MIND & LIFE
INSTITUTE

PRESENTS

Mind and Life X

Dialogues between Buddhism and the Sciences

The Nature of Matter, The Nature of Life

WITH

HIS HOLINESS
THE DALAI LAMA

Dharamsala, India
September 30-October 4, 2002

Mind and Life X

The Nature of Matter, The Nature of Life

At the outset of his famous 1943 lectures *What is Life?*, the physicist Erwin Schrödinger posed the question, Can that which takes place inside a living organism be accounted for by physics and chemistry? In the 2002 Mind and Life meeting we explore the perennial question concerning the nature of life and its relationship to matter. Schrödinger's question is asked once again, but now within a broader and modern context. We explore his question through those sciences — physics, chemistry, and biology — that have occupied themselves directly with this inquiry.

In addition, however, we include the important voices of Western and Buddhist philosophy as well. On the one hand we examine the current scientific views on the emergence of life, the important role of evolution, and the extraordinary moral challenges we confront today because of biotechnology. Remarkable developments have taken place in the sciences that underpin all these areas. But in addition we also examine the foundational assumptions on which the modern theories of life depend, and the implications of these for the very definition of life we employ and the ethics we adopt for the use of the awesome biological technologies under development.

In physics and biophysics the detailed mechanisms of life are finding exact description, while at the same time quantum physics is fashioning a new, precise and non-mechanistic notion of holism as an essential feature of matter. What are the implications of this holism for the foundations of biology? In the new science of complexity, suggestive models are being developed for the rich array of processes that yield order from chaos and support life. The concept of emergence is often used in this science to account for the novel properties that arise from complex physical systems as they become the elements of structure and function that operate in living cells.

What is emergence, and can it really account for the distinctive features of life? Evolution through natural selection is science's explanation of the development of higher life forms (including sentient beings) from its humble predecessors. How can we understand the dynamics of causation in these accounts? Finally, in recent years human control of the genetic material at the kernel of life has become a reality. The clumsy means of eugenics of the past are being replaced with powerful new biotech methods that promise great benefit for human health and food production, but the risks of unintended harm are also high. To these moral and philosophical issues we will bring both the best thinking of science and of Buddhist philosophy.

PARTICIPANTS

Tenzin Gyatso, His Holiness the XIV Dalai Lama

Michel Bitbol, M.D., Ph.D., Directeur de recherché at the Centre National de la Recherche Scientifique, in Paris, France

Steven Chu, Ph.D., Theodore and Frances Geballe Professor of Physics and Applied Physics at Stanford University; co-winner of the Nobel Prize in Physics in 1997

R. Adam Engle, J.D., M.B.A., Chairman and Co-founder of the Mind and Life Institute, and General Coordinator of the Mind and Life conferences

Ursula Goodenough, Ph.D., Professor of Biology at Washington University in St. Louis, Missouri

Stuart Kauffman, M.D., Chief Scientific Officer and Chairman of the Board, BiosGroup Inc., Santa Fe, New Mexico

Eric Lander, Ph.D., geneticist, molecular biologist, mathematician, and Director of the Whitehead Institute Center for Genome Research at the Massachusetts Institute of Technology (MIT)

Prof. Dr. Pier Luigi Luisi, Professor of Macromolecular Chemistry at the ETH-Zentrum, Institut für Polymere Departement Werkstoffe

Matthieu Ricard Ph.D., author, Buddhist monk at Shechen Monastery in Kathmandu and French interpreter since 1989 for His Holiness the Dalai Lama

Arthur Zajonc, Ph.D., Professor of Physics at Amherst College

INTERPRETERS

Geshe Thupten Jinpa, Ph.D., President and Chief Editor for the Classics of Tibet Series produced by the Institute of Tibetan Classics in Montreal, Canada

B. Alan Wallace, Ph.D., independent scholar, Mind and Life researcher

Monday, September 30

Arthur Zajonc, the scientific coordinator of the Mind and Life meeting, will briefly introduce the week's framework and objectives. He will give a brief overview of the perspectives to be brought to bear on the nature of life and matter, and act as moderator for the day's session.

