ART, BIOTECHNOLOGY AND THE CULTURE OF PEACE

Edgar DaSilva
Former Director Division of Life Sciences, INSULA, UNESCO House, France

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Contents

Summary

Biotechnology, in its voyage from ancient times into the expanding frontier areas of today's world of scientific research, has revealed itself as the gene of diplomacy and international cooperation in the relationships between nations. Economic and biotechnological considerations, strong elements in themselves, drive policy implementation that draws upon the support and sustenance of the public's logic and understanding of science obtained through the avenues of art and culture. More and more scientists are teaming up with artists to harness the world of microbes and biotechnology in the pursuit of one's natural well-being, of the conservation of environmental heritage, and of human comradeship and welfare. Art and culture in revealing the human face of biotechnology help engender solidarity amongst different cultures. Furthermore, they nurture individual solidarity and collective commitment in especially young children – tomorrow's architects in the quest of the culture of a sustainable peace.

1. Introduction

Biotechnology, through the passage of time and its applications in agriculture, industry and medicine, has moved beyond the frontiers of biobased materials and revolutionized medicine into the domains of the arts, philosophy and theology. A vector that binds the haves and the have-nots of society in the frameworks of market-driven economies and worldwide poverty, biotechnology has contributed to the emerging trade profiles of the newly industrialized countries in the southern hemisphere Some four decades ago attention was drawn to the catalytic role of microbes in diplomacy and to use of their 'technological carte blanche' for improving the quality of life and human well-being worldwide

In current times, the human face of biotechnology and its societal dimensions and implications is being revealed and transformed through the arts, cine fiction, literature, and TV. More and more scientists are teaming up with artists to harness the world of microbes and biotechnology in the pursuit of one's natural well-being, of the conservation of environmental heritage, of human comradeship and welfare, and of mental and spiritual tranquility – the foundation stones of a veritable quest of a culture of peace pioneered in UNESCO and the UN system by Federico Mayor in his capacity as then Director-General of UNESCO.

"If we wish to create a lasting peace we must begin with the children"

Mahatma Gandhi

Economic and biotechnological considerations, strong elements in themselves in motoring policy implementation need, nevertheless, the support and sustenance of the public's logic and understanding of science [see also – *Some Social, Educational and Political Aspects of* Biotechnology] that nurture individual and collective peace especially in young children –tomorrow's architects of a much desired sustainable peace through the avenues of art and culture. The concept of culture that impacts on economic development and prosperity embraces traditional beliefs and customary practices, the so-called high arts such as literature, painting, dance and opera; and all the elements of popular culture, including soap operas, M-TV videos, dime store novels, (comic strips) and blockbuster movies'. All these elements of culture influence "how markets develop, how they are perceived, and how people choose to express themselves as participants in the market process". Culture matters in economic development since the latter is the guarantor of cultural heritage and of cultural advantages in the market-oriented economies of today's world. Cultural entrepreneurship can make a significant impact since it drives national kinship and regional strategies in engendering a work ethic that helps combat, minimize, and eradicate the scourges of disease, hunger, lack of shelter, loss of inspirational and spiritual motivation, poverty and unemployment. Cultural heritage and legacy are the twin motors of technological advancement and economic development that have their roots in ancestral agricultural practices and food fermentations [see also – *Fermented Foods and their Processing* and *Conventional Plant Breeding for Higher Yields and Pest Resistance*].

2. Biotechnology – Ancestral Art and Culture

The practice of biotechnology in the cradle of agriculture [see also – *Agricultural Biotechnology*] – The Fertile Crescent in 10,000 BC and its contributions to the evolution and spread of culture and languages beyond the then Middle Eastern arc of then peace, plenitude and prosperity – and today's cradle of distrust, dissension and destruction, has been the focus of scientific analysis and technical review. Archaeological, genetic and botanical evidence of seed remains and of agricultural practices and tools reveal intuitive application of domestic skills in the development of cultural practices and rudimentary microbial fermentations in Mesopotamia *circa* 6000 BC. Moreover, the origins and evolution of cultural and linguistic diversity have been traced in the dissemination of seeds, their sowing in different geographical areas, and to the development of agricultural traditional-based agricultural knowledge and practices. Thus there exists a strong worldwide linkage between agricultural diversity and cultural diversity.

