International conference on biotechnology in public – DNA and the quality of life

A meeting with the above title was organized by the United Nations Industrial Development Organization (UNIDO) and the European Federation of Biotechnology (EFB), Task Group on Public Perception of Biotechnology (TGPPB), at the Vienna International Centre, Vienna, Austria from 2 to 4 December 1998. The other sponsors were the City of Vienna, Department of Biotechnology and Genetic Engineering, Ministries of Agriculture and Forestry, Economic affairs, Environment, Youth and Family Affairs, Labour, Health and Social Sciences, Science and Transport of the Austrian Government, and the Austrian Biotechnology Industry. The conference was organized to commemorate twenty-five years of the advent of the recombinant DNA, to provide a forum to examine the wider socio-economic implications of the recombinant DNA technology, and to reassess the hopes as well as the fears that have been raised during these twenty-five years. There were over 200 participants from the Austrian and European NGOs: environmentalists, activists and media, scientists, and policy makers from the European Economic Community. The meeting was inaugurated by H. E. Barbara Prammer, Federal Minister for Women's Affairs and Consumer Protection, Government of Austria. In her inaugural address, she mentioned that the Austrian consumers are very much concerned about their environment and the social impact of biotechnology products. She stated that in contrast to the pharmaceutical products, which if later were found to have adverse effects, can be withdrawn; the genetically modified organisms (GMOs) which are self-replicating, once introduced in the environment, cannot be taken back. She stressed that the publicly funded research should be for public good, and the products are safe only if the consumers think that they are safe.

Keynote address by Nobel Laureate, Arthur Kornberg (Stanford University), titled Biotechnology: Impact on Science, Industry and Society, followed the inauguration. Arthur Kornberg pointed out that the organizers had assigned him the title '25 Years of Biotechnology: What has happened and where are we going from here?'. He said 'my dismal record for anticipating the future in science disqualifies me completely. I'm simply not able to predict the future, even five years from now'. He added, 'Even-though recombinant DNA was invented in our Biochemistry Department at Stanford in 1972, none of us, including Paul Berg and Dale Kaiser, who did it, anticipated that it would quickly ignite explosive developments in genetic engineering. Nor could we have foreseen the ingenious biotechnology developed around genetic engineering, all in very few years.' He remarked; 'The future is invented: it cannot be predicted.' For example, it is the universality of biochemistry that makes bacteria, yeast and animal cells into factories for producing proteins, hormones and vaccines. Referring to the present age in biological and medical sciences as the age of 'gene hunting', he said that this is the most revolutionary advance in the history of these sciences and will perhaps lead to even greater understanding of the basic biological processes in terms of the universal language, and unanticipated applications.

He focused on four problems facing science, in general, and biotechnology, in particular. 1. The anti-science and anti-technology attitude that prevails in the society. 2. The consequent lack of support for basic sciences. 3. The commercialization of biotechnology. 4. The possible abuses of genomic knowledge. He pointed out that the anti-technology attitude originates from fear, distrust and finally rejection of science by uninformed or misinformed public. Emphasizing the importance of basic research, Kornberg said that the common saying 'Necessity is the mother of invention' should be 'Invention is the mother of our necessities.' Further, he said, 'No country which aspires to enter the next century of science and technology can afford to be left behind. The consequences of not keeping up with the world pace in science are disastrous.'

He stated that the public concern about the safety of genetic engineering is influenced by the fantasies of Michael Crichton in his novels: *Andromeda Strain* and *Jurassic Park*. Doomsday scenarios projected by ethicists, environmentalists and alarmists shape the public opinion. After 25 years of work with recombinant DNA and genetic engineering with millions of experiments, he was not aware of any adverse result. Kornberg concluded his talk by quoting the eminent philosopher of science and society, the late Karl Popper, 'Next to music and art, science is the greatest, most beautiful and most enlightening achievement of the human spirit', and added, 'I disagree only in placing science first'.

The conference was divided into three main sessions: Biotechnology and Health; Biotechnology, Agriculture and Patents; Biotechnology Industry and the Environment.

The session on Biotechnology and Health had four speakers. Margaret Liu (Chiron Corp., USA) – *Genes as vaccines* – described the development of new vaccines with genetically detoxified toxins, and of DNA vaccines. Charles Arntzen (Cornell University, USA) – *Bananas as vaccines* – stated that contrary to the prevailing notion, plant-based edible vaccines will not be a dietary component; they will be medical products, and are expected to bring down the vaccine delivery cost. He was hopeful that the product would be ready for phase I clinical trials in about three years. Corinne Savill (Novartis, Switzerland) – *Xenotransplantation: overcoming the shortage of donor organs* – said that the ability to modify the donor species for organ transplantation offers exciting possibilities and described the development of transgenic pigs for overcoming the shortages of human organs. They provide several advantages: a clean product, as the donor can be screened, timing of the transplantation can be planned; overcomes the limitation of organs; and both the recipient and donor can be prepared well in advance. At present, the focus is on pre-clinical research, and production of disease-free pigs, in good health, that can be used as donors. Hyperacute effect that leads to immediate rejection of the xenografts has been overcome in experiments carried out on non-human primates. All biosafety aspects of such transplants are being investigated. The benefits will accrue to the individuals

