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Workshop Report

Future Challenges for Life Sciences Research

Brussels, 28 September 2004

EGLS

The European Group on Life Sciences (EGLS)

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This document is an informal report written by an independent rapporteur. It does not necessarily reflect the views of the speakers or the Commission.

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Introduction and the Commissioner's final thoughts

Observing the rapid and exciting discoveries being made in the life sciences and biosciences, former Research Commissioner Philippe Busquin made an important decision, in 2000, to assemble a panel of experts to monitor and provide advice on current and future progress in this field.

"When I set up the European Group on Life Science (EGLS), I realised that there was a pressing need for intensive debate on the socio-economic and ethical implications of these emerging sciences and technologies," he noted at the time. In particular, Mr Busquin said he was conscious that public debate – and media fascination – in Europe was too narrowly focused on GM agriculture, something that had polarised public opinion and perhaps ignored the paradigm changes taking place in society today.

The EGLS – which has included Europe's leading thinkers in the life sciences – has advised the Research Commissioner on emerging issues in life science (LS) research and policy. Through reports, workshops and information exchange, their counsel over the past four years has helped to define and refine policy-making – especially in the lead up to the Seventh Framework Programme (FP7) for research – in this challenging field.

The final workshop organised under the auspices of the EGLS, entitled *Future challenges for life science research,* was an excellent opportunity for the members of the Group to express their thoughts openly on the major issues that may lie ahead for the whole area. It was also a chance for the Commissioner to thank them for their invaluable contribution to improving the Science and Society dialogue at the EU-level.

At the launch of the workshop, Mr Busquin said a measure of the Group's success lay in the fact that over three-quarters of the original members were still involved, a testament to their commitment and dedication. "Science is in flux, especially the life sciences… [so expert] groups of this kind are indispensable to we policy-makers who may not necessarily be scientists or qualified in that area," he said. Members of the EGLS hailed from 11 different countries, making it a pluralist, multicultural and geographically diverse group, noted Mr Busquin.

Mr Busquin emphasised the fact that the EGLS acted as an advisory group but also as a communication forum with the public, in particular through the previous conferences that were held which were open to the wider public.

On a personal note, he concluded that he has been able to say certain things with confidence, feeling that he was not contradicting the experts. "I based what I have said [these past years] on statements from people very qualified in the field," he continued. "We have had this important dialogue so Europe can remain at the cutting edge of science."

Welcome (by co-chairs Christian Patermann and Victor de Lorenzo)

Co-chair, Christian Patermann, director for biotechnology, agriculture and food research at the European Commission, introduced the one-day workshop as an overview of opinions, or "a panorama of perspectives", on the future of life sciences research from eminent scientists in the EGLS.

He also mentioned the timeliness of this exercise in light of preparations for FP7 and the on-going Lisbon Agenda, calling for Europe to become the world's most competitive and dynamic knowledge-based society by 2010. As the so-called "next wave" after ICT, greater effort and investment in the life sciences will help build this dynamic knowledge economy, he suggested.

Co-chair Victor de Lorenzo, the EGLS chairman, introduced the 12 scientists – including himself – invited to, in his words, "speak up" on what the future will look like for the life sciences. He then congratulated Mr Philippe Busquin on his foresight in creating the EGLS, saying that he will be remembered as the Commissioner who listened and responded.

Executive summary

The workshop provided valuable insight into the perspectives for life sciences, both in the field of research and its socio-economic implications. Future challenges – as well as hopes and benefits – springing from the enlargement of the European Union were also matters of concern during the workshop.

The main messages on life science research were as follows:

- Life science research can help European agriculture tackle its three main challenges: the shift in economic power away from primary producers; the huge changes needed in agricultural infrastructure and systems; and the effect of trade globalization and liberalization that could lead to a 20 to 30% cut in EU agricultural output. Issues shaping the research agenda for the coming years in this field include: weaknesses in the food system and problems with consumer trust; nutrient losses in some soils (and overloading in others), water/air supply and quality; ethical issues, such as animal welfare; food safety, accountability, transparency and quality; and how best to use advances in technology.

- The world's food supply and natural resources are under threat from population growth, new diseases and environmental degradation. The 'gene revolution' and agricultural biotechnology are powerful and probably essential tools for generating sustainable agriculture, increased productivity, new markets for plant-derived products, and for making developing countries more independent.

- The subject of genetically modified (GM) plants and life science applications in agriculture was raised as a symbol of both hope and controversy. Nutrient loading and growth hormones in food production were identified as a future threat. Should the right scientific and regulatory environment be in place, the field of plant-based pharmacology, or 'pharming', carries significant promise as a cheaper, more effective medium for drug development.

- Promising fields for basic research in developmental biology were identified. First, basic research on early development patterns, including experiments on different species, to better understand principles of biological evolution, such as speciation and the common origins of living organisms. Second, greater effort to shed light on later stages of development will help to understand species differentiation and biological mechanisms, such as tissue regeneration and other functions guaranteeing the stability of organisms throughout their lives. Third, on the path towards possible future therapeutic applications, more basic research on stem cells (embryonic and adult) – and on regeneration and growth functions – is needed. Last, as most living organisms on Earth are at one stage of their life parasites or symbionts (i.e. pregnancy, vegetal roots and fungi, intestinal micro-flora, etc.), a boost in basic research on interactions between organisms is necessary.

- The importance of the microbiological dimension of biodiversity and its potential for new products and innovations was also outlined: some 70% of the Earth's biomass and 80% of the oxygen on the planet comes from microorganisms. This means that further exploring the microbial world is vital for a host of new medical and environmental applications. The role of micro-biodiversity and the interface between genomics and the environment (environmental genomics includes the exploration and exploitation of microbial reactions for environmental purposes) stood out as potential areas of growth in the life sciences.

- The ongoing conquest of the global genome worldwide, if left unchecked by Europe, will mean a massive genetic resource will be owned by the few who get there first. At the moment, 'metagenomics' – harvesting microbial genetic diversity for biotechnological exploitation – is dominated by non-European scientists. Researchers in our continent have the ability and vision to do this on a large scale, but lack funding and appropriate structure. It is increasingly clear that much of our future as sustainable societies will depend on our ability to reduce industrial waste and to come up with cleaner technologies and industrial processes, as well as renewable energy sources. By exploring the wealth of new possibilities present in the microbial world, many of these challenges can be taken up.

- In fact, many presentations picked up on this 'big picture' approach to the life sciences. For example, the idea of 'trans-kingdom genomics' – in which humans are not seen as isolated entities, but share a wider world interacting with 'biotic and abiotic partners' – was introduced in relation to the 'metagenomics' question. Another speaker explored the 'systems biology' approach to farming practices and the environment, leading to healthier food and sustainable development. Meanwhile, in the cancer field, it was observed that a shift from reductionism to systems biology is already taking place. And, from the IT perspective, it was suggested that 'big biology' in the future will rely increasingly on interdisciplinary skills, massive datasets, bigger investment, better education and state-of-the-art infrastructure.

