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The Organic Revolution in Science

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Thank you so much for inviting me to this Conference, I am greatly honored to be among such a distinguished panel of speakers. I was so inspired this morning that I could happily have gone on listening all day. We were treated to living, working embodiments of visionary biology, compared to which genetic engineering is an abomination, a threat to all our values as human beings, to life itself. I am indeed one among the more than 140 scientists from 27 countries who are calling on all Governments to impose a moratorium on genetic engineered crops and products, to ban patents of life-forms and living processes and to hold a comprehensive public enquiry into the future of food security. We are submitting an open

letter to the heads of delegation at the up-coming World Trade Organization meeting in Seattle, urging them to reject life-patents from Trade-Related Intellectual Property Rights, and not to allow the WTO to put trade and investment above the need for strong international and national safety standards in genetic engineering.

We are among the growing number of scientists who see the need to oppose corporate control of life and our life-support system, and finally, of thought. Corporations are steadily gaining complete control of our free press, our independent education and research institutions and of science itself: they want to tell us what is sound science as opposed to phony science. Free, independent science is going extinct, and that is perhaps the most serious hazard we face as science and technology have increasingly become instruments of oppression and destruction under corporate capitalism.

Fortunately, the tide has turned, the genetic engineering debate has united the world. It has become the focus of the largest, most inclusive civil rights movement in the millennium against this corporate feudalism. A tidal wave is sweeping across the world and it has reached the United States. I shall talk more about that to-morrow in the workshop with Prof. David Suzuki.

For now, I want to talk about the organic, ‘orgasmic’ revolution in science that has motivated me and prepared me to engage in the biotechnology debate, which gives me the opportunity to contribute to this wonderful synergy that is emerging to regenerate and revitalize our earth.

Escape from Plato’s cave

Denis Diderot of the French Enlightenment describes a dream he had after reading Plato.

He finds himself imprisoned in Plato’s cave and sitting in the middle of a crowd of men, women and children. Their hands and feet are in chains and their heads clamped so they cannot look around. But the majority are eating, drinking, laughing and singing, not in the least bothered by their chains, even to the extent that they look rather hostile at those who try to free themselves or to help others do so.

If someone says,"The beef is full of hormones!" they will carry on unperturbed.

"The wine is contaminated with pesticides!"

"shut up!" they may reply.

"You’re eating genetically engineered food!"

"She’s crazy, Take her away!"

They have their back to the entrance of the cave, and are only able to look at the far end where a great screen is hung.

Behind them are kings, ministers, politicians, corporate managers, professors for the public understanding of science, bioethicists, rogues, charlatans makers of illusions, and the whole troupe of merchants of food, health and hope. Everyone of them has different colored slides, and is projecting images onto the great screen at the end of the cavern, whole scenes that are so life-like that the prisoners take them for real.

Diderot adds that, if an intelligent person grows suspicious, and with painful effort and contortion, overcomes the powers that keeps his head turned and scales the wall to escape from the cave, "he had better take care, if he ever returns, to keep his mouth shut as to what he has seen. . . ." [1]

Diderot is inviting us to overcome the tyranny of powers that be, and the even greater tyranny of habit to see nature as dictated by intellectual laziness, by convention and 'common' sense. More than two centuries later today, we can also read that as an allegory of overcoming the Platonic-Cartesian illusion: to turn around, scale the walls of the cave, to see *and experience* the real world. The grand illusion of the mechanistic universe has indeed been finally exposed at the beginning of the 20th century for what it is -- abstract, projected images of reality. But have we escaped from Plato's cave? We are on our way. There is indeed an organic revolution going on in western science to take us out of the mechanical era.

The 20th century will be seen, in retrospect, as the most important watershed of western civilization. Not the least among the reasons are the scientific developments which overturned everything that has been taken for granted as self-evident and true by the dominant, industrialized culture. The first upset came when Einstein's relativity theory broke up Newton's universe of absolute space and time into a multitude of space-time frames in which space and time are no longer neatly separable. Furthermore, each space-time is tied to a particular observer, who therefore, not only has a different clock, but also a different map. Stranger still -- for western science, that is, as it comes as little surprise to other knowledge systems, or to the artists and poets in all cultures -- quantum theory demanded that we stop seeing things as separate, solid objects with definite locations in space and time. Instead, they are de-localized, indefinite, mutually entangled entities that evolve like organisms. Two properties of quantum systems that pose the greatest difficulties for the mechanistic framework are 'quantum superposition' and 'quantum non-locality'. Let me explain what they are.

