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Maharishi Ayurveda: An Introduction to Recent Research

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Abstract

This article presents an overview of recent research on Maharishi Ayurveda, reviewing studies completed over the last two years at several medical research institutions. These studies support two principle themes of research. The first is that Maharishi Ayurveda rasayanans (herbal or mineral preparations designed to optimize health, promote longevity, and treat specific disorders) bring about physiological balance and biological integration. The second is that recent studies empirically validate the internal consistency of the theoretical framework of Maharishi Ayurveda, providing evidence that the diagnostic and therapeutic approach of Maharishi Ayurveda can be applied in multiple clinical settings and verified through scientific investigation.

INTRODUCTION

Maharishi Ayurveda is a complete science of health based on the classical Ayurvedic knowledge of ancient India, which has been brought to light in modern form by Maharishi Mahesh Yogi. It is a complete science of health in the sense that no aspect of life falls outside its scope. Containing both subjective and objective approaches to health, it deals with consciousness, psychology, physiology, behavior, and environment (Maharishi Mahesh Yogi, 1986, pp. 108-115). It simultaneously improves the health of both the individual and society, and views the two as interdependent (*Maharishi's Program to Create World Peace*, 1986, pp. 4-5; for a review of research please see Wallace, Fagan, & Pasco, 1988, in this issue.)

The main focus of Maharishi Ayurveda is the refinement and optimization of the physiology using a variety of measures that promote both resistance to disease and development of the full potential of the individual. This is described as a state of perfect health. Maharishi Ayurveda is primarily oriented toward prevention and includes techniques designed to increase the efficiency and balance of the physiology. As an effective and increasingly well-documented prevention strategy, it significantly reduces the need for remedial health procedures (Orme-Johnson, 1987), yet it also includes procedures for

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treatment and cure of a number of specific diseases, including chronic diseases and psychosomatic disorders which are refractory to conventional therapy. There is now growing scientific evidence that Maharishi Ayurveda is an important new source of prevention, health maintenance, and treatment programs with clinical applications in every medical specialty.

Although Ayurveda represents the most ancient science of health, developed in India thousands of years ago, it has been made newly available throughout the world beginning in 1980. Maharishi's revival and dissemination of this ancient Ayurvedic knowledge, known as Maharishi Ayurveda, has inspired a renewed interest in scientifically investigating the effectiveness of Ayurvedic procedures and has helped to initiate a major trend toward more natural means of health care.

The past ten years have seen a change in health perceptions and practices in the entire industrialized world. Health consumers are more conscious of stress as a real entity which has physiological and psychological implications in their own lives, and they are increasingly adopting lifestyles that permit them to maximize their state of health. Maharishi Ayurveda includes effective procedures for reducing and eliminating the deleterious effects of stress on the physiology. As such, it has risen to prominence as a major approach to health which is claiming worldwide attention.

Ayurveda comes from the ancient Vedic tradition of India. *Veda* is a Sanskrit term which means knowledge. According to Maharishi, the Vedic tradition brings out the knowledge, based on the experience of fully developed human consciousness, that consciousness itself is the fundamental reality of nature. In Maharishi's recent revitalization of Ayurveda, the primordial undifferentiated state of "pure consciousness"—which the ancient Vedic tradition understood to be the basis of all existence—is identified with the unified field of natural law described in unified quantum field theories of modern physics as the source of all force and matter fields in material creation (Maharishi Mahesh Yogi, 1986, pp. 24-29; Hagelin, 1987).

Ayurveda belongs to the area of Vedic knowledge known as *Upaveda*. According to Maharishi, *Upaveda* deals with that point of existence at which consciousness is transformed into matter. It contains the knowledge of how human consciousness, becoming fully established in the total potential of natural law structured in the unified field, brings the physiology into accord with all the laws of nature, and thus infuses balance and integration into all areas of physiological functioning.

The word Ayurveda comes from the Sanskrit root *ayu*, which means span of life. So Ayurveda, Maharishi emphasizes, means the knowledge of the whole span of life. Traditionally, Ayurveda is specifically intended to promote longevity, but there are also many ancient tomes dealing with the full spectrum of medical disciplines, including surgery, pediatrics, obstetrics, toxicology, internal medicine, and many other branches of medicine. Maharishi identifies the three most important ancient texts as *Caraka Samhita*, *Sushruta Samhita*, and *Vagbhata Samhita*. Making the knowledge in these texts available to contemporary medical practice required a great seer, a person of Maharishi's vision.