Presentation: Concerning the Origin of Life on Earth
Pier Luigi Luisi

The main assumption of the scientific research on the origin of life is that life originated from the inanimate matter throughout a series of spontaneous steps of increasing molecular complexity, up to the onset of the first self-replicating cells. The experimental data supporting this view (including prebiotic chemistry) are critically reviewed. The overall mechanism implies that the prebiotic steps leading to life are deterministically regulated and the relation between determinism and contingency is then discussed in this framework.

The assumption that minimal cellular life arose from a series of chemical reactions entails several significant implications that are usually taken for granted by mainstream science: for example that transition to life can be reconstructed in the laboratory; also, that cellular life is constituted only by molecules and their energetic interactions. This view brings also to a definition of life that is presented within the framework of the autopoiesis of Varela and Maturana. It is also shown that the view of the Santiago Authors permits making a bridge between biology and cognitive science and up to the domain of consciousness — so that these domains are no longer severed from molecular biological sciences — although nothing "transcendental" has been inserted in the picture.

The consequences of all these statements are discussed, including questions that concern the dialogue with Buddhism. Finally, the experimental work carried out in some leading groups towards the construction of semi-synthetic cellular models of life (minimal living cells) is presented. The final question is about the meaning of constructing synthetic cellular life in a lab, both for the fundamental and applied sciences, and for the advancement of our knowledge in general.

Tuesday, October 1

Presentation: Biological Evolution
Ursula Goodenough

Organisms are endowed with genetic instructions for producing traits that collectively enable them to carry on and reproduce in particular environments (niches). Each trait, in turn, is the emergent property of a few core biological "ideas" — cell division, control of gene expression, perception and signal transduction, uptake and secretion, and motility — that are mixed and matched in time and space, and each core idea is, in turn, ultimately emergent from molecular shapes. Running this sequence in reverse, genetic instructions generate molecular shapes that interact to generate core ideas that interact to generate traits that interact to generate organisms. Each of these transitions in complexity entails the emergence of numerous properties that were not operant at "lower levels," where emergence describes the generation of something more from nothing but.

In my talk I will first describe these five biological levels — genetic instructions, molecular shape, core idea, trait, and organism — using both simple cartoons and real images, the goal being to render understandable how an organism comes into being. Once this is in place, then an understanding of biological evolution becomes straightforward: during evolution, genetic instructions are changed such that different molecular shapes generate variants on core ideas, and hence variant traits, and hence variant organisms able to survive and reproduce in novel niches — a sequence that can also be run in reverse. These transitions will be illustrated with examples from embryology and neurobiology. Major emphasis will be given to the genetic interrelatedness and the interdependence of all creatures.

I will close by indicating a way that the concept of emergence, biology's most interesting mode of creativity, can be applied to the evolution of our basal human forms of mentality. Just as the evolution of the beaver has occurred in a novel niche of the beaver's own construction, so has human evolution occurred in the context of the novel cultural niches we create. Indeed, human mental development has become dependent on information obtained from culture. Our cultures are the constructs of human language, which co-evolved with brains that can understand/transmit language. Human language entails abstract symbolic mentation, and sometime along the way there emerged as well the mental capacity for abstract representation of experience and self-experience, these being the neural operations that undergird basal "human consciousness" or awareness of awareness.

Wednesday, October 2

Presentation: The Human Genome and Beyond
Eric Lander

The sequence of the human genome and of other organisms such as the fly, worm, yeast, and fungi are generating more data than ever before, and it is only going to increase as we build maps of the genetic variation and analyze DNA arrays. This presentation will address how managing the avalanche of biological information is requiring the marriage of information technology and biology, leading to a new paradigm in biology, and allowing us to ask questions that we could not have conceived of ten years ago.