Schrödinger's cat

Quantum superposition is usually presented as the paradox of Schrödinger's cat (which is not at all kind to cats). The cat is kept inside a box with an atom which has a probability to decay radioactively. When it does, it sends a signal that triggers cyanide gas to be released to kill the cat. According to quantum theory, unless and before the box is opened by someone, 'the observer', the cat is in a 'quantum superposition' of being dead, being alive and being both dead and alive simultaneously [2]. This strange indefinite quantum system is real, in the sense that it can be experimentally created in many forms. However, once the quantum system is *observed*, or measured by a macroscopic, classical instrument, including a person,

then this indefinite quantum system, described by a wave-function of quantum superposition of all the possibilities, suddenly 'collapses' into a definite state. So, when the box containing Schrödinger's cat is opened, it ceases to be a quantum system, the cat will be observed in one of two definite states: either dead or alive.

This 'collapse of the wave function' is generally thought to represent a transition between the quantum and the classical domains -- the former is that of elementary particles (that's why Schrödinger's cat is just a parable) and the latter is that of ordinary macroscopic systems like human beings and houses. However, not all physicists are happy with dividing up the world into quantum and classical domains. Many argue, as I do, that quantum physics actually applies to the whole of reality.

Non-local entanglement

'Non-locality' is usually presented as the Einstein, Podolsky and Rosen paradox (the EPR paradox). Although Einstein contributed a lot to quantum theory, he could never accept how the theory describes or fails to describe reality, leading to many paradoxes, including quantum superposition. The intangible, indefinite quantum state bothered him, as it continues to bother many physicists. Something told Einstein that, "God does not play dice!". He assumed there must be a deeper structure underlying quantum mechanics which can represent reality without the contradictions inherent in the accepted theory.

In order to try to show that is the case, Einstein, Podolsky and Rosen proposed a 'thought experiment', or *gedanken* experiment (which in the end overcame their objections, especially when the experiment was actually carried out) [3]. The experiment consists of elementary particles prepared in pairs, and allowed to move apart in opposite directions. According to quantum theory, if we measure a property of one of the pair, such as *spin*, in which ever direction we choose, the other of the pair would have a correlated property. Say, if the first particle is measured to be spin *up*, the other would be spin *down*; if the first is spin *left*, the second would be spin *right* and so on. It would be so regardless of which property is measured, and *no matter how far apart the particles are.*

The results cannot be explained by any model that involves *local* interactions, say, by a signal being sent from one particle measured to the other, for such a signal, if it exists, would have to take no time at all to travel, which is considered impossible in classical physics. Furthermore, no set of prepared answers can produce the results as predicted by quantum mechanics, which means that neither particle *actually* had the definite property before it was measured. The conclusion that has to be drawn is that the effect of measurement (or 'collapse of the wave function') of one particle is somehow instantaneously communicated to the other one. It is as though the separated particles are still one single *coherent* system, or, in a 'pure state', with a common wave function, like Schrödinger's cat in the box.

By extrapolating the experimental results, it must mean that the two particles could be light-years apart (a *light-year* is the enormous distance traveled by light in one year, which is 9.46×10^{12} km) and still the 'collapse' of the wave function of one particle instantaneously collapses that of the other as well.

Schrödinger introduced the concept of ‘entanglement’ in 1935 to describe the phenomenon of non-locality. The two particles are, so to speak, entangled with each other in a pure, coherent state. ‘Entangled’ is such a wonderful word to describe this inseparable oneness. It turns out that the two particles do not even have to be prepared together so that they are originally one system. Experimentally, one can even allow any two particles of matter, including big particles like neutrons and protons, to be produced at distant and unrelated sources. As soon as they have come together and interacted, they become entangled with each other long after they have collided and separated. They have become one quantum system. Could it not be so for big particles like human beings?

And, there is something else. It matters who does the observing and how. The potential observer and the observed are also entangled with each other. The so-called observer actually takes part in determining the outcome. One might say, once the intention for observing is there, the entanglement begins. Just think, the moment we have decided to attend this meeting, we have become entangled with one another, even though we were on opposite sides of the globe. And once we have interacted here and now, we shall remain entangled with one another long afterwards, perhaps ever after.

This transforms the very meaning and texture of our lives, as I argue in my book, *The Rainbow and the Worm*.

The universe of organisms

In the aftermath of quantum theory, English philosopher Alfred North Whitehead declared that physics has to be entirely rewritten in terms of a general theory of the organism. On account of quantum superposition, non-local entanglement, and the mutual entanglement of the observer and observed, Newtonian mechanics is indeed merely a flat projection of organic reality. Inert objects with simple, definite locations in space and time do not exist. Instead, all nature is alive with process and happenings. The totality of all that happens is a pattern of flows and influences, now diverging from one locus, now converging towards another in such a way that "each volume of space, or each lapse of time includes in its essence aspects of all volumes of space, or of all lapses of time."

In Whitehead’s organic universe, everything is an organism, from elementary particles such as photons and electrons to human beings and galaxies. An organism senses its environment as a whole because it is itself a coherent whole. More than that, it is a field of coherent activities, which draws on its experience of other organisms to make itself whole.