2.1. Fermentation technology and art

Folkloristic manufacture of some 38 domestic-based traditional alcoholic foods and beverages [see also – *Fermented Foods and Their* Processing] by indigenous people in Asia, Africa and Latin America involved a two-step common pathway using a starch-rich substrate for production of fermentable sugars for use by yeasts and lactic acid bacteria, and the preparation of a starter culture with a desired microflora.

"*Your food shall be your medicine and your medicine shall be your food*"

Hippocrates (460-377 B.C.)

Discovery and study of the brewing relief of the Old Kingdom (2650 – 2134 BC) in the tomb of the royal acquaintances and manicurists Niankhkhnum and Khnumhotep of King Nyuserre Ini (2453 – 2422 BC) matched the detailed beer-making processes practiced and described by the alchemist Zosimus in the 3rd century AD.

In Korea, onggi pottery from the period of the Yi dynasty (1392 –1910) is still in current use in the traditional preparation of fermented cabbage – *kimchi*.

In 1624 D. Stolcius von Stolcenberg in Frankfurt used the alchemical approach in fermentation art to pictorially describe in *Viridarium chymicum* the phases of putrefaction and fermentation.

Artist	Origin	Title of work	Remarks
Hans Holbein -The Younger (1497-1543)	German	The Cheese Burgher	Reawakening of artists to fermentation and its products
Johannes Vermeer (1632-1675)	Dutch	Dough Kneaders	
Albrecht Dürer (1471-1528)	German	Great Piece of Turf, Die BioReaktore	Depicts frustrations of fermentation artists and lifelessness of life
Aubrey Beardsley (1872-1898)	British	The Frontispiece for A Gentleman's Guide to Conversational Art in	Illustrates concept of aseptic flow and operation

		Slurry Management	
Katsushika Hokusai (17601-1849)	Japanese	Mt. Fuji Seen Behind a Cistern	Description of the hydrodynamic process
Vincent Van Gogh (1853-1890)	Dutch	The Artist's Room in Arles	Expresses need for automation in fermentation
Edvard Munch (1863-1944)	Norwegian	Headspace	Deals with foam control
Wassily Kandinsky (1866-1944)	Russian	Medium Composition IV (Algal Culture)	Organisms require different nutrients to thrive under artificial conditions; Uncannily "combines concept of agitation with the undiscovered structure of the helical genetic material"
Paul Klee (1879-1940)	Swiss	Red Ballon Inflated by CO_2	Introduces air filtration and baffling; impeller shows production of ribosomal RNA in the nucleolus that was demonstrated 50 years later
Lyonel Feininger (1871-1956)	American	Many Valves	Anticipates CAD use in baffler design
Alberto Giacometti (1471-1956)	Swiss	Kultur Vessel	Gives outline of a wiry reactor that teems with the intricate life of it contents
Henry Moore[a] (1898-1986)	British	Relaxed Cell Mass	Duality of cell as fermentor and fermentor as cell
Piet Mondran (1872-1944)	Dutch	Arrangement	Develops black box and modular concepts of fermentation design
Henri Rousseau (1844-1910)	French	Eden Regained	Living rather than the technological aspects of fermentation emphasized
Marc Chagall (1887-1985)	French (Russian born)	The Brewmaster	"Fermentor and technologist become one"
Amedeo Modigliani (1884 -1920)	Italian	Impella	Significant contribution to vessel architecture
Salvador Dali (1904 -1989)	Spanish	Autumn Autolysis	Transition from growth to stationary phases resulting from nutrient depletion in growth medium
Juan Miro (1893-1983)	Spanish	Steel Life	"Anticipates, respectively, sterilizable biosensing and plant cell culture"
Jackson Pollock (1912-1956)	American	Rheology I4	Produces a joyous carnival of mycelium and hydro-dynamics

Table 1: Biotechnology and culture expressed through the painters' brush

In summary, current folkloristic fermentation methods are more closely associated with the ancient Egyptian beer brewing process [see also – *Production of Alcoholic* Beverages] captured in the murals and relief in the tombs of the pharaohs as well as those in documented ancient papyrus records and writings. And, the successful replication today in Japan of the ancient beer brewing process reaffirms the long-held universal admission that the practice of microbiology in that country is indeed the practice of art and science. The cultural nuances of the brewing art- science relationship of fermentation technology – art in ancient times and science in the modern era (Table 1) have been captured through the elegance and the eloquence of the painters' brush.

