Transdisciplinarity: A Scientific Essential

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ABSTRACT: Transdisciplinarity in science is necessary to counteract the rapid growth of scientific results and information, the elimination of logical inconsistencies, and the effect of specialization whereby uncomparable disciplines develop. A correspondence is drawn between the uncontrolled growth, immune system malfunction, repression/expansion, and isolation that are characteristic of cancer and of the scientific concept of modernity. Suggestions are presented regarding the promotion of healing in both of these realms.

KEYWORDS: transdisciplinarity; science; cancer

INTRODUCTION

With the title I have already revealed the point of this essay: transdisciplinarity is scientifically essential; it is a scientific *conditio sine qua non*. If this article were a classic crime story, I would have made a fatal mistake. Just imagine that a thriller of Patricia Highsmith having a title like "Jack was the Murderer!" The underlying thought behind my approach is based on the following insight: in real life we are primarily confronted not with riddles or problems, but with solutions. Life in essence *is* a solution. Of course, it is also a riddle and a problem. But above all it is a solution— simply because it *is*. Other examples are the phenomenon of *gestalt*;[1] in a medical context, the organ; and, even more complex, the immune system. Are these not quite fascinating solutions that, if they work correctly, are taken for granted? In short, I am going to present scientific transdisciplinarity as a solution—a solution that currently is only a limited part of scientific reality.

Before I begin my actual arguments, I want to tell you that I was warned against writing this essay by a person of some importance, a Nobel Prize winner. He claimed, "From a scientist we may expect an immediate and comprehensive knowledge of a certain topic. Therefore, we generally expect that he will not get involved with an unfamiliar topic."[2] Some of you may recognize this as by none other than Erwin Schrödinger—the first lines of the foreword of his book *What is Life*? He wrote that scientists should not enter unfamiliar territory, foreign scientific topics. Nonetheless, this Nobel Prize winner in physics did exactly that. And it is well that he did so!

Schrödinger wrote a complete book on a biological topic—a book that has since become a transdisciplinary classic. Why did he attempt this? As a Nobel Prize win-

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ner, he knew his words would be taken seriously; and yet he was risking making a fool of himself. I do not know why Schrödinger dared to do this, but I can imagine a reason, which I would like to illustrate with the help of the physicist and man of letters Georg Christoph Lichtenberg (1742–1799). Commenting on the trend toward increasing specialization and differentiation in the 18th century, he claimed, "One who is able to understand only physics and chemistry is also not able to understand them truly."

Schrödinger probably took the risk because—in the sense of Lichtenberg—he believed that disciplinary cognition on its own, even within its methodological correctness, risks leading nowhere. This is so for two reasons: first, because detailed disciplinary cognition can easily be regarded as absolute; and second, because disciplinary cognition allows us to see the trees, but not the forest. To be able to see the overall context, we must think transdisciplinarily.

The question, therefore, is not so much whether each one of us is able to perceive transdisciplinarily, but if doing so is adequate to the truth. This might be the reason that when Schrödinger warned us against "transdiciplinary cognitive dilettantism," he did so in a contradictory, paradoxical way:

> Even the name of institutions of higher education [universities] reminds us that throughout antiquity and many centuries afterwards only the universal perspective was fully recognised [in the sense of cognition].… But the growing scope both in the depth and scale of our scientific disciplines has led us into a dilemma.…. It has become nearly impossible for a single mind to understand more than a tiny and very specific part.… If we do not want to give up our true cognitive objective for ever, then there can only be only one solution to this dilemma: some of us have to dare to take an overall approach to facts and theories, even when they risk taking their knowledge from second hand or they risk exposing themselves to ridicule.[3]

Please keep these words in mind when I—admittedly, a layman when it comes to biology and medicine (my main field of activity concerns research into basic human communication theory)—try to discuss topics such as the immune system and cancer. So what can we learn from Schrödinger's "dilemma of cognition"? It is as dangerous *to* venture into alien disciplines as it is *not* to.