- Developments in genomics (and increasingly proteomics) go hand-in-hand with improvements in computing power. Well-documented databases (e.g. databases of referred articles, of genes and proteins for biomedicine and health sciences) are an enormous treasure for the advancement of scientific research. A formal 'forward' method in analysing large research databases could be limiting. 'Inverse' searching, on the other hand, combines different databases by finding new relationships between data.

- Four major challenges (and opportunities) for life science research related to animal models, population ageing and future medicine were identified. First, the integration of knowledge from atoms to the whole organism (the so-called 'systems biology' approach) is needed. Second, medicine and basic science should be closer, and animal models (especially for disease) provide a critical link. Third, it is time for second-generation molecular medicine to start – i.e. integrative molecular medicine carried out by interdisciplinary research units, effective training programmes for clinicians to train in molecular biology, and effective means for scientists engaged in basic research to deepen their understanding of medical practice. Last, more effort is needed to intensify research on degenerative and metabolic diseases.

- In the stem cell field, applicable research results can realistically be expected within the coming 20 years in, for example, regenerative medicine, cell and gene therapy, or assisted fertility treatment. Reproductive cloning (cloning for babies) is banned in most countries. Cloning to produce stem cells for research, derived from patients suffering from complex diseases, will help to produce therapeutic approaches to those diseases. To use such individualized stem cell lines for therapy on a large scale would probably be unrealistic on economic grounds. Banks of embryonic stem cell lines derived from embryos donated by patients in IVF clinics offers a much more likely route to the treatment of serious degenerative diseases. Other routes for overcoming the problem of graft rejection look more promising. Other areas to watch out for include new sources of oocytes, derived from embryonic stem cell lines, for possible use by sterile adults or homosexual couples who want their own biological children (i.e. generating gametes from their own stem cells lines), as well as using therapies and nanotechnologies for improving foetal surgery and medicine.

- In the future, the unpredictable risk of diseases – especially infectious diseases affecting children – could dominate the international scene. Many gaps remain in science's understanding of infections, immunology and other areas of biology, and a boost to research efforts is needed to help fight these pathogens. Developing new vaccines is extremely expensive, partly due to the cost of regulatory requirements. A fundamental goal is to share research findings and expertise, in particular with developing countries, to improve global health. For this, transdisciplinary research is needed, as well as monitoring and early warning systems for epidemics and the study of reservoirs for infectious diseases. Animal models are helpful but more clinical research is needed.

- Life sciences developments are tightly linked to social and cultural trends. Biological sciences together with social sciences have great potential to address a number of fresh challenges facing modern cultures. Among the emerging areas in this regard are evolutionary theory (biological and cultural, including memetics), cognitive biology, socio-biology, bio-politics and bio-pedagogy, which can play a key role in attempts to solve problems, such as terrorism and other issues related to human nature and social dynamics.

The main observations on the socio-economic aspects of the life sciences were:

- The economics of the life sciences was a recurring theme throughout the workshop. It came up in relation to the mounting costs of new drug development and the potentially missed opportunities in the GM-food sector. In fact, the cost of regulation was raised as a major issue of concern and it was shown how over-regulation may stifle progress in the life sciences, as well as in the fight against infectious diseases. Protecting the consumer, including the consumer's right to choose, is valuable and necessary, but Europe's inclination towards over-regulation unduly inhibits innovation and also generates extra costs, in particular in the field of GM-food labelling. It was suggested that the cost of regulation should be made explicit as a percentage of the price, like a value-added tax (VAT). Then consumers would know what they are paying for, and can make informed choices.

- The relationship between industrialised and developing countries, and the possible shared benefits from adequate research strategy and policy, was also raised in several contexts, including drug development (i.e. the European and Developing Countries Clinical Trials Partnership) and the challenges of globalised trade, feeding growing populations, and agricultural technology.

- In addition, it was underlined that the possible drawbacks for developing countries might arise when strategies and decisions made in the industrialised world do not take the realities on the ground into consideration – the issue of intellectual patents and the complexity and cost of drug development (i.e. who pays?) works against the genuine needs of developing countries, especially with the growing threat of infectious disease.

- Consideration of ethical values was a recurrent motif and 'caution' was a word used by several speakers in relation to the publishing and/or publicising of findings – particularly in relation to embryonic stem cell research, GMOs in food and feed and, most recently, plant-based pharmaceuticals – to the broader public.

- The issue of education was recognized as a bottleneck for the future of life sciences research. The lack on interest of the young in scientific affairs was recognized as an alarming trait spreading throughout Europe. This coexists with successful schemes for appealing young talent (i.e., the EMBL Graduate student Programme), which are a useful reference for the future. Furthermore, more could be done in Europe to encourage trans-disciplinarity, such as the cross-fertilisation between biology and clinical practice. Several mentions were made of the potential value of medical students/researchers and clinical practitioners (such as in cancer research) learning more about what developmental biologists are doing, and vice versa.

In conclusion, the shared interest and possible further collaboration between members of the EGLS and the Commission-appointed EURAB (European Research Advisory Board) was acknowledged as an added value in the process of providing scientific advice to support and help shaping the European life sciences research agenda.

Science at the service of society and agriculture in the new Europe (presented by Patrick Cunningham)

Patrick Cunningham, Professor of Animal Genetics at Trinity College Dublin (IE), said his task for the day was to reflect on where we have come from and where we are going in agriculture and scientific research. "Today, there are new drivers of the agenda that are creating new challenges." He elaborated on these challenges under three sub-headings: structural changes, enlargement, globalisation and trade.

Over the past two or three generations, there has been a shift in food production patterns, stretching the food chain. Today, around 5% of Europeans are involved in food production. Of the 7 million farms still existing, only a quarter of them are viable – the rest rely on off-farm work or are underemployed.

As a consequence of structural changes, primary producers' share of consumer expenditure has decreased every year and, over the past ten years, real prices of food have dropped by 30%. Some farmers have made up for this loss with increased efficiency. Using a map, he showed how the food market is being concentrated in fewer hands. In Norway, 99% of food is bought from just five companies. The picture is similar in Sweden, Finland and Switzerland with 94%, 92% and 88% respectively. At the other end of the scale, you have Portugal, Slovakia and the Czech Republic with 16%, 19% and 37% of the market share in the top five hands.

Growing from 15 members to 25, the EU has taken on 105 million more mouths, of which 23% work in agriculture. Production efficiency in the new Member States is much lower, requiring significant EU investment in years to come.