Think of each organism as an entity that is not really confined within the solid body we see, which just happens to be where its wave-function is most ‘dense’. Instead, invisible quantum waves are spreading out from each one of us and permeating into all other organisms. At the same time, each of us has the waves of every other organism entangled within our own make-up. The realization and maintenance of self and other are completely intertwined. The self is de-localized over all that we experience; just as all that we experience is entangled within our being.

The meaning and texture of life as an organism

In a very real sense, no person is alone, no man is an island. We are not isolated atoms each jostling and competing against the rest in a Darwinian struggle for survival of the fittest. Instead, each of us is supported and constituted, ultimately, by all there is in the universe. We are at home in the universe. In this entangled universe, we cannot do violence to our fellow human beings or our fellow inhabitants of the earth without doing violence to ourselves. And the most effective way to benefit oneself may be to benefit others.

Most of all, we are not impotent observers outside nature subject to the slings and arrows of outrageous fortune. Instead we are participants in the creation drama which is constantly unfolding. We are constantly co-creating and re-creating ourselves and other organisms in the universe, shaping our common futures, making our dreams come true and realizing our potentials and our ideals.

All this presupposes that each organism is a quantum coherent being that can be described by a wave-function, with the attendant properties of quantum superposition and non-locality. Is there any evidence that organisms are quantum coherent? And what does quantum coherence entail? In my book, *The Rainbow and the Worm*, I have proposed that the organism is, in the ideal, a quantum superposition of coherent activities, with instantaneous (non-local) noiseless intercommunication throughout the system.

The idea that organisms may be quantum coherent was still beyond the pale in mainstream biology when I proposed it in 1993 [4]. I was inspired by Herbert Fröhlich's [5] original proposal in the 1960s that organisms may store energy as 'coherent excitations', and by Fritz Popp, who suggested that organisms are quantum coherent photon fields [6]. Today, mainstream scientists including Roger Penrose [7], are invoking quantum coherence to account for the coherent electrical activities observed by neurophysiologists in widely separated parts of the brain [8].

Crystal consciousness

I must emphasize that my claims about the coherence of the organism are based on empirical findings from our own laboratory as well as from established laboratories around the world. These are described in detail especially in the second edition of *The Rainbow and The Worm*. Perhaps the most suggestive evidence for the coherence of the organism is our discovery, in 1992, that all living organisms are liquid crystalline.

What we actually discovered was a novel non-destructive imaging technique that reveals living, moving organisms to be liquid crystalline. The technique is based on the polarized light microscopy [9] that earth scientists have used to study mineral crystals and other materials, such as liquid crystals, which have a certain degree of molecular order. But crystals, even liquid crystals, have static order, so how can living moving organisms be crystals? The answer is that organisms are so dynamically coherent at the molecular level that they *appear* to be crystalline [10].

Visible light vibrates one hundred zillion times a second (1 followed by 14 zeros), at least ten thousand times faster than the molecules can move coherently together. So long as the motions among the molecules in the cells and tissues are sufficiently coherent, they will appear to be statically ordered, or crystalline, to the light passing through. This is analogous to the ability of a very fast film to capture the image of a moving object as a sharply focussed ‘still’ picture. This imaging technique is telling us that the living organism is coherent beyond our wildest dreams, with dynamic order that extends from the molecules, the cells and tissues right up to the entire organism.

There is a dynamic, liquid crystalline continuum of connective tissues and extracellular matrix linking directly into the equally liquid crystalline interior of every single cell in the body. Liquid crystallinity gives organisms their characteristic flexibility, exquisite sensitivity and responsiveness, thus optimizing the rapid, noiseless intercommunication that enables the organism to function as a coherent, coordinated whole. In addition, the liquid crystalline continuum provides subtle electrical interconnections which are sensitive to changes in pressure and other physicochemical conditions; in other words, it is also able to register ‘tissue memory’. Thus, the liquid crystalline continuum possesses all the qualities of a highly sensitive ‘body consciousness’ that can respond to all forms of subtle energy medicines [11]. One begins to get a sense of the violence we routinely do to organisms including ourselves under the old mechanistic paradigm. And genetic engineering is the culmination of that paradigm [12].

Dr. Frankenstein is a scientist obsessed with mastery over nature; so much so that he attempts to create the perfect human being, only to realize too late that he has created a monster. Mary Shelley’s classic is as much a parable of the mechanistic science that inspires the deed as it is of the scientist playing god. The genetic engineer has no concept of the organism as a whole. It has no respect for the extraordinary coherence and integrity of the organism. Let me show you what the organism is really like under our imaging technique.

This happens to be the little brine-shrimp from San Francisco bay, but every single organism is the same, including us. The living body is a grand jazz concert in which every single cell, every single molecule is performing and improvising from moment to moment. And yet each molecule, each cell is so sensitive and responsive that it keeps fully in step and in tune with the whole. And that is how we come to see in the organism all the colors in the rainbow dancing before our very eyes.

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