THE RELATIONSHIP BETWEEN DISCIPLINARITY AND TRANSDISCIPLINARITY

This leads us to the question about the relationship between disciplinarity and transdisciplinarity (or interdisciplinarity). Kurt S. Zaenker illuminates a central aspect of this question when he writes, in the preface of his book *Communication Networks in the Body. Psychoneuroimmunology—Aspects of a New Scientific Discipline,*

> Development of a new scientific discipline is a high cultural performance. It doesn't arise accidentally, but results out of current changes in scientific interpretation. The emergence and acknowledgment of the scientific discipline psychoneuroimmunology pose a good example for this claim. It has many roots in single observations of physicians, psychologists and neuro-biologists. Bringing these results together, however, required the efforts of visionary scientists such as Robert Ader and Nicholas Cohen, as well as Bernie Fox from the U.S.A. and Hugo Besedovsky from Basel—to name just a few—who could bundle the results of their individual areas of expertise within the broader context of interdisciplinarity.[4]

The process of emergence and differentiation of a scientific discipline is itself a multidisciplinary process. Similarly, the existence of individual scientific disciplines represents a multidisciplinary process, because each discipline is constrained to determine and understand itself anew in the changing context of cognition as a whole. Thus each single scientific discipline has a transdisciplinary aspect. Whereas specialization within a discipline implies formation of a rather specific thought framework leading to the discipline's particularization, transdisciplinarity tends to reintegrate this specific thought framework into the broader context of cognition as a whole, into the so-called unity of knowledge.

Both trends, disciplinarity and transdisciplinarity, can be compared to the breathing process: inhaling as formation of a specific framework of thought; exhaling as reintegration of that framework into cognition as a whole. Disregarding either of these two essential breathing elements would lead to breathlessness, with all its resulting symptoms. The configuration of a specific thought framework would lead to isolation if there were no intention of integrating this specific knowledge into the general context of cognition.

I will discuss this issue in more detail later. Now I would like to return to the thought of Zaenker, who identified the emergence of scientific disciplines as a high cultural phenomenon. In this idea there is another transdisciplinary element, which I would like to introduce indirectly.

Since the work of Adolf Portmann, Helmuth Plessner, and Arnold Gehlen, modern anthropologists have agreed that humans—in contrast to animals, whose lives are determined by instincts—do not have fixed solutions regarding their orientation and actions in the world. How can humans orient themselves if not by appealing to their instincts? Humans have significant help from their ability to interpret the reality they encounter**.** This gives humans the means to behave meaningfully. It is this ability that is implied by culture.

This brings us back to the transdisciplinarity hidden in the thought of Zaenker. Given that each cultural behavior is imbedded in a certain *weltanschauung* (philosophy), this must be so for scientific activity. Science can operate only against the background of an all-embracing understanding of human cognition. Scientific insight as a cultural act occurs transdisciplinarily as it emerges out of a context of interpretation located between scientific and extrascientific cognition. Naturally, science itself is not imaginable without interpretation; all scientific facts need interpretation. The choice of certain facts is itself already an interpretation of those facts: by focusing on particular facts as being worth analyzing scientifically in more detail, I am interpreting them, I am attributing meaning and value to these facts. In other words, the *weltanschauung*, being a high cultural performance, is indispensable to the interpretation of established facts.[5]

Sydney Brenner, prominent pioneer of genetics and Nobel Prize winner (2002), was speaking of this interrelation between facts and interpretation in a recent interview, when he said:

> At the same time people are crying for a new biology. They say they want to make "integrative biology" or "systems biology." Hardly anyone calls it by its proper name, theoretical biology, because this has a bad reputation. I think, however, I can remit the sins of the past and declare: we need a theory that comprises all that (molecular, structural, cellular, developmental,… and evolutionary biology). Imagine, we not only need to discuss all this stuff with our expert colleagues, but eventually we have to teach it at universities, at schools, and to the public. How could we manage without a comprehensive theory? This is the challenge we have to meet.[6]

The sociologist Friedrich Tenbruck puts it similarly: "Each new understanding of being [= *weltanschauung*] reveals necessarily far-reaching implications and extensive effects. It is essential … that our acting cannot be determined by facts, but by opinions about facts—especially as we know the facts only through our perception."[7] In other words, the predominant explanation of the what and how of nature, humanity, and society determines to a wide extent—although this has mostly not been realized—the goals of human actions, including, of course, the goals of science.[8] It can be said, then, that transdisciplinarity is necessary to create a scientific discipline and to define a scientific discipline in relation to others and in relation to nonscientific ways of cognition.