Criticism that global trade harms least developed countries (LDCs) is unfounded, he commented. Virtually all LDCs have open access to EU markets and the net impact of Union policy is small, as most trade with the developing world is complementary. From a food production point of view, competition with other emerging regions – e.g. parts of Asia, the Pacific and Brazil – is more troublesome, as their real production costs are, on average, half those of Europe. In this context, the liberalisation of trade in agricultural produce could reduce EU production by between 20 to 30% in the future, he suggested. "This is all economics, not science, but it is major driver [of policy] nonetheless," he said.

Other challenges he mentioned include the problem of consumer distrust in the wake of the BSE crisis and other major food scares which were a "wake-up call for science and the food industry" and have led to major changes in food production processes and a big task ahead for zoonotic scientists. Other harbingers are SARS and Asian flu. "Incubators of challenges in the future," he called them. The Single Europe Act means that we can trade freely but also that we can "trade freely in disease". Nutrient loading from intensive cropping and farming is another problem (with nitrogen and phosphate surpluses of up to 70% in known cases). And ethics is a big issue in the agriculture sector as, too, is the principle of food traceability – leading to the EU's 'farm-to-fork' initiative.

GM food is another 'hot' subject that will probably continue to stimulate debate in the future, but has no real scientific base for concern. Extensive use of the growth hormone *Bovine Somatotropin* (BST) in milk and meat should be further investigated.

On the plus side, enlargement of the Union presents Europe with a huge internal market of some 500 million people. It adds a large pool of talented and skilled scientists and agriculturists, and additional resources to Europe's current base, while the much-maligned CAP has in many ways "been a great stability force".

[No questions or comments on this session]

Present frontiers in cancer research (presented by Leonardo Santi)

Leonardo Santi, Chairman of the Italian National Committee for Biosafety and Biotechnology (Presidency of the Council of Ministers), spoke about the expansion of research frontiers, in particular the advances in molecular research and cell treatments. He said treating cancer is tough because you have to apply knowledge at the molecular level to complex situations – using "reductionism" which has been described as exploring every detail of a detail.

"The biological search over the past decades has gradually made it possible to identify, in certain serious illnesses like cancer, specific defects in the function of a cell and its micro-environment, or molecular signatures," he said. In turn, this provided "invaluable information [for] preventative diagnosis by classifying these defects according to their molecular profile and by choosing the most appropriate treatment for the cell… given the deterioration".

He said the borders of research are constantly evolving. New knowledge on genomics, biodata processing, bioengineering and so on provides fresh opportunities for linking fundamental and clinical research, in particular for serious illnesses like cancer.

He then went on to explain some of the work he has been doing over the years and to examine future trends in cancer research. In one example, he explained multi-stage carcinogenesis (process of tumour development) and highlighted how improvements in molecular science help researchers understand the cellular changes taking place which eventually lead to malignancy and clinical cancer. He showed a scheme which explained a new process – using engineered mice – for developing natural (leukocyte) interferon alpha and interferon alpha recombinant to treat cancer and, in particular solid tumours. And the antibodies, he said, can be used for treating chronic leukaemia and lymphoma, breast cancer and Hodgkin's disease.

He also spoke of the process research takes from reductionism to integrated systems biology, which requires an understanding of the information encoded in biological networks and mapping the design rules for increasingly complex biological sequences. For example, from genes to pathways, circuits and networks which are progressively ordered groupings (organelles, cells, tissues, organs) and widened into a picture of the homeostatic integration of myriad and complex interactive networks (in short, our physiology).

From there, his presentation described the analysis and application of the principles of biological design from 1750 (based on empirical understanding of biology and chemistry) through to five years from now, where the power of genomics and computing, through mechanical reductionism, lead to rational medicine and customised care. Thus, in the 21st century, "systems biology" will evolve – through biotechnology, new discoveries and large-scale computing – into "big biology" which uses interdisciplinary skills, massive datasets and will rely on big investments, better education and state-of-the-art infrastructure. Among his examples, he explained how society would benefit through more tailored diagnostics and medicine (genetic profiling, smart cards, disease management and prevention, etc.), and he showed some of the latest work on proteomics – combining proteins and genomics – for drug development.

Question, Answer, Comment

Q. As cancer research becomes more personalised, costs will increase, which has social-ethical implications. Who pays? (V de Lorenzo)

A. Pharmacogenomics for prevention has yet to be fully achieved… [if and when it is] you are left with an individual response, on the one hand, and a social one, on the other (L Santi)

A. The more you individualise treatment, the more difficult it is to justify the expense. We propose all relevant stakeholders sit down and figure out how we can get drugs to the market faster and reduce costs… (B Diderichsen)

Science: an essential dimension of culture (presented by Ladislav Kovac)

Ladislav Kovac, Professor of Biochemistry at Comenius University, Bratislava (SK), spoke about the evolution of life in biological and socio-cultural terms, implying that developments in the natural sciences should not ignore those in social/behavioural sciences. He cited historical events, such as the Holocaust, the spread of communism and the 9/11 terror attacks as evidence that humans learn slowly, if at all. "The use of rational means for irrational goals: this is the message of the twin towers in New York," he said.

"The prime importance of contemporary biology reaches far beyond its exploitation in human health care and in biotechnology," he noted. It breaks new ground in the cultural – i.e. human and social – sciences and is instrumental in understanding the present state of humankind, he added, with all the risks and dangers individuals and societies now face.

He talked about the distinction between biological evolution – the uniting of genes – and cultural evolution which unites what he calls 'memes'. "In the course of cultural evolution... human nature has changed little, if at all." He said humans are still fearful, social, hyper-emotional and myth-bound beings. This has not happened through a rational, conscious effort. Evolutionary selection of different memes has led to societies that, despite their laws, morals, political institutions, art and science, still occasionally erupt.

He then explained how power is distributed throughout societies, comparing primitive times with modern political systems, and how politicians use tricks and ruses to convince people. However, the error of people's decisions appears only in hindsight. Under the politics, economics and social dynamics "is a fundamental, grounding layer of human biology" – in other words, "human nature" and the interaction between our genetic makeup and memetic influences. "This is the basis of human social behaviour," he concluded.

We live in a dangerous world that we know little about using the current tools and approach, he said. Our response to the danger is to spend more on military R&D and medicine that is potentially of marginal worth. Meselson (2001) said "Technical solutions cannot solve the problem of terrorism." But what can?

To defeat terrorism, Mr Kovac explained you have to understand it better. "Terrorism seems to be, at its very basis, a phenomenon of human biology, not problems to be approached by molecular biology." But biology does play a role – in emerging fields such as bio-behavioural research and the expansion of biology into areas previously the reserve of cultural (human and social) sciences.

"The fact that molecularisation of biology has enabled impressive technological interventions should not detract from this need to move to the upper level of inquiry." Emerging areas in biology, such as generalised evolutionary theory (which includes memetics), cognitive biology, socio-biology, bio-politics, and bio-pedagogy, are examples of where more support and effort could be placed, he said.