Much of the ancient medical wisdom of Ayurveda has been lost over time. Maharishi's restoration of Ayurveda is based on the Maharishi Technology of the Unified Field—a technology of consciousness which allows direct experience of the unified field of pure consciousness, and has been accomplished in collaboration with the most respected

Ayurvedic physicians of India. This completely modern, verifiable approach to Ayurveda is characterized by careful attention to the preservation of ancient principles which skilled Ayurvedic physicians found to be safe and effective. Maharishi asserts that the re-awakening of Ayurveda reflects the resurgence of the traditional values of life governed by natural law (Maharishi Mahesh Yogi, 1986).¹

The scientific and medical establishment has also shown a new interest in Ayurveda. The unique effectiveness of Ayurvedic procedures has resulted in a readiness among doctors to use this system in their daily practices. In the United States, the World Medical Association for Perfect Health—USA, and the American Association of Ayurvedic Medicine have a combined membership of 750 medical doctors. There is also growing interest among clinical investigators in documenting the benefits of this system for contemporary medical practice, and among laboratory-oriented researchers in discovering the mechanisms through which the different therapeutic techniques produce effects. Many of the results of the first two years of research into Maharishi Ayurveda are presented in the main body of this article.

The approach of modern empirical science has engendered many technological wonders in this century, which have been so captivating that appreciation for traditional approaches to medicine has declined. Practitioners have disregarded subjective means of gaining knowledge in favor of objective methods; traditional medical practices and expertise have been lost. Through Maharishi Ayurveda, the ancient medical knowledge is being rediscovered in a form in which it can be verified by modern methods of empirical research.

Over the past thirty years many physicians have become familiar with the Maharishi Technology of the Unified Field, especially the Transcendental Meditation (TM) and TM-Sidhi programs, and have been prescribing these practices to their patients as a means of reducing stress. These programs, Maharishi asserts, are the practical foundation of Maharishi Ayurveda. Over 350 scientific investigations into the benefits of the Transcendental Meditation program, carried out at medical research institutions throughout the world, have demonstrated that these techniques can have a profound impact in clinical settings, improving physical and mental health; reducing major risk factors for disease; alleviating a wide variety of clinical problems including psychosomatic disorders and chronic, degenerative diseases; reducing requirements for medical care; and reversing the detrimental effects of aging. A paper by Wallace, Fagan, and Pasco (1988) in this issue reviews this research in greater detail.

Although Maharishi has been the main source of the revival of this ancient knowledge, he himself gives credit to the eminent *vaidyas* (Ayurvedic physicians) who have been working with him to restore Ayurveda to its original purity and completeness. These include Dr. V.M. Dwivedi, Dr. B.D. Triguna, President of the All-India Ayurveda Congress, and Dr. Balraj Maharshi, the directors of the Maharishi World Center for Ayurveda in Maharishi Nagar, India, and of the Council of Vaidyas at the Maharishi World Center. The comprehensive understanding of the whole of Ayurveda which was necessary for the restoration that Maharishi undertook would have been impossible

¹ Maharishi has brought out the knowledge of Ayurveda in a number of medical conferences attended by both traditional Ayurvedic doctors and Western medical doctors. These conferences include the Assembly on Health and Longevity, January 1980, Seelisberg, Switzerland; the International Assembly on Vedic Science, November 1980 to April 1981, New Delhi, India; the World Assembly on Vedic Science, July to November, 1986, New Delhi; and the International Medical Conference on Maharishi Ayurveda, March-April, 1987, Maharishi World Center for Ayurveda, Maharishi Nagar, India.

without the collective knowledge and experience of these great physicians who have been the heirs of a long tradition of recorded as well as unrecorded medical knowledge.

RECENT RESEARCH ON MAHARISHI AYURVEDA

A primary purpose of recent research on Maharishi Ayurveda has been to empirically investigate the underlying consistency in the theoretical principles of Maharishi Ayurveda. This is in contrast to the previous research on other systems of traditional medicine, which has focused on isolated herbs and has sought to document particular clinical effects or mechanisms of action.