CURRENT PROBLEMS OF SCIENTIFIC TRANSDISCIPLINARITY

I would like to emphasize three main problems in scientific transdisciplinarity. The first is the rapidly increasing production of scientific results and information. Who is still able to keep track of the many relevant new publications in specific fields? And who is still able to keep up to date beyond one's own core field? How can we manage and utilize this vast, growing amount of knowledge? Indeed, this increased knowledge has, paradoxically, led to increased disorientation. And, as we have seen, it results in even more specialization, which threatens to lessen our cognitive scope.

The actual creation of this huge amount of scientific information is a second problem of transdisciplinary research; it is the background of the success story of any form of knowledge that we call scientific cognition. Without going into detail about the historic and humanistic context of its origins,[9] we can say that the central structure of cognition of scientific modernity is closely linked to the elements of logical consistency, definiteness, and causality following Aristotelian logic. The cognitive objective of modern science is a logically consistent construct of overall reality—or, to say it differently, the elimination of all inconsistencies. The medium of this new cognitive concept is print, which was and is the ideal means of identifying and preserving consistent knowledge. Not by accident, print became a historical reality in the 15th century. (Mark Markus has written an excellent work on this topic.[10]) According to Galileo the "cognition-credo" of modernity can be formulated as follows: "to make everything that is logically consistent definite, and everything logically inconsistent consistent."

The third problem is the increasing (in the context of the axiom of consistency) number of objects of cognition that cannot be logically compared. Once more, I would like to cite Sydney Brenner: "If we … want to simulate cells or organisms successfully, it is not only necessary to understand the language of machines, but we also have to be familiar with what we can call the grammar of a biological system. We have to acquire a definite understanding of how a cell or an organism is processing information."[11] And according to Herbert Pietschmann,

> The logical axioms, which are obviously taken for granted in every technical language, are opposed to true communication between the disciplines. Terms are defined differently in each discipline, although they are homonyms; for example: energy, information, evolution, even such fundamental terms as space and time. Therefore, interdisciplinary dialogues demand not only courage, to grow beyond the exactitude of their own technical language, but also attention, not to betray their own scientific area because of sloppy expression.[12]

The current problems of transdisciplinarity in scientific modernity—the increasing production of scientific results and information, the elimination of all (logical) inconsistencies, and the increase (in the context of the axiom of consistency) of (logically) uncomparable cognition disciplines/areas—need to be addressed and solved.

TWO DISEASE PATTERNS

Here I would like to exemplify my general remarks in the context of the phenomena of cancer and communication. Let us turn first to the multiform phenomenon called *cancer*, which has these specific characteristics:

- cancer is *uncontrollable* growth;
- cancer is *malfunction* of immune system;
- cancer is *repression/expansion*;
- cancer is *isolation*.

Transferring these characteristics into the realm of communication,

- cancer is *forced* communication;
- cancer is *malfunctioning* communication;
- cancer is *aggressive* communication;
- cancer is a *denial* of communication.

In these respects, cancer appears as a multifaceted communication phenomenon showing elements of exaggerated communication on the one hand and malfunctioning or denied communication on the other.

Now I would like to make a parallel observation: I would like to compare the disease pattern of cancer with that of another "disease" with quite similar characteristics**,** the scientific concept of modernity. In this concept, also multifaceted, we find the characteristics mentioned above in connection with cancer:

- uncontrollable growth,
- malfunction of the immune system,
- repression/expansion,
- isolation.

Uncontrollable growth refers to the ever-growing production of scientific results. *Malfunction of the immune system* refers to the elimination of contradiction in the realm of science. *Repression/expansion* refers to the fact that modern science does not tolerate extrascientific forms of knowledge—for instance, from the spheres of art or religion and spirituality. Rather it represses them and expands at their expense.[13] Finally, *isolation* indicates the characteristic of epistemological incompatibility with other scientific disciplines and with other, nonscientific cognition cultures such as art and religion. On the basis of these parallels, I would like to designate this disease pattern as *cognition cancer.*

TWO HEALING/RECOVERY PATTERNS

I propose two healing or recovery patterns for these disease patterns.

The Healing/Recovery Pattern in Epistemic Context: Reaccepting Fundamental Contradiction as a Base of Cognition (First in Physics)

I will start with the epistemic pattern because it appears earlier in history and because by this means the medical pattern may be better understood. This pattern of epistemic recovery does not come from outside science; it intrudes from within, emerging from science itself—and not from just any science, but from its royal discipline, physics.