2.2. Fermented foods and culture

"*Beer is a living proof that God loves us and wants us to be happy*"
Benjamin Franklin

The worldwide cultural heritage of biotechnology is found predominantly in food and nutrition. The food intake of millions of people since time immemorial has been influenced by customary beliefs and cuisine skills indisputably associated with the dietary cultures of the Chinese, the Indian and the Persian-Arabic civilizations in the Southern hemisphere. The application of traditional knowledge, emerging from repetitive domestic practices, is now associated with the use of a variety of rural fermentation processes in the preservation of food and food harvests [see also – *Fermented Foods and their Processing*]. In addition, the incorporation of seasonings and spices has added to the flavours of fermented fish, meat and vegetable foods. Endowed with medicinal properties in some cases, and providing for easy digestibility, increased micronutrient content and enhanced food textures and tastes fermented foods like flags have become part of the national fabric and identity (Table 2). *Arak* (Lebanon, Middle East); *Champagne* (France); *Hama* (Syria)

Natural Inoculum	Product	Substrate	Use	Socio-cultural Feature
Africa				
Saccharomyces cerevisiae	African beers from sorghum, maize or sorghum-maize mixes	Sorghum and maize	Alcoholic beverage	Sorghum beer -utshwala (Zulu) and utywala (Xhosa) popular with Bantu tribes working in gold and diamond mines
Lactic acid bacteria	*Talla* (tella)	Sorghum-maize-wheat, mix	Home-processed beer	Served in Ethiopian country-side wedding ceremonies
Fungal mix of *Aspergillus*, *Penicillium* and *Rhizopus* species	Kenkey	Maize	Staple food	Popular with the working class Ghanaian coastal people -*Gas*, *Fantis* and *Ewes*; eaten for its nourishing value
Lactic acid bacteria	*Bussa*	Sorghum-millet-mix		Popular with the Luo, Abuluhya and Maragoli people in Kenya
Rhizopus oryza, A.flavus and *Penicillium citrinum mix*	*Pito*	Sorhgum mash	Alcoholic/food beverage	Source of income for Guinean and Nigerian women who learn the art of domestic brewing during adolescence whilst preparing weekly supplies of this supposedly 'energy-providing' and medicinal drink
L. mesenteroides with lactic acid bacteria, etc.	Gari	Cassava roots	Staple food	Consumed as *eba* by Nigerian low-income groups
Lactic acid bacteria -yeast	Ogi	Maize	Staple food	Nigerian breakfast porridge prepared by low-income group housewives now

mix				being considered for rural markets
Arab States				
Lactic acid bacteria	*Bouza* (Egypt)	Wheat	Wheat-based beverage	*Bouza* - once an ancient divine offering at funeral services, today consumed by lower-income groups
Lactic acid bacteria	Liban argeal (Iraq)	Milk	Milk food	Fermented milk
Lactic acid bacteria	*Merissa* (Sudan)	Sorghum-millet-cereal mix	Alcoholic/food beverage	Similar in production and use with *Bouza, Bussa,* and *Talla*
Asia				
Mucor purpureus	Ang-kak	Rice	Colorant	Use dates back to Chinese *Yuan* dynasty
Aerobic bacteria	Bagoong	Fish (paste)	Seasoning	*Prahoc* (Cambodia); *Bagoon* (Philipiines); *Ngapi* (Mynamar)
Leuconostoc mesenteroides, Saccharomyces sp.	Dosai	Black gram and rice	Breakfast food	Indian pancakes widely popular with all income groups
L. mesenteroides	Idli	Mix of rice and black gram (3:1)	Rice cake	Staple part of vegetarian cuisine and diet
Aerobic bacteria	Mam	Fish or shrimp paste	Liquid seasoning	*Patis* (Philippines), *Nam pla deak* (Thailand) *Nuoc mam* (Vietnam)
Aspergillus oryzae, Saccharomyces rouxii	Miso	Rice and soybean	Seasoning	Traditional rural industry in Japan
Bacillus natto	Natto	Soybeans	Cake	Food supplied in military campaigns; supposed to have originated in Buddhist temples
Neurospora species	Oncom	Peanut press cake	Meat substitute	Part of daily diet of the West Javanese
L.mesenteroides	Puto	Rice	snack	Essentially a Filipino food
Europe				
'*Beer*' Yeasts	Beer	Barley and other starch substrates	Second worldwide staple beverage after tea	Beer-making reportedly associated with the Natufian culture; the oldest known recipe for making beer is written on a 4000 year old tablet in a hymn to the Sumerian goddess of beer *Ninkasi*; Jiu (aka *Kiu*) is an ancient Chinese beer over 4000 years old; The Sumerians are assumed to be the first civilized culture to brew beer
Lactobacillus bulgaricus	Bulgaricus butter milk	Low-fat milk	Food	National product; and the basis of Metchnikov's conclusion re: contribution to prolongation of life