Scientists studying Maharishi Ayurveda have designed their research to investigate the underlying unity of Maharishi Ayurveda in its completeness. Recent research has looked not only at isolated herbs, but also at preparations consisting of several herbs, and even the effects of an entire set of different physiotherapeutic techniques such as the Maharishi Rejuvenation program.

The classical Ayurvedic texts contain very clear and detailed descriptions of effective remedies, including their contraindications and post-therapeutic follow-up prescriptions. Over 100 Western physicians have been trained in these techniques, and use them in their practices at Maharishi Ayurveda Medical Centers in different parts of the world, adapting literal descriptions found in the ancient texts to modern social and cultural circumstances. The experience of these medical doctors has proven that the more the treatment approaches the recommendations of the Council of Vaidyas at the Maharishi World Center for Ayurveda based on the classical texts, the more effective it proves to be (Rothenberg, 1987).

The immediate goal of this recent research on Maharishi Ayurveda has, therefore, been to investigate broader questions about Maharishi Ayurveda as a complete system of health, rather than attempting to modify or improve upon the Ayurvedic techniques. To this end, there has been a high degree of cooperation among investigators at various biomedical research institutions (see Appendix B for a list of institutions collaborating in research on Maharishi Ayurveda).

This article explores the theme of Maharishi Ayurveda as a complete health science from two perspectives:

- **Research Theme I:**

Maharishi Ayurveda *rasayanas* as mediators of balance and intelligence.

- **Research Theme II:**

Empirically validating the internal consistency of the theoretical framework of Maharishi Ayurveda.

This review is limited to the recent research on the physical aspects of Maharishi Ayurveda. We will not be considering the recent research on the Transcendental Meditation and TM-Sidhi programs, or the more recently introduced Psychophysiological Technique and Primordial Sound Technique, all of which are included in the Maharishi Ayurveda approach to health from the angle of consciousness. Three-hundred-and-fifty published research studies on the TM program have been summarized in a number of literature reviews (Wallace, 1986; Orme-Johnson & Farrow, 1977; Chalmers, Clements, Schenkluhn, & Weinless, in press; Blicher et al., 1980). This article also necessarily

omits many important recent papers on effects of Transcendental Meditation on health care utilization, prison rehabilitation, and social disorder, including three published within the past six months (Orme-Johnson, 1987; Bleick & Abrams, 1987; Dillbeck, Cavanaugh, Glenn, Orme-Johnson, & Mittlefehldt, 1987).

**RESEARCH THEME I:
MAHARISHI AYURVEDA RASAYANAS AS
MEDIATORS OF BALANCE AND INTELLIGENCE**

One of the most interesting tasks confronting researchers has been to investigate the concept of balance and intelligence in the herbal or mineral preparations (*rasayanas*) used in Maharishi Ayurveda.

The concept of biological information in modern science, for example as coded in DNA, has a counterpart in Maharishi Ayurveda. The principle of complementarity in Maharishi Ayurveda holds that the sequence of biological information as stored in plants and minerals corresponds to the sequence of biological information in the human physiology. Rasayana therapy utilizes this principle of complementarity to eliminate distortions and restore integrity to the flow of biological information and intelligence. Maharishi explains that rasayanas function like small "tuning forks" that impart the proper resonant frequency and thus restore balance to the system. To use another analogy, rasayanas can be seen as small packets of "software" that supply an essential program to restore integrity to the source code (Maharishi Mahesh Yogi, 1987).

When biological information is highly orderly and integrated, according to Maharishi Ayurveda, the result is physiological "balance"—a state in which the parts of the organism are functioning in an integrated and harmonious state of equilibrium, rendering the organism as a whole both flexible and stable (Maharishi Mahesh Yogi, 1986, pp. 108-115).

Although this theory is difficult to test using strictly objective criteria, recent data appear to indirectly confirm the theory. Workers in the field of medical botany have frequently postulated that if a plant is found to have multiple clinical effects (and multiple ligands for the most important membrane receptors) then the different substances may be interacting to create synergistic effects and minimize side-effects. In other words, the plant probably possesses a certain balancing property over and above the presence of a few principle active ingredients. Many medical botanists hold that this balancing effect is especially true for medicinal plants, many of which contain thousands of different bioactive substances. The ability of rasayanas to treat multiple diseases must be distinguished from that of isolated active ingredients which are used for multiple purposes (e.g., antihistamines are used to treat allergies, insomnia, colds, Parkinsonism, and motion sickness, but these uses all take advantage of the same anti-cholinergic side-effect).