In the beginning of the 20th century, as the logical consistency of scientific cognition was maturing, with many fascinating technical results, the epistemic contradiction emerged in the form of quantum mechanics. This was the first time in the modern history of science that a fundamental contradiction (wave/particle dualism) was accepted as a basis of cognition. This happened in 1927, in the so-called Copenhagen interpretation of quantum mechanics under chief scientist Niels Bohr.[14] Of course, several decades were necessary for this logical contradiction to be accepted by science. Even today it is not entirely accepted—especially, according to Hans-Peter Dürr, in biology and the biological sciences. The phenomenological contrariness of reality that was revealed by physics and that is increasingly being accepted as the basis of scientific cognition has made a significant contribution to the recovery of the "immune system" of cognition.

The Healing/Recovery Pattern in Its Medical Context: the Immune System as a Biological Contradiction

I would like to introduce a communication-gradient model that I recently developed with Nikolaus Bresgen, of the University of Salzburg's Department of Genetics and General Biology. The structure of this model is shown in FIGURE 1. Along with the increasing complexity of realms of being—materia, microorganisms, plants/animals, man/human beings[15] (denoted by Bresgen as *communication orbitals*)—comes an increasing ability and necessity to communicate. The increased complexity of single communication systems goes together with enlargement of the communication-ability gradient and the communication-necessity gradient. The greater the ability to communicate, the greater the necessity to communicate. I would like to illustrate this with help of Solomon Snyder, who, in his essay "Signal Transduction between Cells," writes,

> A single-celled organism such as amoeba can execute all life-keeping functions by itself. It can, for instance, absorb nutrition from its environment, it can move with the help of metabolism, it can provide itself with energy and it can synthesise new cellular molecules. [With the] multi-cellular organism, the situation becomes significantly [more] complicated. Here, various life-keeping functions are distributed across cell-populations, tissues and vital parts that are placed far apart from each other. In order to co-ordinate these functions, there have to be mechanisms that enable single cells or groups of cells to communicate.[16]

Along with the communication-ability gradient on the one side and the communication-necessity gradient on the other (the two horizontal gradients in the model), two vertical communication gradients have to be distinguished: the positive commu-

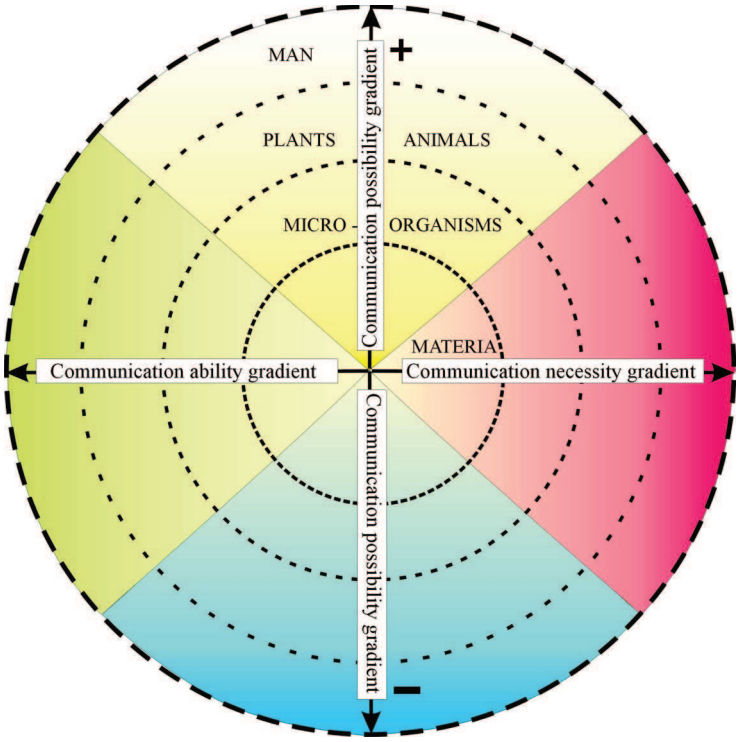

FIGURE 1. Communication-gradient model.

nication-possibility gradient (+) and the negative communication-possibility gradient (–), representing positive and negative developments, respectively, especially as applied to the less-complex communication levels.

These two communication-possibility gradients are of special interest in the realm of human communication, as humans, being self-conscious, are able to consciously affect other communication areas, in positive and negative ways—particularly those areas that are not self-conscious or able to make decisions on their own. Along with the increasing complexity of living systems, then, there is also an increasing possibility of communication malfunction. With human communication, there is, then, the increasing possibility of conscious interference with, subversion, or closing off of communication, but also of *improving* communication.