Lactobacilli-yeast mix	Kefir	Fresh milk	Food beverage	Use originating in the Caucasian mountains linked to the longevity of life amongst the peoples of Armenia, Azerbaijan, and Georgia
Yeasts	Kvass	Fermented rye or barley, or soaked and fermented dark rye bread	Low-alcoholic beverage	A national Russian drink; Ukrainian kvass made from beetroot is credited with beneficial medicinal properties
Lactobacilli	Sauerkraut	Cabbage	Food	"Sauerkohl", prepared in German homes as - a winter diet food now widely accepted and marketed un Europe an North America, was known in ancient China to have fed, seemingly, the armies of Genghis Khan
Latin America and the Caribbean				
Lactobacilli-yeast mix	Chicha	Maize, sweet potatoes or ripe plantains	Alcoholic beverage	Characteristic of the Andes region (Bolivia, Colombia, Ecuador, Peru). This drink nowadays consumed at agricultural, family, social and religious events, was considered by "the Incas to be the vehicle that linked man to his gods through the fecundity of the earth"
Leuconostoc species	Pulque	Maguey cactus (*aka* agave or century plants)	Alcoholic beverage	National drink of Mexico inherited from the Aztecs who used it as an offering to the goddess Mayahuel
Lactobacilli	Queso Chaqueno	Milk	Food	Current cheese process has originated from the process used by the Jesuits in 16th century in Moxos Pampas of Bolivia

Table 2: Fermented foods consumed worldwide in different communities (adapted from Kavanagh, 1994; Steinkraus, 1995)

Ikigage (Rwanda); *Jben* (Morocco); *Kaschiri* (Brazil); *Cachiri* (Colombia); *Kimchi* (Korea), *Masata* (Mozambique), *Munkoyo* (Zambia), *Patagras* (Cuba); *Sake* (Japan), *Sauerkraut* (Germany), *Surstromming* (Sweden); and *Tairu* (Malaysia) are all well known examples of the mix of human and microbial skills that constitute the cultural art and component in the production of fermented foods.

"Bread has always held a central position on the historical scene. It is a never-ending source of inspiration, and a highly symbolic object that gives rise to great curiosity and provides a fruitful theme for creative minds"

Lionel Piolãne

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Bibliography

[Aspects of the arts, biotechnology and cultural practices that contribute to the culture of peace are provided in the list of books and journals cited in 11(a) and webpages 11(b) below. Explicit emphasis on the interaction between art, biotechnology and the cultural contribution to peace is inherent throughout the contribution in the different structural item titles and subsequent texts with accompanying self-explanatory tabulated data, figures and quotations]

Articles from Books and Journals [Concerns initiatives at times cross-referenced in biotech art and practices that contribute to the education of the young biotech leaders of tomorrow that emphasize the strengthening of environmental conservation and management in developing and developed countries for future generations ; see item 2 e.g. other role of bioart and bio-based cultural practices in socio-economic development]

ADAMS, Martin and HENDRY, Pattie (2002); The Lost Art of Bacteriology. The Microbiologist, December 2002, 14-15. Also available from Internet: http://www.sfam.org.uk/pdf/features/paintbugs.pdf.

ANON. (2000) The Biology of Music. The Economist, 12-18, 83 - 85.

Also available from Internet: http://cogweb.ucla.edu/Abstracts/Music_00.html.