who receive such grafts and they will have to be evaluated against the potential ill effects on the health of other human and animal populations who will not benefit directly. A cautious, stepwise approach is being followed to ensure safety. A question was raised during the discussion that a man with heart, lung and kidneys of a pig would still remain a human or not? Julian Crampton (University of Liverpool, UK) – *Mosquitoes to prevent malaria* – presented the state of their research aiming to use transgenic mosquitoes to block the transmission of the malarial parasite and to deliver the vaccine. Transmission-blocking gene has been expressed in the salivary glands of *Drosophila* and mosquito, and stability of the gene has been checked for 24 generations. Mice have been immunized. This system can also be used for introducing desired proteins in plants and animals using mosquito bite as the delivery mechanism. Competitive ability of the transgenic insects in nature is yet to be ascertained. Such insects can be sterilized before releasing in the environment to prevent the spread of the transgene. During the discussions it was pointed out that public would not allow such releases, and acceptance of this approach would be difficult. The fears of its misuse in biological warfare were also raised.

The session on Biotechnology, Agriculture and Patents had six speakers. Gurdev Khush (International Rice Research Institute, Philippines) – *Green revolution or gene revolution?* – discussed the inter-related problems of food production, population and environment. He described the success of the green revolution brought about by the semi-dwarf, nitrogen-responsive, high-yielding varieties of rice developed at IRRI and of wheat at CIMMYT. He pointed out, by 2025: (i) the world population is likely to increase to 8 billion – two billion additional mouths to be fed, and (ii) rising living standards will increase the demand of food items of animal origin, which will divert grains for animal feeding. He added, Europe can afford the luxury of banning cultivation and consumption of genetically modified foods, because there is enough food to meet the consumers' demand. But for the exploding population in the developing world, biotechnology is one of the tomorrow's tools in our hands today. Slowing its acceptance today is a luxury our hungry world cannot afford. Tapio Palva (University of Helsinki, Finland) – *Engineering crops for the desert* – talked about transgenic plants expressing trehalose—a sugar produced by wide variety of organisms which protects plants from desiccation injury. Such transgenic plants showed higher desiccation tolerance and thermal tolerance. Hope Shand (Rural Advancement Foundation International, USA) – *Agricultural biopiracy and food security* – said that the new crop biotechnology would enhance the power of the transnational corporations and aggravate the problem of food security in developing countries. Some of the important questions raised in her presentation were: 'Who would control the new (proprietary) technology and who would benefit?', 'Where do the intellectual property rights end and human rights begin?'. She added, 'Today's intellectual property system is undeniably scale-biased and fundamentally inequitable. It does not offer a level playing field on which farmers and industry, public and private sectors, North and South, can participate as equal partners.' She gave the example of the loss of job opportunities, stating that an Australian biotechnology firm claims to have a capacity to produce 10 million genetically uniform teak and eucalyptus seedlings a year on a robotic assembly line. Only one employee can control the entire operation.

Benny Haerlin (Greenpeace, Germany) – *Science versus democracy* – described the experiences of a Greenpeace (which opposes all releases of GMOs into the environment) campaigner on releases of GMOs in the environment, and use of engineered food items. The main theme of his talk was that the control and regulation of technologies should not be left to those who develop it. He said, 'Genetic engineers have a vested self-interest in promoting their products. Risk assessment of releases of GMOs cannot be properly conducted by genetic engineers alone as they know little about the environment their products are released to.' He stressed that the 'socio-economic impacts of genetic engineering in agriculture must be assessed by the stakeholders in a democratic way and cannot be left to blind market forces.' Carlos Jolly (Monsanto, Belgium) – *Dilemmas of biotechnology* – questioned the scepticism prevailing in some of the European countries in considering that the genetically modified crops introduced are environmentally better than their conventional alternatives, and showed experimental data in support. He answered most of the questions that have been raised in the past or were raised during the meeting by the opponents of the technology. He said, 'the paradigm is to put as much into the seed as possible as genetic information, so as to avoid having to put so much onto the soil – and not giving up harvest yields as a trade-off.' He attributed the opposition to transgenic crops in Europe to lack of economic imperative among the farmers due to farm subsidies. Stephen Crespi (Patent Consultant, UK) talked about the *Intellectual property in biotechnology: the controversial issue.*

The session on Biotechnology, Industry and the Environment included presentations from Alan Colman (PPL Therapeutics, Scotland) – *Making pharmaceuticals in animals*; Mike Griffiths (Environment Analyst, UK) – *Making industry clean: biotechnology and industrial sustainability*; Yves Poirier (University of Lussane, Switzerland) – *Greening the plastic industry*; Mirja Salkinoja-Salonen (University of Helsinki, Finland) – *Microbes in outdoor applications: benefits and threats*; Dieter Soll (Yale University, SA) – *Genomics: an end users perspective*; and Klaus Ammann (University of Berne, Switzerland) – *Should organic farmers embrace biotechnology*?