Question, Answer, Comment

Q. Is there not a problem with social sciences and biology and experimentation? (V de Lorenzo)

A. At the last meeting in Genoa, I proposed that the EU has a unique opportunity to create a 'laboratory of politics', not centralised but functioning through the Member States and political labs promoting pluralism…(L Kovac)

Q. One member of the audience referred to the idea that, now that memes (people) are getting better organised and inter-connected (or networked), they might be considered as genes of a sort of huge organism (mankind or Earth) and this might show in the future that memes (more than genes) determine evolution

A. Good remark. Biologists/generalists can do everything with genes, but we have no direction. We don't have memes in our hands: the gap between what we can do and what we want to do is dangerous. A new perspective can really change human evolution – but not in a Huxley kind of way (L Kovac)

The future of research into developmental biology (presented by Christiane Nuesslein-Volhard)

Christiane Nuesslein-Volhard, Director of the Genetics Department at the Max-Planck Institute, prepared the audience for a leap from philosophy to hard science. She defined her work as a developmental biologist, and stressed the importance of this sort of basic science – carried out on animal models (flies, frogs, worms, mice, chickens and fish) not humans. "It may sound tedious to you, but it is exciting for us," she said.

To understand what the future holds, she quickly reviewed the past, starting with the early work on molecular biology in the 1920s and 1930s which led, eventually, to the discovery of DNA in the 1950s. From that, developmental biologists were given the tools to search for the molecules guiding embryonic development. Today, many genes with important functions are known. It turns out that many have limited "housekeeping" roles and that just a few transcription genes are involved in development. It also became clear that the "mechanisms by which many genes function are similar in all organisms and there is a much smaller number of genes than there are animal functions". So, the traits we observe come from the interaction of these genes. The main idea here was that the concept "1 gene = 1 function" is false because we know that biological functions are driven by a combination of genes. "This is something we've taken home from genomics research," Mrs Nuesslein-Volhard explained.

Developmental biology (DB) has its limitations, although more is being learned every day. The future is hard to predict, she said. But by extrapolating from the past, certain assumption can be made. First, the principles of genetics apply to all organisms because we followed a common evolution – DB focuses on just a few. "There is a need to broaden the scope from the six animals currently studied to increase knowledge of where we came from – a bit like the cultural evolution," she said referring to Mr Kovac's talk. Analysing stem cells – responsible for the differences observed in animals and which are pluripotent and pliable – could be useful in years to come for learning how bodies maintain and heal themselves.

Stem cell growth is key in understanding how used cells in the body replenish (skin, blood, etc.) and in developing therapies for various diseases. But before this can happen a lot of complex fundamental research needs to take place. This type of research is difficult, faces public and government opposition and can often fail, which makes securing finance tough, she stressed. Mrs Nuesslein-Volhard is personally interested in the biological function of parasites – affecting biology, medicine, environmental science, etc.

"But what is the outlook for basic research in DB?" she asked. The biological understanding of cancer, for example, depends on research carried out on flies and mice. She said stem cells have the potential for big things, such as regenerating hearts or making organs, but emphasised the difficulty of success. Cellular gene therapy holds some hope but, after 20 years of research, not much progress has been made, she said. On this, she cautioned "we should be more careful about publicising results prematurely saying that treatments for this or that are possible". Here, Mrs Nuesslein-Volhard reiterated the public concern about the cloning technology used for Dolly the sheep being used on humans: "It's such a huge leap. We can't do it yet and [even if we could] the legal and practical restrictions would be too great… I know a lot of experiments we could do right now but [we] would never dream of doing so."

Questions, Answers, Comments

Q. Member of the audience asked about the DB and ageing

A. I had planned to say more about this. It relates to how the body maintains itself… I'm not surprised we age – like a car can only last a certain time. Cancers occur, cells mutate… it's not our fault and is part and parcel of developmental biology to understand more about it (C Nuesslein-Volhard)

C. A member of the audience said that, as a neuroscientist, he regretted EGLS' lack of interest in this field. He sees fascinating parallels between DB and neuroscience and advocates more dialogue between the fields

Q. One member of the audience said the comment that researchers could do anything is troubling and asked how to overcome distrust

A. I wish I knew. Drawing attention to the science leads to promises which are dangerous when getting funding depends on it. Be honest, that's the most important thing (C Nuesslein-Volhard)

Regulations in LS (Life Sciences) research: lessons from the past and ideas for the future (presented by Derek Burke)

Derek Burke, Professor and former Member of the Governing Body of the Institute for Food Research, Norwich (UK), started out with several quotes from the *Times* newspaper in 2003 and 2004 which highlight and mock, in equal measures, the EU's regulatory attempts.

"Over the past few months, we in Britain have seen lots of headlines about over-regulation," he said, offering several examples. One of the titles read: 'Regulating temperature, the government thinks Britons cannot run a bath'. Here, the Commission sought to protect British consumers from being scalded by insisting that all taps be joint for both hot and cold water. "[A] third headline reported Europe's top motor industries bosses telling the President of the European Commission that doing business in Europe meant extra costs because of 'increasingly dense, complex and often conflicting regulations'. So how much regulation do we want or need?"

The main reason for regulating the life sciences is to manage risk to human and animal health and the environment, without unduly inhibiting innovation, he said. But this leaves several questions unanswered. Who decides what level of risk is acceptable? Can a balance be found between promoting safety, on the one hand, and cost, bureaucracy, invasion of privacy, and loss of innovation and competitiveness on the other?

Food safety is a major concern for all governments, food producers and retailers. Regulations in place are obviously essential and consumers bear the costs. In its efforts to promote food safety, the EU set itself up as an arbiter of consumer choice, Mr Burke suggested, causing "endless complications" and putting it into a role "which is more properly exercised by the market".

Europe decided some years ago that all foods derived from genetic modification should be treated as 'novel', thus they had to be assessed for their safety. Three problems arose from this. First, the question of how 'GM' should be defined: "Does it include, for example, the crude genetic surgery of applying chemical or radiation mutagenesis to the seeds of cereals – as has been successfully done, with minimal regulation and no adverse effects, for over 50 years? The answer, as you know, is no," he said. Second, what should be labelled? And third, what level of GM content should trigger a labelling requirement?

He then went on to explain the inconstancies between this policy and what is happening on the ground in the USA, Brazil and even in Europe, quoting Valencia et al's observations on the anomalies of GM labelling. He talked about the extra cost that regulation adds to the shopping bill and to the LS research bill. "It looks to me as if the demand for more labelling will never stop because it appears to cost nothing. But it does cost, and Europe is paying heavily for it by a loss of competitiveness." He suggested making the cost of regulation (e.g. labelling) explicit as a percentage of the price, like VAT.