ARIE, Sophie (2003); Bacterium restores glue-hidden fresco. The Guardian, 27 June edition

Also available from Internet: http://www.guardian.co.uk/arts/news/story/0,11711,986008,00.html)

BAR-YOSEF, Ofer (1998); The Natufian Culture in the Levant, Threshold to the Origins of Agriculture. Evolutionary Anthropology, 6,159-177

BASZTURA, Joanna (ed.) (2003); Compilation of FP5 Projects, The City of Tomorrow and Cultural Heritage (publisher EU, Brussels, Belgium); Also available from Internet: http://www.cordis.lu/eesd/ka4/home.html

BEN JACOB, Eshel.(2003) Bacterial self-organization: co-enhancement of complexification and adaptability in a dynamic environment. Philosophical Transactions of the Royal Society of London Series A., 361, 1283-1312. Also available from Internet: http://star.tau.ac.il/~eshel/papers/nobel.pdf.

BRADY, Nyle C. (1997); Quo Vadis International Agricultural Research, In: Bonte-Friedman, C. and Sheridan, K. eds. The Globalization of Science, The Place of Agricultural Research, New Expanded edition. The Hague: International Service for Natural Agricultural Research (ISNAR), 1997, 15-25. Also available from Internet:

http://www.isnar.cgiar.org/publications/pdf/vision/brady.pdf.

BRODWIN, Paul.(2000) Biotechnology and Culture: Bodies, Anxieties, Ethics. Bloomington, Indiana University Press, 2000; 248 pp; ISBN 0253214289

CAINE, Renata. N. and CAINE, Geoffrey (eds.) (1994); Making Connections: Teaching and the Human Brain, Menlo Park, CA: Addison-Wesley, page 224, ISBN 0201490889

CAVALI-SFORZA, Luigi L. Genes, (1991) Peoples and Languages, Scientific American, pages 72-78

CIFERRI, Orio and TIANO, Piero (eds.) (2000); Of Microbes and Art: The Role of Microbial Communities in the Degradation and Protection Cultural Heritage. Kluwer Academic/Plenum Publishers, Dordecht, Netherlands, 286 p., ISBN 0306463776

CLARKE, John R. (2001) Seeing Rainbows among the Ruins: Peter Erskine's "New Light on Rome". Sculpture Magazine, 20, (7).

Also available from Internet: www.sculpture.org/documents/scmag01/sept01/erskine/ersk.htm

COHEN, Hal (2002) Bioscience Moves into Galleries as Bioart, The Scientist, 16, (22), page 57. DAWKINS, R. (1990) The Selfish Gene - Oxford University Press ,trade paperback, 352 pages, ISBN 0192860925

DIAMOND, Jared and BELLWOOD, Peter (2003) Farmers and Their Languages: The First Expansions. Science 300 (5619), 597-603.

DOTY, Robert B. (1975) Microbiology on Stamps. ASM News, 41, 679-684.

DURANT, John. (1992) Introduction, In: Biotechnology in Public- A Review of recent Research. The Science Museum, London, UK for the European Federation of Biotechnology; pp. 9-17.

Electronic Journal of Biotechnology [online] (2001) UNESCO Microbial Resources Network (MIRCENS) Activities - Review of Activities (1 January 1990 - 31 August, 2001), Available from Internet: http://www.ejbiotechnology.info/content/mircen/index.html.

FOSTER, Jackson W. (1964) Microbes in Diplomacy. The Graduate Journal, 6,322-332

GAMWELL, Lynn. (2002) Exploring the Invisible: Art, Science and the Spiritual. Princeton University Press, 344 pp. ISBN 0691089728

GAMWELL, Lynn. (2002) Science in Culture, Nature, 422 (817), 817

GRAY, Patricia M.; KRAUSE, Berme; ATEMA, Jelle; PAYNE, Roger; KRUMHANSL, Carol and BAPTISTA, Luis (2001); The Music of Nature and the Nature of Music. Science, 291 (5501), 52-54

HODGSON, John and BORMANN, Ernst (1988), F-art: The Expression of Biological Culture. TIBTECH, 6, (VII – X), 64-65.NY, USA; ISBN 90-6196-256-0

HOFSTADTER, D. R. Godel, Escher,.(1979) Bach: An Eternal Golden Braid, Harvester Press USA; Also Penguin Paperback edition 1980 ISBN 90-6196-256-0; and Professor Stafford Beer Collection SB. I.078 (Class SB.I – General Systems and Cybernetics) which consists of some 2000 books and which is currently housed in the Trueman Street Building of Liverpool John Moores University, UK

HOTZ, Robert L. (2002) Music leaves its mark on the brain. The Los Angeles Times, December 13, Also available from Internet: http://www.latimes.com/chi-021214brain,0,7563471.story.