The first applications of the new genetic information pose important ethical issues for the scientist and biotechnologist. While scientific research has often raised ethical dilemmas in the past, they have rarely been of comparable significance. We will engage these issues together, sharing the methods of ethical analysis used in Buddhist philosophy and in the West.

Thursday, October 3

Presentation: The Sciences of Complexity
Stuart Kauffman

In the past fifteen years, a new body of science, the sciences of complexity, have grown considerably. In a sense, we are entering a new era of science in which the power of contemporary computers allows us to attempt seriously to integrate together the behavior of the parts of systems to understand the behaviors of the wholes the parts constitute. Thus, while Newton integrated his three laws of motion and law of universal gravitation to give us celestial mechanics, by and large, for truly complex systems, the task of integration is a new one.

The sciences of complexity are too widespread and poorly demarked for me to cover the whole of the growing territory. Instead, I will focus on two areas, first, "random Boolean networks", taken initially as models of genetic regulatory networks; and second, co-evolution in biology and the economy as modeled by self organized critical processes.

The newborn child develops from a single fertilized cell, which undergoes about fifty cell divisions. The two major problems of developmental biology are cell differentiation and morphogenesis. In cell differentiation, the initial fertilized egg, or zygote, gives rise directly or indirectly, to about two hundred and eighty five different cell types, such as nerve, muscle, spleen, liver, stomach and other cell types. Recalling that DNA genes encode messenger RNA that is ultimately translated into proteins, cells differ in large part because the genes that are "active" in different cell types differ. Since Jacob and Monods' work forty years ago, it has been clear that genes make proteins that turn other genes on or off.

Thus some complex genetic regulatory network among the genes, and among their products as well, governs how cells differentiate. Using models of genetic networks in which genes are idealized as "on" and "off", I discovered years ago that such networks behave in three regimes, ordered, chaotic, and a phase transition, edge of chaos regime. Many people have done fine work on this class of networks and much is now known of their behaviors. Importantly, the ordered behavior of such networks appears to account for many features of normal cell differentiation, as I will describe.

In addition, it now appears that the same behaviors show up in networks that consider genes to have continuously graded levels of activity, rather than being merely on and off. The parallels between the behaviors of such networks and real cells does not prove that real cell genetic networks are in the ordered regime, but the parallels are powerful and widespread, and serve the following working hypothesis: Evolution has utilized the useful properties of the ordered regime for its further optimization under natural selection. So there are two sources of order in biology, self organization and natural selection.

Physicist Per Bak and his colleagues invented Self Organized Criticality, in which a power law distribution of avalanches of change propagate across a system. A number of workers have made models of biological co-evolution in which such avalanches of small and large extinction events propagate. I will describe this work, which may have applications to the biosphere and the economy.

Friday, October 4

Presentation: What is Matter, What is Life from a Physicist's Perspective
Steve Chu

Feynman has made the claim that "everything that living things can do can be understood in terms of the jigglings and wigglings of atoms." "Understanding" to a physical scientist means that a host of phenomena can be described with a simple set of laws. Furthermore, if the initial starting conditions are known, these laws should enable us to make quantitative predictions of future behavior. By contrast, all of the other sciences (e.g. biology and neuroscience) do not have a set of broadly applicable laws capable of making quantitative predictions. The distinctions between a "descriptive" biological understanding and a "physics" understanding will be discussed. Oddly, physics, considered the paradigm of all sciences, may be unique among the sciences.

Can quantum mechanics, our theory of the atomic world, describe a living object? Is it possible that our quantum theory is overwhelmed by the complexity of the problem, and the time evolution quantum system as large as a single cell cannot be calculated? Thus, do we have a situation analogous to the laws of statistical physics: while no known physical law forbids the violation of the 2nd law of thermodynamics, the probability that a violation of this law will happen during a trillion lifetimes of our universe is negligible.

In order to develop a physical (quantitative) understanding of life, we must find a way to include the essential features of a living entity while omitting many of the details that a fundamental quantum theory demands. Physics has been able to make transitions to higher levels of complexity. Our description of the known "fundamental particles" that comprise the nucleus (quarks and gluons) can be largely ignored in our description of an atom. The properties of the most deeply bound electrons of atoms are not important in our quantum mechanical description of solids.