According to this model, then, human beings have the greatest capability to affect their own and other communication systems positively and negatively. An example of a negative effect of the human communication potential is to imagine an illness that then really occurs. An example of a positive effect is willfully, actively contacting the area of dysfunctional communication, talking to it; or trying to strengthen the psychological immune system and by this means affecting indirectly the physical dimension of the immune system.

In this connection I would like to point to the work of Lawrence LeShan, particularly his book *Cancer as a Turning Point. A Handbook for People with Cancer, Their Families and Health Professionals*. LeShan has developed his own method for mobilizing a vulnerable immune system through psychological change. In his psychotherapeutic sessions, he does not ask patients what they miss; he does not look for communication dysfunctions and shortcomings. He asks them about what they have, about their positive attitudes and particularly their hopes for a way of life that would make them get up each morning willingly and cheerfully. He writes, "A therapy that would mobilize the immune system of the cancer patient must find answers to these questions."[17] He quotes a patient of his with breast cancer, who came to the following conclusion at the and of a session:

> If I (would) have to be an example for my immune system, than I (would) have to live my life as I would wear clothes designed by a leading designer only for me … in this case my immune system would look up and say: "Oh, this lady is worth fighting for.… I have to provide an example for my body, by looking after myself, by paying attention to who I am.…[18]

Corresponding to this, Regine Kather notes in her recently published book *What is Life? Philosophical Positions and Perspectives* that "… the life sciences, as the key scientific disciplines in the 21st century, take generally into consideration only the results of natural sciences such as biology, genetics, and neurophysiology. According to such a determination of man, not only his relation to himself, but also to the whole world will be radically reduced.…"[19] Seeking new scientific horizons, the author comes to this conclusion:

> In order to prevent a minimalist determination of the living and to grasp it in its complexity, we have to replenish our bio-scientific terms and description criteria that refer only to molecular, intercellular, organismic and ecologic issues, with (philosophical, anthropological) categories such as communicative action, and vital self-awareness (e.g., feeling, wanting, remembering)—that is, with non-empirical theory of life forms. … As soon as the basic questions, methods and observations of single determinations are revealed and the borders of single perspectives become visible, it can be shown, whether and to what extent they complement each other.[20]

Sydney Brenner writes similarly: "If we want to effectively simulate cells or even organisms, then we have to learn to understand not only the vocabulary of machine language, but we have also to observe what we call the grammar of a biological system. We have to be absolutely clear in our minds about … how cells or an organism transmit the information."[21]

CONCLUSION

To the most fascinating and detailed insights that we currently observe in the context of cell-to-cell-interaction I have attempted to add the first fragments of another, a transdisciplinary, approach.[22] I have attempted to underline the essential importance of scientific transdisciplinarity, not as a substitute for or logical complement to disciplinarity, but as an unalterable contradiction that maintains a dynamic equilibrium between different areas of cognition.

In a future transdisciplinary communication science (a "bridging" science) I see a number of fundamental research areas. The different communication potentialities in the context of various areas of being need to be clarified; this means making ap-

parent which communicative elements have to be realized in order to obtain a particular form of being—for instance, to elucidate what humans, as opposed to a less complex form of life, require in order to live. The correspondence between faulty communication and a living system's complexity must be determined, along with the specific communication malfunctions that can be observed. Finally, how do the different orders of communication cooperate in the human being? If we acknowledge that "the human being is the convergence point of several 'life' determinations" (Regine Kather), then we have to clarify not only what specific communication is at the levels of different living system (by analogy to the explicated potentials, abilities, and necessities to communicate), but also what constitutes essential communication—what communication should and should not be (potentiality), how it can be (ability), and how it must be (necessity), respectively.

Perhaps my intention can best be illuminated with the description of "the other" by Erich Przywara, a largely forgotten Jesuit theologian. On the occasion of the 30th day after his death in September 2002, Katharina Zechmeister, professor of fundamental theology at the University of Passau, wrote, "The other, the you, cannot be merely comprehended as a pleasant completion of the I.… The other can only be grasped and accepted as really the other precisely if his shocking foreignness pulls me out of my closeness and my certainties."[23] In my opinion this relationship applies as well to that between the natural and cultural sciences and between science and the arts.