So, if the main purpose of regulation in LS is to manage risk to human and animal health and the environment, and there is no evidence that the GM foods approved so far are unsafe in any way, why are they labelled? "The answer is to provide consumer choice. And why is there so much pressure for consumer choice? Not because of evidence of harm." He asked whether this really should be the job of governments to decide. "Argue as we may about who should pay, there is no question but that regulation costs, and it costs European competitiveness," he stressed.

He spoke of the Lisbon and Barcelona agendas as grand goals. "[But] surely we cannot afford to go on like this, mouthing noble aspirations and simultaneously hobbling the new technology by a labelling regime based on perception and politics but not on evidence?"

Questions, Answers, Comments

C. The EU's position was clear on the science but political decisions were being made on this in the meantime (C Patermann)

C. A comment was made by the audience supporting the role of NGOs in pushing for more labelling and safety regulations in the GM area

C. In my opinion, the UK misunderstands NGOs; they are pressure groups and not decision-making bodies. They cannot be brought to the negotiation/decision table unless their stand/position is going to be negotiable (D Burke)

C. On the subject of the future being hindered by regulation, the USA and Asia are already trialling plants for health applications (i.e. pharming), we are going to fall behind. I am struck by the cost of R&D for new vaccines because of increased regulation in the past ten to15 years, and – as far as I know – the benefit it brings has not been measured (P Kourilsky)

C. Extended impact assessment for this is now being applied, including the socio-economic aspects (C Patermann)

C. Why did it go wrong? Because the communication was wrong from the start; we were too general and took easy options; GMO issues have to be negotiated and discussed on a case-by-case basis (B Hansen)

Are there rational arguments against GM (Genetically Modified) plants? What are the consequences for Europe? (presented by Marc Van Montagu)

Marc Van Montagu, Professor and Head of the Laboratory of Genetics at Ghent University, said there are many ways to examine the question of biotechnology; from a medical point of view, agricultural, industrial and environmental. Although all are important, he spoke in more detail about agricultural biotechnology, focusing on six main points: how it affects food and feed production, processing of food, forestry, new materials, molecular pharming, and the environment.

But why are GM plants so important? Mr Van Montagu gave several reasons. He said that the world's food supply, agriculture and natural resources are under threat from population growth, new diseases and environmental degradation. "So, as in the past, many ideas for innovation will evolve from the farmer's experience and from the imagination of those who turn commodity crops into value-added products. Efficient interaction with fundamental research will be key to realising agricultural innovation," he added.

He said the gene revolution will provide tools for: sustainable agriculture, increased productivity and less dependence on agricultural subsidies in developing countries, and new markets for plant-derived products. On the subject of forestry applications for biotech, he confirmed GM trees already exist but, due to international restrictions, his lab has to carry out its tests in Russia and China.

To create new materials, such a bulk products and chemicals, using plant-based genomics costs millions and most of this is taken up by administration and regulatory requirements. Molecular pharming – using plants to make new drugs – is being touted as an affordable and exciting new LS field, as plants are easier to use than animals and could be a big help especially in the developing world for diagnostics.

Mr Van Montagu noted that LS in this area have great potential in bridging the gap between the developed and developing worlds, but they first have to overcome public opposition and concern over safety issues. There is no scientific evidence of harm to human or animals. And the environment is no more at risk to GM plants than it is to traditional agricultural practices – nutrient loading, intensive farming, traditional plant selection, etc. He added that, "our traditional crops cannot survive in the wild, then why could GMOs". But he conceded in the current climate of distrust that, whatever scientists say, opponents will always be against it. He referred to three main arguments raised by GMO opponents: first, that "GMOs harm nature"; second, "multinational companies will control the food chain"; and third, there is a "we are against it" attitude.

Science – and the LS – must reverse this negative image and, thus, increase public participation and scientific education in future developments. "We need to communicate the benefits of science on society more clearly through the stakeholders," he said. In Europe, the EU is trying forge ahead in this area but is often blocked at the national level. This will be a future challenge, he said, implementing the Directives in the Member States. To this, he added that, "The public sector as stakeholder in the further developments and applications of experimental sciences need to mobilise ICSU, UNESCO, UNIDO and the academies to explain the importance of science." He talked about the importance of SMEs in this, especially in relation to biotechnology developments.

Mr Van Montagu spoke about the USA's moves to form a National Institute of Food and Agriculture (NIFA) within the US Department of Agriculture (USDA) and listed what its main mission would be. He concluded by saying that the 21st century will be the century of GM plants, but that it is a pity so much positive energy is wasted on defending the science against 'green' slogans. Better co-operation between basic sciences and environmental groups is vital.

Questions, Answers, Comments

C. Consumers should have the choice, but it's less clear if the labelling is based on the perception of the goods as being 'luxury' – as it is, not developing GMOs is preventing developing countries from sharing in the benefits of these products (B Diderichsen)

C. Consumer choice is fine but on what basis? At least we should make it clear it is 'not' on the basis of safety (P Kourilsky)

C. I perceive a mismatch between what the public says and what they want… (P Cunningham)

Q. Is intellectual property rights important in this argument – who benefits in the end? (N Dewandre)

A. Solutions arise where problems are present (e.g. environmental technology)… it's a defence position for all new industrial development to be patented (M Van Montagu)

Assisted reproduction and stem cell therapy: looking backwards, looking forwards (presented by Anne McLaren)

Anne McLaren, Group Leader in the Wellcome Trust/Cancer Research UK Gurdon Institute at Cambridge University (UK), took the audience back 50 years to the days when she was a postdoc. No one could see then the huge potential of Crick and Watson's DNA discovery. It was a time when there was no knowledge of mRNA or molecular biology, and decades before Southern blotting, recombinant DNA, transgenic mice, etc. hit the scene. Embryo transfer and hormone-induced ovulation in mice were just starting, there were no ultrasound scans for pregnant women, and the world's population was less than half what it is now.

Mrs McLaren journeyed through predictions of the 1960s to the realities of the late 1970s onwards, which were marked by the first IVF birth, in 1978, of Louise Brown. From there, controversy arose as reproductive and genetic technology began to build pace. This centered on two opposing forces: regulation versus prohibition. She explained the debates that followed in the UK Parliament and the early legislative efforts, culminating in the setting up of the UK National Stem Cell Bank which currently curates existing and new human embryonic stem cell (ES) lines, as well as human foetal and adult stem cell lines. These cells are available to UK academics and industry, and to overseas academics, while ownership of cell lines remains with the depositor.

"For this audience, I probably don't need to explain what stem cells are and the potential that cell types have in generating therapies for a lot of serious diseases, such as Parkinson's, diabetes, stroke and MS," she said. Stem cells are capable of self-renewing and can give rise to one or more differentiated cell types, including neural, liver, muscles (including the heart), pancreatic islet cells, blood and cartilage. The three sources of these cells are adult, foetal and embryonic. She went on to explain the ethical, psychological and clinical risks of using stem cells, and outlined the relative merits and uses of the three stem cell sources.