At a meeting of the American Association of Ayurvedic Medicine in February 1987, in Lancaster, Massachusetts, several collaborating investigators at Maharishi International University's Institute for Ayurvedic Studies and other institutions agreed to examine one or two rasayanas as models of balanced preparations. The rasayanas would be studied from many different angles to determine whether multiple disorders could be treated with a single rasayana, and whether multiple ligands could be found. These

formulas are Maharishi Amrit Kalash and Maharishi Ayurveda Bhasma Rasayana. The description that follows represents the group's interim synthesis of these findings.

Maharishi Amrit Kalash

Maharishi Amrit Kalash is a traditional formulation consisting of nine plants indigenous to India. It is traditionally held to be useful in the prevention of illness, promotion of homeostasis or balance, and improvement of general well-being—including the promotion of higher states of consciousness which arise naturally in the course of human development based on increasingly integrated styles of psychophysiological functioning (see Wallace, Fagan, & Pasco, 1988). For this reason, initial studies on Maharishi Amrit Kalash have focused on immune and endocrine functioning, and measures of neurophysiological efficiency.

Drs. Dwivedi, Balraj Maharshi, and Triguna have described this ancient formula which brought about a high standard of health in the Vedic civilization thousands of years ago. The formula was lost, however, when the purity of Ayurvedic knowledge declined. In 1986, these foremost Ayurvedic physicians dedicated themselves to making Maharishi Amrit Kalash available once more.

The nine ingredients in Maharishi Amrit Kalash are: black musale (*Curculigo orchoides*, Gaertn.), Indian wild pepper (*Vitex trifolia*, L.), heart-leaved moonseed (*Tinospora cordifolia*, Miers.), Indian globe thistle (*Sphaeranthus indicus*, L.), butterfly pea (*Clitoria ternatea*, L.), licorice (*Glycyrrhiza glabra*), elephant creeper (*Argyreia speciosa* Sweet), *Vanda spatulatum*, Spreng., and *Gymnema aurantiacum*, Wall. mss.

In Vitro Studies on Maharishi Amrit Kalash

The initial reports of the clinical and pharmacological effects of Maharishi Amrit Kalash and Maharishi Ayurveda Bhasma Rasayana were the subject of talks given by investigators from four continents at two 1987 conferences of the American Association of Ayurvedic Medicine. Many of the talks focused on membrane receptors. Pharmacologists have identified sites on cell membranes, called receptors, to which small molecules, called *ligands*, such as hormones, neurotransmitters, and peptides can bind. Each molecule has a specific conformation and functions like a small key, fitting into the receptor site and activating another enzymatic reaction to produce its effect. It is widely held that many drugs and herbs act by fitting into the receptor site of naturally occurring hormones or neurotransmitters (called endogenous ligands), thus either inhibiting or mimicking their effects.

Hari M. Sharma (1987), Professor and Director of the Division of Anatomic Pathology at the Ohio State University College of Medicine, and his colleagues have found binding of Maharishi Amrit Kalash to opioid (naloxone) receptors in rat brain neuron membranes. The existence of endogenous opioids has been known since 1974, and they have since been found to modulate a large number of physiological processes, especially in the brain and digestive system, including pain perception. The finding is also of importance in light of the growing appreciation of the importance of opioid receptors on tumor cells.

Dr. Sharma's team noticed effects of Maharishi Amrit Kalash on the prevention of platelet aggregation. Platelets are small cells which circulate in the blood and cluster

together to adhere to injured areas in the interior lining of arteries, thereby plugging the site of hemorrhage and promoting clot formation. This phenomenon also occurs abnormally under a variety of stresses, and may trigger heart attacks, strokes, and other vascular disease by inducing both vascular occlusion and spasm in the critical coronary or cerebral arteries.

Further, Sharma and his colleagues noted binding of Maharishi Amrit Kalash to the adenosin diphosphate (ADP) receptors on platelet membranes which are critical to platelet aggregation. It may be that this binding to the ADP receptor is related to the effect of Maharishi Amrit Kalash on platelet aggregation.