ISHIDA, Hideto. (2002) Insight into Ancient Egyptian Beer Brewing Using Current Folkloristic Methods; MBAA TQ, 39 (2), 81-88

Also available from Internet: http://www.mbaa.com/pdfs/TQfeature/2003Egyptian_Beer.pdf.

KAVANAGH, Thomas W. (1994) Archaeological Parameters for the Beginnings of Beer. Brewing Techniques, 2 (5). Also available from Internet:

http://www.brewingtechniques.com/library/backissues/issue2.5/kavanagh.html.

KEMP, Martin.(2003) The Mona Lisa of modern Science. Nature, 421 (6921), 416-420.

KERSHEN, Drew L. (1999) Biotechnology: An Essay on the Academy, Cultural Attitudes, and Public Policy. AgBioForum, 2 (2), 137-146.

Also available from Internet: http://www.agbioforum.org/v2n2/v2n2a12-kershen.htm

KILLICK-KENDRICK,R. (1988) Parasitological Clenhews: Fortnightly Supplement. Trends in Biotechnology 2,1-4

LAVOIE, Don and CHAMLEE-WRIGHT, Emily (2002); Culture and the Wealth of Nations; Cato Policy Report 24, 12-15.

Also available from Internet: http://www.cato.org/pubs/policy_report/v24n1/nations-wealth.pdf.

LONG, Helen, L. Molecular Music (1999); GB Patent No. 2350469, c/o Molecular Music, POB 55, Crediton, Devon EX 17 4WF, UK.

MADOFF, Steve H. (2002); The wonders of Genetics Breed a New Art. The New York Times, Arts and Leisure Section, May 26; also available from Internet: http://www.ekac.org/nytimes.html.

MAX, B.(1988) This and That: thanatomimetics, bradychronotoxins, osmocides and ototoxins. Fortnightly Supplement, Trends in Biotechnology, 2, 8-12.

MIODOWNIK, M., (2003) Genetic Art; Materials Today, 6, page 13; Also available from Internet: http://www.materialstoday.com/pdfs_6_6/column.pdf

MONAGHAN, Peter (2004); The Humanities' New Muse: Genomics. The Chronicle of Higher Education 50 (24), page A12

NADIS, Steve (2000); Science for art's sake; Nature, 407 (6805), pp. 668-670

PALEVITZ, Barry A. (2002); An Odyssey in Science and Art; The Scientist, 16 (22), page 18.

PINĂR, Guadalupe; RAMOS, Cayo; RÖLLEKE, Sabine; SCHABEREITER-GURTNER, Claudia; VYBIRAL, Dietmar; LUNITZ, Werner and DENNER, Ewald W.B.M.(2001) Detection of Indigenous Halobacillus Populations in Damaged Ancient Wall Paintings and Building Materials: Molecular Monitoring and cultivation. Applied and Environmental Microbiology; 67 (10), 4891-4895.

POTTER, Polyxeni, (2003) About the Cover. Emerging Infectious Diseases,. 9 (10), page 1506. PRICE, T. Douglas and GEBAUER, Anne B. Eds. (1995) Last Hunters - First Farmers: new Perspectives on the Prehistoric Transition to Agriculture. School American Research Advanced Series, School of American Research Press, Santa Fe, NM.. 354 pages

PRUSINKIEWICZ, Przemyslaw and LINDENMAYER, Aristid (1990); The Algorithmic Beauty of Plants. Springer-Verlag, 230 pages; ASIN 0387972978

RAICHMAN, Nadav; GABAY, Tamir; KATSIR, Yael; SHAPIRA, Yoash and BEN-JACOB, Eshel (2003); Engineered Self-Organization in Natural and Man-made Systems, In: Proceedings of Tenth International Symposium on Continuum Models and Discrete Systems (CMDS 10) - NATO Advanced Research Workshop. 30 June - 4th July, 2003, Shoresh, Israel

BERGMAN, D.J. and INAN, E., eds. Kluwer Press (in press) - Personal Communication with Professor E. Ben Jacob.