She gave a quick history of animal cloning – how it was done and what implications this had on the public psyche – and spoke of the scientific likelihood of human cloning with current technology. If attempted, she felt there would be a high risk of foetal and neonatal death, malformations and later disease. "If ever made safe and scientifically effective, there would be many and varied ethical objections," she said. The most likely applications could be for "irremediable infertility (male or female), replacement of dead child, or do-it-yourself female reproduction". But she stressed that this would be very much in the future, and banned under current UK law, at least. But generally speaking, she advised great caution on "reproductive cloning".

However, she was confident that stem cell therapy would function alongside drug therapy within this generation. She mentioned the current scientific hurdles and how they may be overcome. She explained some possible uses of cloning for research. Other advances, including nanotechnology, may impact on foetal surgery (already carried out for some conditions).

Mrs McLaren mentioned that stem cell technology might one day make it possible for sterile parents to have their own biological children by generating gametes – ova and spermatozoid – from their own stem cells. She also warned of possible conflicts of interest between mothers, fathers and children in the future and raised the possibility of same-sex reproduction and how it might be achieved using advanced stem cell science. However, decades of research would still be required before this is scientifically possible.

"Things have certainly changed in 50 years. It is tempting to say 'slow down'… but anything potentially harmful to society is approached with caution. If made to choose, I favour regulation over prohibition."

Questions, Answers, Comments

Q. In 2002, you talked about somatic cell nuclear transfer and two years later we exchanged open debate across the Member States and prevented any inhibitory action from taking place (B Diderichsen)

A. Transparency and open discussion are tremendously important, and we reached a decision because there was full debate. There was also significant interest and good coverage of the issue (A McLaren)

Databases for knowledge discovery (presented by Johan van der Lei)

Johan van der Lei, speaking on behalf of EGLS member Jan van Bemmel, said his subject might not be the sexiest but it is certainly important. Databases are diverse and come from different origins. There are hard types – those built from the natural sciences – and soft types which come from the humanities. But there are also hybrids which cover biomedical and health sciences.

Connecting both hard and soft DBs in the life sciences is potentially strange and difficult, said Mr van de Lei. In the biomedicine and health field, you have basic research stored as experimental data, clinical research from patients' records, and health research gleaned from population data. The consequence of which is there is so much information that retrieving it has become a major problem. "We have gone from data starvation to data diarrhoea," he summed up. For example, MedLine contains 11 million abstracts, roughly 500 000 new ones added per year. How can you find new knowledge in that? How do scientists cope with serendipity?

Search engines work in two ways: forward and inverse. A classic example of a forward – Boolean – search using what he called "fingerprints" is Google. The result is an avalanche of information. Inverse searching, on the other hand, combines different databases by finding new relationships between the data – or ontological retrieval of information.

An example of a fingerprint is to search using content, people or organisations. An inverse search uses complex data mining – for example, taking a genetics database and a literature database and searching for new associations and ways to match the records. He showed models of how this works and presented a graph illustrating the phenomenal growth in information systems for primary clinical care between 1978 and 1998 in the UK versus the Netherlands.

He demonstrated how, for instance, patient blood data can then be cross-matched and "critiqued" using computer-assisted ECG interpretation which is more reliable than human diagnosis. The data can be used to support policy-making, too. One can also combine comprehensive population-based research with retrospective clinical and genealogical data to produce prospective, longitudinal databases to help in monitoring the population's health. But Mr van de Lei recognises that using novel 'innovation' to help in science and medicine is not a new concept. "The more we change, the more we stay the same," he said. The invention of the printing press was a revolution in the 15th century, much like ICT is for society now.

Naturally, this raises the question of data privacy. Even there, we are not paving new ground, argued Mr van de Lei. He offered the example of Erasmus' use of the private letters for his own purposes. The critique on Erasmus is that he did not understand the concept of 'not' publishing private information. He thought it was okay – the content was the same, but the medium had changed. The same applies now.

Questions, Answers, Comments

Q. Where is Europe's standing in relation to this? (B Hansen)

A. America is leading the pack in developing these sorts of DBs but, with clinical data, Europe isn't doing that badly – combining disciplines, research is all about teamwork, and Europe is better at this (J van der Lei)

Q. But what about the software side? (B Hansen)

A. It is not really an issue – it is more important to get people to collaborate better; the hurdle of combining clinical and genetic data

C. This is a key area, e.g. in combating things like BSE, collaboration between five countries took place (then a comment on the connection between property rights and individual work not necessarily being collaborative) (B Hansen)

Q. But I thought the USA was good at it, too (C Patermann)

A. In my opinion, after working there for some time, I find the USA is very individual in the way the people work. They will hold back information and focus on getting patents in quickly. Europe is less like this (J van der Lei)

Animal models, an ageing society and 21st century medicine (presented by Matthias Hentze)

Matthias Hentze, who stood in for EGLS member Nadia Rosenthal, adapted the original title of the speech – 'The issue of animal models in LS research' – to more closely fit his own work as a senior scientist at the European Molecular Biology Laboratory (EMBL). "What is the current situation?" he began. From our knowledge of genomes (vertebrates, invertebrates, yeast, etc.) we have developed advanced research techniques, such as injecting embryonic stem cells, and high throughput methods. "Not only is science changing but society is also changing," he said.

The EU is ageing and the implications for science and knowledge based on science – making it interesting and promising for younger scientists, for example – are significant. The solution, he said, is to better integrate scientific knowledge using a systems biology point of view (from atoms to macromolecular complexes to cells to the whole organism) leading to a quantitative understanding. "A key aspect is that we're not descriptive enough and are only semi-quantitative, not making the most out of cross-discipline (i.e. maths with biology)," he added.

We need to integrate biology and medicine for experimental manipulation, he said, and animal models play an important role in bridging basic and experimental science because there are many experiments scientists cannot or will not do on humans. For example, using mouse models, they tested the impact of the relatively common condition of hemochromatosis (HFE) on the body's organs, which justified more studies. He then showed a list of EMBL mouse models available in 2004, including for leukaemia, heart failure, diabetes, muscular dystrophy, and asked if we had what we needed. "Not yet!" he said. We need more tools, such as spatio-temporal gene control (conditional techniques), pharmacogenetics (drugs/small molecules), and integrated phenotyping capacity, but we also need "strong support to harness the possibilities of (mouse) models to understand (complex) diseases". And we require more trained pathologists (especially for mice), *in vivo* imaging capacity, and better bioinformatics.

In moving from the first to second generation of molecular medicine in the 21st century, it is leading to greater knowledge of integrative molecular medicine (i.e. interdisciplinary basic science, joint projects). Here, he mentioned that physical proximity of labs and researchers is an advantage, especially for EMBL. He reiterated the importance of doing basic research and not jumping to the applications stage too fast, but to get there we need better training for molecular biologists. "In view of the ageing population problem, degenerative diseases also need to be emphasised, not just to foster regeneration and to stem the onset of metabolic disease, but also to understand the causes and to develop therapies," he explained. To do this, we need to know molecular mechanisms – which is where animal models come in. In conclusion, we need to strongly support integrative and quantitative systems for biology in fundamental life science, as research on animal models for disease will "have a particular benefit for society".