Sharma's team has also found ligands in Maharishi Amrit Kalash to brain and eye tissue catecholamine receptors in experimental animals. These receptors are the predominant neurotransmitters in the sympathetic nervous system. This may help explain the reports below which describe effects of Maharishi Amrit Kalash on the functioning of the central nervous system and on the immune system.

T. Hauser, Dr. R.K. Wallace, and Dr. K.G. Walton of the Institute for Ayurvedic Studies at Maharishi International University (MIU) report that Maharishi Amrit Kalash bound with high affinity to 100% of the platelet imipramine receptors (Hauser, Wallace, & Walton, 1987). The drug imipramine has a pronounced anti-depressant effect, and binds to receptors on brain, platelet, and other cell membranes. Although there is no known endogenous ligand corresponding to imipramine, it is widely held that a naturally occurring molecule must exist which is specific for imipramine receptors and which may be responsible for mood states. There has been a concerted effort on the part of neuroscientists for the past 15 years to isolate and identify the endogenous ligand for imipramine receptors because of its important implications for the treatment of depression.

Hauser, Wallace, and Walton point out that it is highly unusual to find either botanical or chemical substances that bind to the imipramine receptor with such high affinity. Their findings are therefore encouraging in the search for an endogenous ligand, in the sense that identifying a naturally occurring *botanical* ligand to the imipramine receptor may make it easier to identify the endogenous *human* ligand. These studies by Sharma's group and the MIU group indicate that Maharishi Amrit Kalash appears to contain ligands for every receptor tested to date: ADP, endorphin, catecholamine, and imipramine receptors.

The presence of such a wide variety of ligands suggests that the preparation may be acting on a wide variety of tissues through a number of different mechanisms. This finding is not unexpected. Every plant contains thousands of various alkaloids, steroids, flavinoids, terpinoids and other molecules with bioactivity, and Maharishi Ayurveda preparations may consist of many different plants. In addition, Maharishi Ayurveda usually uses the entire part of the plant, for example, the whole fruit or leaf, and not just one constituent. It is therefore easy to see how Maharishi Amrit Kalash may contain many ligands.

Many rasayanas are recommended on the basis of *constitutional type*. In Maharishi Ayurveda, every individual can be categorized into one of several different body types, depending on his or her physiological and psychological characteristics. These characteristics determine how a person will respond to various foods, climates, activities, and food supplements or rasayanas (Sharma & Dash, 1976). (See description of constitutional types below.) The finding of many different types of ligands within one preparation

might explain the traditional use of Maharishi Amrit Kalash by individuals with any psychophysiological constitutional type. It may be that Maharishi Amrit Kalash is appropriate for anyone because it has the appropriate balance of ligands and other molecules. Previous research has shown that individuals with different constitutional types have different balances of neurotransmitters in the peripheral blood (Singh, Singh, & Udupa, 1980).

The presence of so many naturally occurring ligands in one preparation suggests that the preparations are balanced in the sense described above. Pharmaceutical companies invest a great deal of time and resources carefully manipulating the formulas of various remedies, to enhance the desired effect while minimizing side-effects. In the case of Maharishi Ayurveda rasayanas, this balancing is carried out by nature. To a botanical pharmacologist or phytochemist, the finding of such a wide variety of ligands to mammalian cell membrane receptors suggests an intimate relationship between plants and mammal neurochemistry, and is indicative of the elegance, beauty, and harmony in nature.

Human and Animal Studies on Maharishi Amrit Kalash

The findings discussed so far represent only the *in vitro* (test tube) research on Maharishi Amrit Kalash. A number of *in vivo* (animal and human studies) also support the concept that Maharishi Amrit Kalash brings about general balance in the physiology. Sharma and his colleagues have recently finished a series of experiments in mice showing that feeding Maharishi Amrit Kalash increases the immune response and prevents chemically-induced cancer (H. Sharma, 1987, personal communication). These studies will be presented by Dr. Sharma at the Federation of American Societies for Experimental Biology in Las Vegas in May, 1988.

Improvement of neurophysiological efficiency with Maharishi Amrit Kalash. The hypothesis that Maharishi Amrit Kalash improves neurophysiological efficiency has been supported by recent research on human volunteers (Gelderloos et al., 1988). The study evaluated the performance of healthy, normal men on a test of discriminatory vision, which is closely related with aging. (The ability to discriminate within the peripheral visual fields declines in older subjects.) The test also measures neural performance since it depends on delicate information processing in both peripheral and central areas of the nervous system.