Despite these allowable simplifications, we also know that higher levels of complexity introduce fundamentally new properties and phenomena that are absent in simple systems. "More is different", and historically, the scientific community has not had a distinguished track record in predicting new phenomena that emerges from collective behavior. What are our prospects that a physical, mechanistic theory of life can be developed? Ultimately, are there foreseeable limits to our ability to understand the physical world?

Philosophical Presentation:

On Two Methodological Breakthroughs of Science, and their Consequences for our Conception of Matter and Life.

Michel Bitbol

Science arose from two basic methodological assumptions. The first one is objectification, namely detachment of scientific descriptions from any kind of subjective or situated data. The second one is finiteness, namely the attempt at encapsulating knowledge within a small number of symbols and laws, out of which phenomena can be derived in a finite number of logical steps entirely mastered by scientists. But these two methodological assumptions have been put under strong pressure during the last century. They are growingly perceived as oversimplifications, and new methods are progressively enacted.

1) In quantum physics, detached descriptions of nature are willy-nilly replaced by predictive rules valid for entangled experimental situations. Quantum theories are then easier to understand under the presupposition of a participatory theory of knowledge than within the usual frame of subject-object dualism. Moreover, these theories exhibit a very strong form of relational holism (non-separability) which is more immediately consistent with a participatory stance than with any other conception of knowledge.

Accordingly, the traditional view of matter as a set of individual bodies endowed with properties is replaced, at the microscopic level, by abstract structures of relational dispositions. And at the macroscopic level, "material bodies" are construed as coarse appearances which co-emerge, together with viable knowers, from a background of dispositions in flux.

2) In the life sciences, it is the assumption of finiteness that has shown its limits. Reference to (algorithmic) complexity is an explicit statement of the impossibility of accounting for certain occurrences by means of a restricted set of symbols defined once and for all. As for the concepts of emergence and evolutionary contingency, they partake of a new, more modest, idea of what biological science should do. Not deriving structures from premises and laws, but showing the means by which they are self-generated. Not mastering every step of the processes, but identifying a way of triggering them.

We will try to identify the sources of the enduring philosophical resistance to these two rising trends of physical and life sciences. We will especially discuss the possibility that, after having favored the birth of the modern science of nature during the 17th century, the Western view of the world has turned out to be too narrow to accommodate the latest developments of this science.

PARTICIPANTS

Tenzin Gyatso, His Holiness the XIV Dalai Lama, is the leader of Tibetan Buddhism, the head of the Tibetan government-in-exile, and a spiritual leader revered worldwide. He was born on July 6, 1935 in a small village called Taktșer in northeastern Tibet. Born to a peasant family, His Holiness was recognized at the age of two, in accordance with Tibetan tradition, as the reincarnation of his predecessor, the XIIIth Dalai Lama. The Dalai Lamas are manifestations of the Buddha of Compassion, who choose to reincarnate for the purpose of serving human beings. Winner of the Nobel Prize for Peace in 1989, he is universally respected as a spokesman for the compassionate and peaceful resolution of human conflict. His Holiness has traveled extensively, speaking on subjects including universal responsibility, love, compassion and kindness. Less well known is his intense personal interest in the sciences; he has said that if he were not a monk, he would have been an engineer. As a youth in Lhasa it was he who was called on to fix broken machinery in the Potola Palace, be it a clock or a car. His Holiness has a vigorous interest in learning the newest developments in science, and brings to bear both a voice for the humanistic implications of the findings, and a high degree of intuitive methodological sophistication.