NOTES AND REFERENCES

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3. Ibid., p. 29ff.
4. ZÄNKER, KURT S., Ed. 1991. Kommunikationsnetzwerke im Körper. Psychoneuroimmunologie—Aspekte einer neuen Wissenschaftsdisziplin. Heidelberg, p. 9.
5. WALLNER, FRITZ G. 1997. Aspekte eines Kulturwandels. Der Bedarf nach einem neuen Begriff des Wissens. *In* Fritz G. Wallner & Barbara Agnese, Von der Einheit des Wissens zur Vielfalt der Wissensformen, Wien, pp. 11–28. In this article the author describes the "Vienna Circle" as an unintended contribution to so-called "negative philosophy." As Wallner puts it (p. 18): "The 'Vienna Circle' has had different effects, as some admirers today would like to see. The Vienna Circle [unintentionally] showed what is not possible.… And the biggest achievement of the Vienna Circle is that those who conducted the examination did not expect to be unclear about what description means; that description of the world is an assumption that cannot be resolved in a logical sense. Description of the world is not possible, because one has to make random assumptions."
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7. TENBRUCK, FRIEDRICH H. 1984. Die unbewältigten Sozialwissenschaften oder Die Abschaffung des Menschen. Wien, Köln, Graz, p. 30ff.
8. A rather illustrative example for this is the development of field theory in the 19th century. See Ulrich Sexl, 1989, Was die Welt zusammenhält. Physik auf der Suche nach dem Bauplan der Natur. Frankfurt/Main, Berlin.
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10. MARKUS, MARK. 1999. Buchdruck und Erkenntnisverständnis. Salzburg. Even with theology, normally home and shelter for paradoxes, there are growing tendencies to make their religious doctrines logically consistent. Karl Rahner, one of the most influential theologians of the 20th century, pointed to this tendency when he said, "Christians are, despite their orthodox confession to the [paradox] holy trinity, on the whole, in their religious daily lives, consistently monotheistic. One can come to the conclusion that, if we would terminate the [logically inconsistent] doctrine of trinity as wrong, for most of our [modern] religious literature it would have nearly no effect at all." Der dreifaltige Gott als transzendenter Urgrund der Heilsgeschichte. *In* Mysterium Salutis II, Einsiedeln, 1976, p. 319ff. See also Gisbert Greshake, 1997, Der dreieine Gott. Eine trinitarische Theologie, Freiburg, p. 15.
11. BRENNER, "Eine einsame Stimme aus der Prägenomik-Ära," p. 32.
12. PIETSCHMANN, HERBERT. 2002. Eris & Eirene. Eine Anleitung zum Umgang mit Widersprüchen und Konflikten. Wien, p. 77ff.
13. In this respect Herbert Pietschmann notes: "… natural science does not confine itself to classifying the outside world or improving the situation of mankind in its environment; rather, science commands also the inner world (by disposing it), it decides what is good for the people, how they should live, what they should do." Das Ende des naturwissenschaftlichen Zeitalters, Wien, Hamburg, 1980, p. 180.
14. I would like to point to the fact that the notion of contradiction does not refer to a constructed logical paradox, such as the famous liar paradox. Much more, it discerns the phenomenological paradox that, similar to the constructed one, cannot be dissolved logically, but—and this is interesting—in contrast to the constructed paradox, it functions in reality. See Etienne Klein, Gespräche mit der Sphinx. Die Paradoxien in der Physik, Stuttgart, 1993; translation of "Conversations avec le sphinx. Les paradoxes en physique," Paris, 1991, pp. 23–30.
15. Materia; nonliving communication systems; Microorganisms, living communication systems of low complexity—e.g., bacteria, viruses); Plants/Animals/Organs, complex living communication systems without self-consciousness; Man/Human Beings, complex living communication systems with self-consciousness.
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20. Ibid., p. 13.
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22. See also Herbert Pietschmann, 1997, Limits of Specialization and Integrated Approaches. *In* A. Mizrahi, S. Fulder & N. Sheinman, Eds., Potentiating Health and the Crisis of the Immune System, New York, pp. 39–45; and Herbert Pietschmann, Die Notwendigkeit der Erweiterung des naturwissenschaftlichen Denkrahmens. *In* Alois Stacher, Ed., Ganzheitliche Krebstherapie, Wien, 2000, pp. 23–39.
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