Two groups totalling 48 men over 35 years of age were matched for age, education, and length of time practicing the Transcendental Meditation technique, and were randomly assigned to receive either Maharishi Amrit Kalash or a placebo which was closely matched in appearance and taste with the experimental tablets. The design was double blind.

The subjects participated in three testing sessions: pretest baseline, after three weeks, and after six weeks. The stimuli consisted of fields of "X's" with one "V" at different places in the visual field on different presentations. Stimuli were presented for 350 milliseconds in a three-channel tachistoscope and subjects were required to identify precisely where in the visual field the "V" appeared. A repeated measurement ANCOVA, with the pretest scores as covariates, showed that the Maharishi Amrit Kalash group had greater improvements on both the three- and six-week tests ($F=4.25$; $df= 1, 45$; $p<.05$).

Principal investigator Dr. Paul Gelderloos explains that this test requires the subject to maintain a stable, quiet inner awareness with a continuous, unrestricted flow of outward attention, so that the entire visual field is monitored and fine details can be

discerned at the same time. He notes that Ayurveda describes this ability as one of the fundamental qualities of fully developed human awareness.

Gelderloos suggests that Maharishi Amrit Kalash may have a significant influence on the nervous system as a whole, since the unrestricted attention that is required for a high performance on this task involves many areas of the brain. That these results were gained over such a short period of time, he believes, holds great promise for the long-term effects of Maharishi Amrit Kalash.

The subjects taking Maharishi Amrit Kalash also had significantly fewer health problems during the six-week experimental period. Stored frozen serum samples are currently being analyzed for biochemical changes induced by the intervention. Frozen serum aliquots are available to interested investigators.

Effects of Maharishi Amrit Kalash on allergies. Maharishi Amrit Kalash may also prove to be a significant modulator of immune functioning. As part of a series of pilot studies on the rasayana conducted by the Institute for Ayurvedic Studies, seasonal allergic rhinitis sufferers taking Maharishi Amrit Kalash tablets twice daily were found to have improved symptoms of seasonal allergies. A prospective, double-blind and placebo-controlled trial was conducted during the spring allergy season, May 14 to June 18, 1987 (Glaser, Wallace, & Robinson, 1987). The principal variable in the study was the symptoms of allergy as measured by a daily diary developed at Johns Hopkins (Norman, 1971) which measures the duration of the principal rhinitis symptoms: sneezing; stuffy and/or runny nose; red, itchy, watery eyes; coughing; and use of medication. This diary is one of the most commonly used measures of allergy patients' response to intervention.

Fifty-four subjects chosen from an applicant pool of 180 volunteers suffering from vernal allergic rhinitis were pair-matched by age, gender, medications used, and severity of symptoms during a one-week baseline period, and then randomly assigned to either the experimental or placebo group. Analysis of the data showed significant mean differences between the matched pairs ($p < .05$) for the first three experimental weeks. By the fourth week, since both groups were improving at the end of the grass pollen season, the differences were less ($p = .07$).

We hypothesize from this study that Maharishi Amrit Kalash functions as an immune modulator not simply by enhancing the immune response, but by reducing the inappropriate response of the immune system to non-threatening stimuli such as pollen, thus conserving immune reserve and heightening immune sensitivity and responsivity. These results could be acting on many different aspects of the immune system: humoral, cellular, or even on immune regulators such as steroids or other factors. The current study supports this hypothesis, since Maharishi Amrit Kalash appears both to strengthen some aspects of the immune system and to suppress others, in the case of the pollen hypersensitivity of these allergy patients.

General health improvements through Maharishi Amrit Kalash. One of the most striking examples of how Maharishi Amrit Kalash brings about balance comes from a prospective study of the subjective effects of the substance on current users (Glaser & Moriarty, in preparation). Questionnaires on general health were mailed to 500 individuals who had ordered Maharishi Amrit Kalash before they began to take the rasayana. There was a 78% response rate, and all responders were mailed a second questionnaire 60 days after they received their one- or two-month supply of tablets. Of these

55% returned the second questionnaire, giving a complete response rate of 43%.