Research and Information System for the Non-Aligned and Other Developing Countries; (RIS) World Trade and Development Report 2003; Cancun and Beyond; Academic Foundation, New Delhi, India, 2003, 130 p

ROOT-BERNSTEIN, Robert. S. (2001); Music, Creativity and Scientific Thinking; Leonardo, 34 (1), 63-68. Also available from Internet:

http://hipercubo.uniandes.edu.co/redes03/pdf/leonardo/music_scientific.pdf.

SAYERS, Robert and RINZLER, Ralph (1987); The Korean Onggi Potter; Smithsonian Folklife Studies, Smithsonian Institution Press, Washington DC, USA; 288 pages SF5

SEILACHER, Adolph.(1997) Fossil Art. The Royal Tyrell Museum of Palaeontology, Drunheller, Canada, 64 pages

STEINKRAUS, Keith. H (1995); Handbook of Indigenous Fermented Foods; 2nd Edition, Revised and Expanded; publ. Marcel Dekker Inc., New York.-Basel-Hong Kong,, page 776. ISBN 0-8247-93512-8

UBELAKER, Douglas. H. (1999) The Impact of Disease: Two Worlds Meet. Perspectives in Health, 4 (1)

VARMUS, Harold. (2003) Building a global culture of science; The Lancet, 360, sup. no. 1, p.1-4.

VASIL, I. K. (2002) Turning Point Article – The Wanderings of a Botanist, In Vitro Cellular and Developmental Biology–Plant 38, 383-395.

VON ENGELHARDT, D. (2003) Cancer as a Dialogue between Biology and Culture. The Aventis Magazine, 1, 12-17. Also available from Internet: http://www.aventis.com/main/home_static.asp.

YOUNG-JA, Lee (2000); Onggi Folk Museum, Koreana, 14 (3), 24

Web-pages [Relevant titles of explicit significant information resources concerning varied aspects of art, biotechnology biological warfare, biotech education and biotech science for peace are available in the following webpage references]

CENTER FOR GENETICS AND SOCIETY; Analysis: Art and Popular Culture, 11 August, 2003. http://www.genetics-and-society.org/analysis/popular.html.

DALKE, Kate. 1) Scientific Artists capture the World; 2) Medical Illustration starts with Dissection, 3) Pastel Proteins, Special Issue Art & Science, Genome News Network, 2003, October 3. Available at: http://www.genomenewsnetwork.org/articles/10_03/capture_world.shtml.

DASILVA, Edgar J. International Biotechnology: Diplomacy, Policy and Statesmanship, Editorial. Electronic Journal of Biotechnology [online], 15 April 2002, vol. 5, no. 1

http://www.ejbiotechnology.info/content/vol5/issue1/editorial.html. ISSN 0717 3458

DASILVA, Edgar J. Quo Vadis Biotechnology? Current Trends and Future Issues, 2003; Available from Internet: http://www.iva.se/biotechnology/

DAVIS, Joe. Project Statement Ars Electronica 2000. Available from Internet:

http://www.aec.at/festival2000/texte/artistic_molecules_2_e.htm.

DAVIS, Joe. (2003) Genesthetics; Joe Davis Bioart archive,

http://www.clondiag.com/art/joe.davis/index.php.

DUNN, John and CLARK, Mary (1997) A. Life Music: The Sonification of Proteins. Leonardo Online: Articles.

Available from Internet: http://mitpress2.mit.edu/e-journals/Leonardo/isast/articles/lifemusic.html.

GENA, Peter and STROM, Charles.(2001) A physiological approach to DNA music,. Portable Document Format. Available from Internet: http://www.artic.edu/%7Epgena/docs/gena-strom-DNA.pdf.

HARMS, Ute (2001); Biotechnology Education in schools, Electronic Journal of Biotechnology, [online] 5, (3); Available from Internet:

http://www.ejbiotechnology.info/content/vol5/issue3/teaching/01/index.html

HOTZ, Robert L.(2002) Music leaves its mark on the brain. The Los Angeles Times, December 13; also available from Internet: http://www.latimes.com/chi-021214brain,0,7563471.story.

MicroNZ [online] 2003; Available from Internet:http://asmconferences.org/micronz/.