Michel Bitbol is Directeur de recherché at the Centre National de la Recherche Scientifique, in Paris, France. He is based at the Centre de Recherche en Epistemologie Appliquee (CREA) in Paris. He teaches the Philosophy of Modern Physics to graduate students at the University Paris I (Pantheon-Sorbonne). He was educated at several universities in Paris, where he received successively his M.D. in 1980, his Ph.D. in physics and biophysics in 1985, and his "Habilitation" in philosophy in 1997. He worked as a research scientist from 1978 to 1990, specializing first in the hydrodynamics of the blood flow in arteries, and then in the microstructure of the red blood cell membranes studied by EPR and NMR techniques. From 1990 onwards, he turned to the philosophy of physics. He edited texts of general philosophy and of quantum mechanics by Erwin Schrödinger, and published a book entitled *Schrödinger's Philosophy of Quantum Mechanics* (Kluwer, 1996). He also published two books in French on quantum mechanics and on realism in science, in 1996 and 1998 respectively. More recently, he focused on the relations between the philosophy of quantum mechanics and the philosophy of mind. He published a book on that topic in French in 2000, and worked in close collaboration with Francisco Varela. In 1997 he was the recipient of an award from the Academie des Sciences Morales et Politiques for his work in the philosophy of quantum mechanics He is presently learning some Sanskrit in order to get a better understanding of basic texts by Nagarjuna and Candrakirti, for a new philosophical project on the concept of relation in physics and the theory of knowledge.

Steven Chu is the Theodore and Frances Geballe Professor of Physics and Applied Physics at Stanford University. He did his Ph.D. and postdoctoral work at Berkeley before joining AT&T Bell Laboratories in 1978. While at Bell Laboratories, he did the first laser spectroscopy of positronium, an atom consisting of an electron and positron. Also at Bell Laboratories, he showed how to cool atoms with laser light (optical molasses) and demonstrated the first optical trap for atoms. This trap, known as "optical tweezers", is also used to trap microscopic particles in water and is widely used in biology. His group demonstrated the magneto-optic trap, the most commonly used atom trap. He joined the Stanford Physics Department in 1987. His group at Stanford made the first frequency standard based on an atomic fountain of atoms and developed ultra-sensitive atom interferometers. Using the optical tweezers, He developed methods to simultaneously visualize and manipulate single bio-molecules. His group is also applying methods such as fluorescence microscopy, optical tweezers and atomic force methods to study the protein and RNA folding and enzyme activity of individual bio-molecules. Notable findings include the discovery of "molecular individualism" and the chemical/kinetic basis for "molecular memory". For his work, he has received numerous awards including co-winner of the Nobel Prize in Physics in 1997. He is a member of the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, and the Academia Sinica. He is also a foreign member of the Chinese Academy of Sciences and the Korean Academy of Science and Engineering.

R. Adam Engle is the Chairman and Co-founder of the Mind and Life Institute, and has been the General Coordinator of ten Mind and Life conferences. He is also the Chairman and founder of the Engle Capital Group, a financial services and investment management company based in Boulder, Colorado. Previously, he was a founder of NetSage Corporation; Australian Nutri/System; Colorado Friends of Tibet; and a founding member of the Social Venture Network. From 1967 to 1976, he was engaged in the private practice of law in Beverly Hills and Santa Barbara, and was the General Counsel of GTE, Iran. He was educated at the University of Colorado (A. B. in Economics), Harvard University (J.D.) and Stanford University (M.B.A).

Ursula Goodenough is Professor of Biology at Washington University in St. Louis, Missouri. She was educated at Radcliffe and Barnard Colleges and at Columbia and Harvard University, where she received a Ph.D. in 1969. She was Assistant and Associate Professor of Biology at Harvard before moving to Washington University. She teaches a cell biology course for undergraduate biology majors and also co-teaches a course, The Epic of Evolution, with a physicist and a geologist, for non-science students. Her research focuses on the cell biology and (molecular) genetics of the sexual phase of the life cycle of the unicellular eukaryotic green alga Chlamydomonas reinhardtii and, more recently, on the evolution of the genes governing mating-related traits. She wrote 3 editions of a widely adopted textbook, *Genetics,* and has served in numerous capacities in national biomedical arenas. She joined the Institute on Religion in an Age of Science in 1989 and has served the organization since then in various executive capacities. She has presented and published papers and seminars on science and religion in numerous arenas and wrote a book, *The Sacred Depths of Nature* (Oxford University Press, 1998) that offers religious/spiritual perspectives of Nature, particularly biology at a molecular level.