Significant increases were found in psychological well-being ($p < .03$) and alertness during daily activity ($p < .03$). In addition, there were significant improvements in individuals who regularly experienced a great diversity of common disorders. These included headaches ($p < .01$), backaches ($p < .01$), sinus congestion ($p < .01$), difficulty digesting meals ($p < .01$), underweight ($p < .01$), and anxiety ($p < .03$). During the two months subjects took Maharishi Amrit Kalash they had fewer colds than during the previous two months (.39), $p < .01$.

These improvements in such a wide variety of areas of general health, and in so many different physiological systems, imply that Maharishi Amrit Kalash must be acting on an extremely basic level to produce its effects. This study strongly supports the hypothesis that Maharishi Amrit Kalash increases physiological balance on many levels.

Maharishi Ayurveda Bhasma Rasayana

In addition to the work underway, there has been a great deal of interest in another ancient formula, Maharishi Ayurveda Bhasma Rasayana. This preparation was developed from ancient Ayurvedic texts by Dr. Dwivedi, the most renowned expert in the preparation of rasayanas. This rasayana has only begun to be studied in the past two years. Its active ingredients and mode of action have not yet been determined, and its exact composition is currently under analysis by the Institute for Ayurvedic Studies at MIU. In addition to containing mineral constituents, the rasayana contains extracts of the fruit of *emblica officinalis*.

Classic Ayurvedic texts describe Maharishi Ayurveda Bhasma Rasayana as having general positive effects on the immune system and tissue repair mechanisms. It is traditionally reputed to be one of the most effective Ayurvedic approaches to minimizing or reversing the detrimental effects of the aging process, being claimed to have protective effects against tissue, organ and organ system pathology associated with aging (Sharma & Dash, 1976, part 6). For this reason, initial research has focused on defining the effects of this rasayana on immune- and age-related pathology in laboratory animals, including cancer, atherogenesis, and experimentally-induced deficits in learning and memory.

A number of studies on this rasayana are currently underway at several institutions. These studies were inspired by promising findings with Maharishi Ayurveda Bhasma Rasayana in studies conducted by Dr. Tony Nader at MIT, using rat models of age-related pathology, which are described in the next section.

Maharishi Ayurveda Bhasma Rasayana: Its safety and effectiveness in animal models of diet-induced tissue damage, in brain lesions and in chemically-induced cancer lesions. Nader tested the safety and effectiveness of Maharishi Ayurveda Bhasma Rasayana; the mixture was supplied by Dr. Dwivedi.

Its mutagenic potential was first tested with the AMES test, in collaboration with Dr. P. Wuerzner, Nestle Biological Research Laboratories, Switzerland, and it was given orally for three weeks to two species of mammals, rats, and hamsters, at a dose of 20 gm/kg (20 times the per kg dose used in humans) to test it for toxicity. This was done in collaboration with Drs. P. Neuberne and G. Schneider at MIT. Animals were observed for behavioral changes and complete autopsies were performed at the end of the test

period. The AMES test showed the mixture to have no mutagenic potential, and no toxic effects were detected in either animal behavior or in gross or microscopic examination.

Three models were used to test the effectiveness of the mixture. The first experiment was done in collaboration with Dr. P. Neuberne and D. Bueche at MIT. In a blind controlled design, 20 weanling rats were put on a low-choline, low-methionine, high-fat diet known to cause liver, kidney and cardiovascular damage. The experimental group consisted of 10 of these rats which had Maharishi Ayurveda Bhasma Rasayana 20 gm/kg body weight (20 times the per kg dose used in humans) mixed with their diet. Complete autopsies were performed after 30 days; microscopic pathology was assessed by two experimenters independently on a scale of 0 to 4. In 8 rats that died in the first six days of the experiment, the typical 4+ hemorrhagic kidney and 1-3+ liver pathology was seen. In the other rats, significantly less pathology was seen in kidneys (1.1) and livers (2.4) of animals on Maharishi Ayurveda Bhasma Rasayana when compared to control kidneys (2.8) and livers (3.3). No pathology was seen in any of the other organs in both groups. Biochemical analysis of Maharishi Ayurveda Bhasma Rasayana showed insignificant amounts of choline or methionine.

The second experiment, with the same collaborators, was also performed in a blind, controlled design. Dimethyl-hydrazine (30 mg/kg) was given to 20 rats in five divided doses known to cause colon cancer in rats. Ten of these rats had Maharishi Ayurveda Bhasma Rasayana (5 gm/kg) added to their diet. The rats were observed for a period of 6 months, after which autopsies were performed and gross and microscopic pathology of the colon assessed. There were 30-40% fewer cancer lesions in the rats receiving Maharishi Ayurveda Bhasma Rasayana as compared to controls.