NEAVE, Ruth (2002); Is Science Art? Page maintained Jarron, M.H., April 2; available from Internet: http://www.dundee.ac.uk/museum/science.htm.

O'REILLY, Hunter (2003); Biology through Art Course (for students of University of Wisconsin-Milwaukee), Available from Internet: http://www.uwm.edu/~horeilly/bioart/.

PARSONS, Lawrence; (2003) Brain Basis of Musical Performance, Cognition, Perception, and Improvisation, Subtle Technologies 03, May 22-25, University of Toronto, Toronto, Canada; Available from Internet: http://www.subtletechnologies.com/2003/parsons.html.

Philadelphia International Airport, Art and Exhibitions (2003);

Available from Internet: http://www.phl.org/art.html.

Pulse of the Planet, (2001); Available from Internet: http://www.pulseplanet.com/.

ROTA, Gladis and IZQUIERDO, Juan (2003); "Comics" as a tool for teaching biotechnology in primary schools; Electronic Journal of Biotechnology [online]; 6 (2)

Available from Internet: http://www.ejbiotechnology.info/content/vol6/issue2/issues/2/index.html

ROTHWELL, Nancy (2004). Can Art Enlighten Science?

http://www.arts.telegraph.co.uk/connected/main.jhtml?xml=/connected/2004/02/13/ecfvos13.xml.

SALLEH, Anna (2000); Couple makes music with fungus. Australian Broadcasting Science Online,

November 10, 2000, Available from Internet:

http://www.abc.net.au/science/news/stories/s210368.htm.

SAVONA-VENTURA, Charles (1997). Maltese Medical history as seen through Postage Stamps; Available from Internet: http://www.geocities.com/hotsprings/2615/medhist/stamps.html.

University of Art and Design Helsinki (UIAH); Workshop and Seminar in Environmental Art Fermentation (1st – 12th September, 2003, Helsinki, Finland); Available from Internet:

http://www2.uiah.fi/conferences/fermentation/english.htm

Biographical Sketch

Edgar DaSilva, a graduate of the University of Bombay in microbiology and chemistry, was awarded, in 1962, the Bachelor of Science Degree (First Class with Honors). In 1966, he obtained the Master of Science Degree, and in 1969 his Doctoral Degree for research studies on the cyanobacteria. As a NORAD Fellow, his research study, on the marine algae at the Norwegian Seaweed Research Institute, Trondheim, Norway, in 1970, was followed by a teaching assignment at the University of Helsinki, Helsinki, Finland. Two years later, he joined the Institute of Physiology, University of Uppsala, Uppsala, Sweden as a UNESCO fellow. He is a former Vice-President of the World Federation for Culture Collections (WFCC), author of several scientific publications, and member of well-known microbiological societies. Moreover, he has also been a keynote plenary speaker at several international events in, Argentina, China, Kuwait, Nigeria, South Africa, Sweden, Thailand, USA, etc. on biopolicy issues in regional co-operation, microbiological education, and on globalization and sustainable development.

At UNESCO since 1974 in various capacities within the Division of Scientific Research and Higher Education and the Division of the Basic Science Dr. DaSilva has been instrumental in the planning and implementation of several UNESCO regional and international programmes in applied microbiology as well as in the development of the global networks dealing with management and use of microbial resources and training opportunities in the fields of marine and plant biotechnology. Moreover he mobilized several extrabudgetary programmes in close cooperation with UNEP and UNDP and Donor Member States for activities in national development in biotechnology and regional cooperation in microbiology.

He also was the Director, Division of Life Sciences that was subsequently transformed into a Section of the Life Sciences within a new Division of the Basic and Engineering Sciences prior to his retirement from UNESCO.

Currently Dr. DaSilva has had teaching assignments as Visiting Professor at the International Centre for Biotechnology (ICBiotech) in Osaka University and its outreach station, and teaching assignments at the UFS, and at the Outreach station of ICBiotech at Mahidol University, Thailand and at the University of the Free State, Republic of South Africa.

A fellow of the World Academy of Art and Science and following a keynote lecture to the Biotechnology Division of the Royal Swedish Academy of Engineering Sciences and the Biofocus Foundation, Dr. DaSilva was awarded the Biopolicy Award in 2003.