Stuart A. Kauffman, M.D., Chief Scientific Officer and Chairman of the Board, BiosGroup Inc., received a first B.A. from Dartmouth College in 1961, attended Magdalen College, Oxford University from 1961-1963, and obtained a second B.A. He received his M.D. degree from the University of California/San Francisco in 1968. After an internship and postdoctoral fellowship in genetics in Cincinnati, he joined the Department of Theoretical Biology, University of Chicago in 1969. From 1973 to 1975, he was in the Public Health Service at the National Cancer Institute. He joined the Department of Biochemistry and Biophysics, School of Medicine, University of Pennsylvania in 1975 as Associate Professor and became Professor in 1980. Since 1985, he has served as a consultant to Los Alamos National Laboratory, and from 1986 to 1998 as Professor at the Santa Fe Institute, where he is presently an external professor. In 1996, Dr. Kauffman formed BiosGroup, in partnership with what is now Cap Gemini Ernst & Young. Major areas of research include Developmental Genetics, Theoretical Biology, Evolution, and the Origin of Life. He was awarded the John D. and Catherine T. MacArthur Fellowship 1987-92 and The Herbert A. Simon Award 2000. He has published three books with Oxford University Press: T*he Origins of Order: Self-Organization and Selection in Evolution* (1993), *At Home in the Universe* (1995) and *Investigations* (2000).

Eric Lander, Ph.D., a geneticist, molecular biologist, and mathematician, is a member of the Whitehead Institute and the Founder and Director of the Whitehead Institute Center for Genome Research, one of the world's leading genome centers. He is one of the driving forces behind today's revolution in genomics, the study of all of the genes in an organism and how they function together in health and disease. Dr. Lander has been one of the principal leaders of the Human Genome Project. He is also Professor of Biology at the Massachusetts Institute of Technology (MIT). Dr. Lander earned his B.A. in mathematics from Princeton University in 1978 and his Ph.D. in mathematics from Oxford University in 1981. In addition to his work in biology, he was an assistant and associate professor of managerial economics at the Harvard Business School from 1981 to 1990. Dr. Lander was named a Rhodes Scholar in 1978 and received a MacArthur Foundation Fellowship in 1987 for his work in genetics. He was elected to the U.S. National Academy of Sciences in 1997, the U.S. Institute of Medicine in 1998, and the American Academy of Arts and Sciences in 1999. He has received numerous awards and honorary degrees, and has served on many advisory boards for governments, academic institutions, scientific societies, and companies.

Prof. Dr. Pier Luigi Luisi has been Professor of Macromolecular Chemistry at ETH-Zentrum, Institut für Polymere Departement Werkstoffe, one of the most prestigious technical universities of Europe, since the early 1980s. Earlier, he traveled and worked in Italy (where he got his degree), the United States, Sweden, and the former Soviet Union. His major interest in research is in the phenomena of self-assembly and self-organization of chemical systems, and on the emergence of novel functional properties as a consequence of the increase of the molecular complexity. He is presently well known in the field of origin of life and origin of protocells, where he combines a hard-core experimental approach with the basic philosophical questions about minimal life. In this field, he is a follower of the theory of autopoiesis as proposed by Varela and Maturana, and developed it further into the experimental chemical autopoiesis. Professor Luisi is also responsible for an intense program that bridges science with humanities, the Cortona-Weeks project. He is author of over 300 scientific papers and also author of literature books, including children's books.