Questions, Answers, Comments

C. B Diderichsen supports the premise of collaborative/integrative approach but thinks we need more medical students with a knowledge of molecular biology. In the current EU charter, getting diplomas transcribed to "move brains around the Union freely" would help

The future of research in infectious diseases (presented by Philippe Kourilsky)

Philippe Kourilsky, Director-General of the Pasteur Institute, gave some statistics of the incidences of worldwide infectious disease to illustrate the importance of this field of science: AIDS is still with us, new strains of pathogens (for example: bird flu) are constantly emerging, antibiotics resistance is a growing concern, and about one-fifth of cancers are linked to infectious diseases. “Epidemics are still around!” he stressed.

A lot of research into infectious disease is being done but it should not be taken in isolation, he said. What is troubling is that we have vaccines and they are often not reaching the people in need – many infectious diseases in least developed countries (LDCs) are neglected by researchers, policy-makers and pharmaceutical companies, he commented. In addition to the huge humanitarian problem, such an oversight poses a potential threat if these diseases happen to spread. He questioned the point of science if knowledge is not shared between developed and developing countries. “We have a measles vaccine yet several hundred thousands children still die every year.”

He emphasised transdisciplinary research. As an example, he talked about efforts to monitor epidemics using satellite technology, and said that the study of animal reservoirs for infectious disease is undermanned. Bio-terrorism poses a genuine threat and not necessarily from sophisticated diseases, noted Mr Kourilsky. Vaccines' clinical trials are difficult. Animal models are poorly predicted so that more research on humans is needed, he said, especially if we are going to curb infectious disease in the least developed countries (LDCs), where they tend to strike hardest, under conditions dominated by low hygiene and multiple infections.

New vaccines cost up to half a billion euros and LDCs can afford neither the available drugs nor the most recent vaccines. Vaccines only represent 2 to 3% of the pharmaceuticals market – 30 times more is spent on drugs in terms of global Rand D. He mentioned the regulatory issues from earlier in the day and said that development costs have increased by 300% in the past years. He noted the “hidden link between ethics and regulation standards”. More safety is one thing for developed countries but “globalising” moral standards is questionable. Thus a few adverse reactions in the USA to the Rotavirus vaccine led to its withdrawal but no one asked if it might still be suitable for LDCs.

Dealing with ethics properly is important, and sharing research requires changes in processes as biology is an integrative science which ultimately needs to be applied to what is happening on the ground. “We must share knowledge and products,” he said. The issue of whether health is a public good to be shared, not just an economic issue, is of major importance. He mentioned political aspect and how Europe approaches this. The Union is not generous enough towards LDCs and falls far behind the USA. The EDCTP (European & Developing Countries Clinical Trials Partnership) has not lived up to its potential, he said. “There are major scientific, humanitarian, societal and political issues and I am happy to have been given the chance to stress them in strong terms today,” he concluded, adding that it is an issue for science, but not one to be addressed in isolation – sharing is important in all respects.

Questions, Answers, Comments

C. A member of the audience from Glaxo-SKB corrected Mr Kourilsky on the cost of drug development, saying it is around €800 million not half a billion and he wanted to know how they are meant to deal with ethics

A. Who will decide on a standard for ethics? Can decisions be made locally? How autonomous do they dare to be? Mr Kourilsky gave the example of rabies vaccine which used to be developed in mouse brains but the product was not of good enough quality, according to the WHO. It is still very much needed in, for example, Vietnam, and the new methods are beyond their reach.

Q. A delegate from Bayer says it cost three times that because of the multiple trial requirements. She said they cannot make drugs for such low prices: the issue is intellectual patents and complexity of drug development versus the needs (in the infectious disease area). She mentioned a staggered payment system for LDCs depending on the ability to pay and making health a political priority in these countries

C. Mr Hansen lamented the failings of the EDCTP and reflected on the Busquin speech back in 2000 about industry input in research and the need for public-private partnerships and platforms

The conquest of the global genome (presented by Victor de Lorenzo)

Victor de Lorenzo of the National Centre of Biotechnology, Madrid (ES), spoke about the huge impact that DNA sequencing has had in the area of environmental genomics, which is being spearheaded by Venter et al. ('Environmental genome shotgun sequencing of the Sargasso Sea', *Science* 304: 66-74) in their work on meta-genomics – from the microscopic to the truly macroscopic.

Venter's efforts have led to the discovery of thousands of novel microbial species and more than 1 million new genes – naturally, being a North American collaboration, their institutions have a privilege in the resulting intellectual property he pointed out. Data on around 300 meta-genomes are being collected by Venter and company from sites all over the world. But what is Europe doing in this field? If Europe does not try to match Venter's approach, "ownership of the massive genetic resources of the planet will be in the hands of the few who get their first". He showed that the EU Framework Programme for research has changed emphasis and that not expressly including environmental biotechnology in FP6 could possibly explain why Europe is falling behind in meta-genomic research – a type of research that harvests microbial genetic diversity for biotechnological exploitation. Europe has the vision and ability in this field but lacks the funding and structural mechanism to do it on a large scale.

He presented a figure showing the known biological diversity (i.e. ~100 000 micro-organisms, ~300 000 plants, 1.5 million animals) but explained that the biggest reservoir of species – mostly micro-organisms like eubacteria and archaea – is "non-culturable" in laboratories anyway. For example, some 70% of the biomass on Earth and 80% of the oxygen produced by living organisms comes from the very smallest members, the micro-organisms. Earth is a microbial planet, as shown in a chronology of the evolution of organisms on which animals and plants appear relatively recently. "But how can we access this microbial diversity?" he asked.

He offered several examples, asking if diversity is real or apparent. Using a picture of various types of television, he wanted to make the analogy that there are several ways of counting gene biodiversity and, hence, the results will differ markedly if species, or the the genes themselves are counted or the biochemical reactions are tallied. Different televisions represent different organisms but they all have the same function, which is, according to the metaphor, to show a broadcast (i.e. execute a given role in a biological context). He also introduced an analogy with the novel of Don Quixote as a story, as a book or as an edition in a different language. The quest of the genetic diversity of the microbial world was compared to efforts to understand the origin and immense variety of human languages. , He showed overlapping rings which symbolised the mapping of genomes. "If you make enough sequencing, little by little you will cover all sequences," he noted. He questioned the utility of even attempting to sequence them all, but the lure is that "the more genomes we do sequence the more new genes we'll discover – perhaps there is no plateau in sight".