Allan Colman described the efforts at PPL Therapeutics in producing therapeutic proteins in milk of transgenic animals. He pointed out that the proteins produced in milk are cheap, safe, clinically effective and the process is consistent, and presently three products are in clinical trials. Alpha-1-antitrypsin protein is expressed at a concentration of 40 g/l, while human plasma protein at a concentration of more than 30 g/l. The first production facility has been set up in Edinburgh, they have a herd of about 1000 genetically altered sheep, protein is purified within three days, at the production rate of 1 kg/week, and 170 batches have been produced.

Dieter Soll discussed the genomics and its applications. He briefly described the DNA array technology as a tool for identifying novel genes, and expression of genes under specific stresses. His message was that genomics affects every

researcher in life sciences, and they cannot ignore genomics.

Klaus Ammann emphasized that the principle of the symmetry of ignorance (experts and non-experts have different types of knowledge, yet both have equal status) must be accepted in discussion of the environmental concerns regarding the GMOs. Referring to the transgenic crop plants, he said, 'the situation in 1998, where tens of thousands of field releases have been undertaken, there is still no trace of any hazard, which has been clearly defined, despite the numerous disasters having been supposed by our friends from the protest industry.'

There were panel discussions on each session, and a general round table discussion – *Biotechnology: promises and concerns*, Chaired by Bernard Dixon, EFB-TGPPB. The distinguished panellists included social scientists, representatives from NGOs, policy makers and scientists from academia and industry. Besides biosafety, the issues raised were related to globalization and its impact. The conference certainly helped in better understanding of the different view points, and perhaps narrowed the gap between the promoters and opponents of the recombinant DNA technologies.

Last, but not the least, the organisers are commended for their painstaking efforts in arranging an excellent meeting.

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RESEARCH NEWS

Evidence of oil formation during Archaean times

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Discoveries in earth science, in the past few decades, have often modified or enriched many existing views in diverse areas such as the beginnings of life on earth and its periodic extinction and explosion, about extra-terrestrial agencies and their roles in influencing evolution, climate and ecology, about the earth's interior zones and their physics and chemistry, plate tectonism, volcanism and earthquakes. Now, a recent contribution to petroleum geology has widened current textbook beliefs on the subject by bringing out evidence of oil in ~ 3 billion-year-old rocks, in very early Precambrian (Archaean) times, a period hitherto considered unlikely to harbour oil.

Petroleum, natural gas and coal, the three essentially biologic products, are fossil fuels produced by transformation of organic material buried in inland seas or in coastal marine basin sediments accumulating around continents. Molecular palaeontological studies[1] have identified several organic compounds present in the cell membranes of early life such as plankton, bacteria and other sea-floor dwelling organisms as the precursor chemicals for the genesis of oil. The teeming presence of organisms, their burial in suitable sedimentary environment and initiation of chemical changes leading to transformation of organic material are therefore basic criteria for the generation of oil. The slow *in situ* chemical conversion of the buried organic material to liquid and gaseous hydrocarbons takes place over millions of years, under increasing temperature with the removal of oxygen and other elements. Compaction of the loose host sediments in course of time forces out the hydrocarbons to migrate outward into favourable structural traps in porous sedimentary rocks where they are preserved for long geologic periods, provided these host formations escape high-grade metamorphism and the associated high temperature which, if it exceeds 200°C, will destabilize the hydrocarbons and convert them to black carbonaceous material.

For a long time it was believed that rocks older than 400 million years lacked the prolific life needed to form the organic detritus and this was considered a reason for the absence of petroleum deposits in old rocks. Besides, there was little continental shelf and rise available for sediments to accumulate around the single large continent like Pangea till its breakup at the end of Triassic, some 190 m.y. ago. The steady parting of land masses thereafter provided fresh continental edges and marine basins as repositories for erosional and organic debris. Apart from the paucity of abundant life forms and basins for sediments to accumulate, the greater potential of hydrocarbons to be destroyed by erosion, deformation or metamorphism in very old rock formations explains why 60% of the world's oil come from Cenozoic, during the last 70 million years, and progressively less (25%) in Mesozoic (225–70 m.y.) and Palaeozoic (570–225 m.y.).

Though most of the world's oil comes from post-Palaeozoic strata, a few older occurrences (> 570 m.y. or Proterozoic and Archaean periods) are also known (Table 1). The oil fields of Oman, China and Siberia belong to the late Proterozoic, while the small occurrences of hydrocarbon reported from rocks of MacArthur Basin in Australia, vein pyrobitumen found in Precambrian sedimentary sequence of North America and bituminous nodules in the rocks of Transvaal sequence of South Africa all belong to middle to late Proterozoic times[2,3]. The Australian occurrence in the MacArthur Basin (1400–1700 m.y.) coincides with the appearance of eukaryotes – the unicellular organisms constituting the chief source of oil. Geologists Roger Buick (University of Sydney, Australia), Berger Rasmussen and Bryan Krapez (both from University of Western Australia, Nedlands, Australia) have now found evidences for occurrence of oil still further back in time during the Archaean period[3,4]. They have found petroleum generation and migration in ~ 3.0–~ 2.75 b.y. old non-marine sandstones and ~ 3.25 b.y. old deltaic sediments in