Matthieu Ricard is a Buddhist monk at Shechen Monastery in Kathmandu and French interpreter since 1989 for His Holiness the Dalai Lama. Born in France in 1946, he received a Ph.D. in Cellular Genetics at the Institut Pasteur under Nobel Laureate Francois Jacob. As a hobby, he wrote *Animal Migrations* (Hill and Wang, 1969). He first traveled to the Himalayas in 1967 and has lived there since 1972. For fifteen years he studied with Dilgo Khyentse Rinpoche, one of the most eminent Tibetan teachers of our times. With his father, the French thinker Jean-François Revel, he is the author of *The Monk and the Philosopher* (Schocken, New York, 1999), and of *The Quantum and Lotus* with the astrophysicist Trinh Xuan Thuan (Crown, New York, 2001). He has translated several books from Tibetan into English and French. As a photographer, he has published several albums, including *The Spirit of Tibet* (Aperture, New York) and *Buddhist Himalaya* (Abrams, New York, forthcoming 2002).

Arthur Zajonc is Professor of Physics at Amherst College, where he has taught since 1978. He received his B.S. and Ph.D. in physics from the University of Michigan. He has been visiting professor and research scientist at the Ecole Normale Superieure in Paris, the Max Planck Institute for Quantum Optics, and the universities of Rochester and Hannover. He has been Fulbright professor at the University of Innsbruck in Austria. As a postdoctoral fellow at the Joint Institute for Laboratory Astrophysics he researched electron-atoms, collision physics, and radiative transfer in dense vapors. His research has included studies in parity violation in atoms, the experimental foundations of quantum physics, and the relationship between sciences and the humanities. He has written extensively on Goethe's science. He is author of the book: *Catching the Light,* co-author of *The Quantum Challenge*, and co-editor of *Goethe's Way of Science*. In 1997 he served as scientific coordinator of "The New Physics and Cosmology," the sixth Mind and Life Dialogue with the Dalai Lama.

INTERPRETERS

Geshe Thupten Jinpa was born in Tibet in 1958. Trained as a monk in south India, he received the Geshe Lharam degree (equivalent to a doctorate in Divinity) from Shartse College of Ganden monastic university, where he also taught Buddhist philosophy for five years. He also holds B.A. Honors in Western Philosophy and Ph.D. in Religious Studies, both from Cambridge University. Since 1985 he has been a principal English translator to His Holiness the Dalai Lama, and has translated and edited several books by the Dalai Lama including *The Good Heart: The Dalai Lama Explores the Heart of Christianity* (Rider, 1996), and *Ethics for the New Millennium* (Riverhead, 1999). His most recent works are *Songs of Spiritual Experience* (co-authored, Shambhala, 2000) and *Tsongkhapa's Philosophy of Emptiness* (forthcoming from Curzon Press), and the entries on Tibetan philosophy of the forthcoming *Routledge Encyclopedia of Asian Philosophy*. From 1996 to 1999, he was the Margaret Smith Research Fellow in Eastern Religion at Girton College, Cambridge University. He is currently the president of the Institute of Tibetan Classics, which is dedicated to translating key Tibetan classics into contemporary languages.

B. Alan Wallace trained for many years in Buddhist monasteries in India and Switzerland, and has taught Buddhist theory and practice in Europe and America since 1976. He has served as interpreter for numerous Tibetan scholars and contemplatives, including His Holiness the Dalai Lama. After graduating summa cum laude from Amherst College, where he studied physics and the philosophy of science, he earned a doctorate in religious studies at Stanford University. He has edited, translated, authored, or contributed to more than thirty books on Tibetan Buddhism, medicine, language, and culture, as well as the interface between science and religion. His published works include *Tibetan Buddhism From the Ground Up*; *Choosing Reality: Buddhist View of Physics and the Mind; The Bridge of Quiescence: Experiencing Buddhist Meditation*; and T*he Taboo of Subjectivity: Toward a New Science of Consciousness.* His forthcoming anthology of essays entitled *Buddhism and Science: Breaking New Ground*, which he edited, is soon to be published by Columbia University Press.

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"This is my simple religion.
There is no need for temple; no need for complicated philosophy.
Our own brain, our own heart is our temple; the philosophy
is kindness."

His Holiness the Dalai Lama