Here, he advocated the "network approach to biology", something which is gaining ground in science at the moment. In fact, discovering new genes is relatively easy, he commented, but finding out how they function and finding applications for them is much tougher. He showed slides on the breadth of research possible in this field and outlined the progress in the application of biotechnology in industrial sustainability (the subject of an OECD report) and 'green' chemistry. The USA is spending something in the range of 3 billion dollars over the next 4 years on this while the EU barely puts up around 10-20 million euros in Microbiology all in all in the 6th FWP. He calculated that, all things considered, the USA is spending ten times more in this area. "[Much] of our future as sustainable societies will depend on our ability to reduce industrial wastes and to come up with cleaner technologies and industrial processes, as well as renewable energy sources," Mr de Lorenzo explained. Exploring what the microbial world has to offer "paves the way to produce cheap energy (H_2)" and a host of other environmental technologies. We are entering an epoch of "trans-kingdom genomics in which humans are not seen as isolated entities" but share a wider world interacting with "biotic and abiotic partners" which, when explored as a whole system, should benefit health, food and sustainable development in the near future, he concluded.

Questions, Answers, Comments

C. We agree that not enough is being done in microbial diversity, it is important for finding new genes and gene variants… which have very important applications (M da Costa)

C. Mr de Lorenzo compares microbiological discoveries to those of Christopher Columbus and geographical explorations of past centuries: getting there first counted

Q. Is there a microbial limit, or is it like astronomers trying to measure the Universe?

A. It's limited but this is still open to debate (V de Lorenzo)

European Research Advisory Board (EURAB, presented by Helena Illnerova)

Helena Illnerova, President of the Academy of Sciences of the Czech Republic and EURAB member, thanked Mr Patermann for his warm welcome and commented on the importance of the life sciences in general and how future collaboration between EGLS members and EURAB would be useful to the work carried out by the Advisory Board. She then explained what EURAB is and what it does.

It is a high-level, independent, advisory committee created by the Commission to provide advice on the design and implementation of EU research policy, in particular the European Research Area (ERA), the Lisbon Agenda and the future of European R&D. It is made up of 45 top experts – 20 from academia, 20 from industry and five appointed by the Commissioner – from across Europe and beyond.

Mrs Illnerova gave a précis of the members' backgrounds and examples of the work it has already carried out since being set up, including issues affecting the future of university research in the ERA, how to increase the attractiveness of science, engineering and technology careers, and what to do about enlargement and the ERA. It has provided recommendations on, among other topics, improving innovation in Europe, the setting up of technology platforms, and on SMEs and the ERA.

She commented on the EGLS' important legacy and outlined just a few of its contributions to the debate on socially sensitive problems in modern biology. She applauded the Group's outlook on the future of biology especially in the context of the social acceptance of S&T. To secure the future, Mrs Illnerova mentioned the role of basic research and the importance of instilling a sense of excitement among the young generation in science.

She was impressed that the EGLS – and this meeting – tackled not just the developed world's problems but also those in LDCs, and stressed the importance of sustainable agriculture and the overlap between European and global problems. Mrs Illnerova went on to mention an area of biology she has worked in for many years, namely endogenous clocks, or the body's own timekeeping mechanism, and how important this is to modern health and life quality. "Maybe more effort should go into preventative medicine: we could set up a ten commandments for healthy lifestyles," she said, and then concluded by offering several rules for healthy living, such as sleeping well, and quoted Czeslaw Milosz's poem *Bobo's Metamorphosis*.

EURAB colleagues follow up

Mrs Illnerova's fellow EURAB members added some important points to the presentation, saying that a harmonised system, like that in the USA, for infectious disease control in Europe would be an important development. Mention was also made of the measures to get more youth involvement in science, and how to promote excellence regardless of where it comes from and which country. One EURAB member said he will take EGLS' legacy forward in 'translational research', especially in human medicine, and commented on the regulatory stumbling blocks and the administrative burden posed by FP6.

Final general comments

The floor was opened to general comments and final remarks. A McLaren said in 20 to 30 years stem cell therapy will join drug therapy but she could not see the pharmaceutical industry gearing up for it yet. A EURAB delegate from a pharmaceutical company said it is early days yet but they have their "toes in the water". B Diderichsen of EFB in Denmark said they are looking at stem cells for diabetes and have EU funding for it. He continued: "It's a relief to talk openly like this without having to sign some kind of secrecy contract… this is the sort of thing which helps us get to Lisbon."

A representative from Portugal said the meeting was by no means trivial and it was very comforting and interesting to hear Mr Kourilsky's views. He pondered how to get more clinicians to learn basic biology and said the EU's role is key in issuing directives from outside Portugal to help build momentum on many scientific issues.

V de Lorenzo spoke about the young people and science challenge and offered the "curiosity versus mission" dichotomy as something the EU could learn more about in explaining participation levels in S&T. P Cunningham posed the question of what is being done in the EU-25 but also what cannot be done. L Kovac noted that young people are still curious about science but their attention is being redirected to other professions. M Van Montagu concurred with Mr Kovac and said it might be a throwback to the view of science as negative – old guys in lab coats.

Delegates discussed the meta-genome speech given by Mr de Lorenzo and one even suggested that if Venter is doing such a good job with why should Europe try to compete. The view was to put the best scientists on the best science and give them money, then the results will flow from this simple equation. Added to this was the "freedom" to explore the research unencumbered. A delegate from the Evangelical Church said she felt the day's discussion had been constructive. From its point of view, public dialogue is important and the meeting proved there is a sincere openness to dialogue and listening, even if consensus is not always reached. She expressed hope that this sort of debate will continue under FP7.

The EMBL was held up as a model for promoting young careers and M Hentze was called on to explain why it works so well. Several reasons were offered, including the prestige of the organisation being a draw card to young scientists, its effective recruitment and the fact that it offers generous career prospects, but he added that the individual's motivation is also important: "We go where we can do our best work… we shouldn't talk down [European] science but advertise our strengths instead," he said.

Conclusion (by co-chairs Christian Patermann and Victor de Lorenzo)

At the end of the day, Mr Patermann summed up the main points covered by the 50 or so delegates during the workshop and expressed satisfaction at the candid and honest dialogue that had taken place. This, he felt, would contribute solidly to the all-important dialogue on science perspectives currently taking place throughout Europe.

Mr Patermann said, in conclusion, that the Commission would carefully analyse the points raised and comments made during the day in view of future policy-making in the life sciences and science in general.

Mr de Lorenzo's final comments were on the subject of how to encourage more young people into scientific careers and the life sciences, in particular. Here, he stressed the importance of understanding whether research career decisions are driven purely by curiosity or motivated more by mission and the need to achieve. The EU might wish to learn more about this distinction, he said. He later mentioned the EMBL's successful recruitment strategy as an example of how to nurture scientific talent.

http://europa.eu.int/comm/research/life-sciences/egls/index_en.html