) that regularly appear as the background of the front cover of International Microbiology were made by microbiologists from Spain. One of them, from the Institute for Marine Sciences (CSIC, Barcelona), provided us with an image of the recently discovered bacteriovorous protist *Minorisa minuta*, one of the smallest eukaryotic cells known so far (1.4 µm average). Latin American countries have a long history of prominent researchers in public health and infectious diseases, since the early 18th century. Continuing our tradition of promoting microbiologists pioneers from the "South", our back covers featured the portraits of Rafael Rangel (1877–1909), the Venezuelan founder of parasitology and biological analytics in his country, in March and June, and Miguel Ángel Ugarte Vega (1862–1898), pioneer of medicine in Honduras, in September and December.

As in previous years, on behalf of the publication and editorial board, I would like to thank and recognize the efforts of the many researchers who voluntarily devoted part of their time and expertise to reviewing the manuscripts received by our journal. A list of their names and affiliations can be found on page 267 of this issue. Their work is of utmost importance in sustaining the quality and validity of International Microbiology.

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