Nader conducted his third experiment in collaboration with Dr. J. Ramirez, MIT. Four groups of 6 rats each were trained to run a Y maze and then had microscopic entorhinal cortical lesions produced with a stereotactic device to cause learning deficits. The rats were then retrained to run the maze and the number of errors and the time to reach criterion were computed. Each group received one of the following treatments: saline, gangliosides, Maharishi Ayurveda Bhasma Rasayana until the time of surgery, or Maharishi Ayurveda Bhasma Rasayana until the end of the experiment. The only significant difference among the 4 groups was in the group that received Maharishi Ayurveda Bhasma Rasayana until the end of the experiment: there were fewer errors and the time to reach criterion was shortened.

Nader concludes that Maharishi Ayurveda Bhasma Rasayana has protective effects against kidney and liver damage produced by a low lipotrope, high fat diet. He believes it may have protective effects against dimethyl-hydrazine induced colon cancer and may help recovery from nerve damage (Nader, 1987; Nader, Bueche, & Neuberne, 1987).

Because of Dr. Nader's initial findings on the prophylactic effect of the Maharishi Ayurveda Bhasma Rasayana on chemically induced carcinoma, researchers asked another question: do Maharishi Ayurveda Rasayanas have cancer chemotherapeutic action? Preliminary studies on Maharishi Ayurveda Bhasma Rasayana conducted by researchers at several medical research institutions have shown cytotoxicity against a number of malignant cell lines.

Effects of Maharishi Ayurveda Bhasma Rasayana on human neuroblastoma cells and transformed lymphocytes. In the fall of 1987, one group found that Dr. Dwivedi's preparation inhibited human neuroblastoma cells in culture. The

inhibitory effect was proportional to the concentration of rasayana. The same rasayana did not appear to have inhibitory effects on normal human bone marrow in preliminary studies. The team is currently extending its studies to other cell lines, including normal cells and melanomas, and is investigating the influence of the rasayana on cancer cell differentiation. Meanwhile, in a pilot study, another group has noted inhibitory effects against a line of transformed lymphocytes. The MIU Institute for Ayurvedic Studies is now making samples of this rasayana available to interested investigators.

Conclusion to Research Theme I

The results of the research on these two rasayanas confirm that rasayanas have clinical effects on multiple disorders, suggesting that they act by strengthening the immune system and restoring balance in the physiology. Since Maharishi Amrit Kalash has been shown to have many different ligands, this reaffirms the importance of using the whole plant in accordance with the descriptions of the classical Ayurvedic texts to produce a balanced effect in the whole physiology. In contrast to this comprehensive approach of Maharishi Ayurveda, modern science focuses its attention on identifying the *active ingredient*, which frequently acts on an isolated aspect of the physiology and therefore often produces unwanted side effects.

The research presented here has used modern scientific methods to bring to light the inherent balance and intelligence in the relationship between plants and man without resorting to a reductionistic approach that fragments the balance in nature and treats symptoms rather than the underlying causes of disease. There is great promise in this approach for the future treatment of the major diseases of the latter half of this century, the chronic degenerative diseases. These diseases tend not to respond to a simple "magic bullet" like antibiotics, but require an intervention that has more fundamental systemic effects.

RESEARCH THEME II: EMPIRICALLY VALIDATING THE INTERNAL CONSISTENCY OF THE THEORETICAL FRAMEWORK OF MAHARISHI AYURVEDA

The research on Maharishi Ayurveda differs from other research programs in traditional medicine in that the design of the overall research effort is planned to test the integrity and internal consistency of the medical system as a whole. The collaborative work completed to date strongly suggests that the descriptions of human physiology and disease processes, prevention, and cure contained in the ancient texts provide a useful and valid approach to the effective treatment of disease and preservation of health.

According to classical descriptions in ancient Ayurvedic texts, different individuals have different mental and physical characteristics (Sharma & Dash, 1976). They receive health recommendations based upon their own constitutional type, known as one's *prakriti* (nature). There are three primary *prakriti* categories, which are determined by unique methods of Ayurvedic examination of mental and physical characteristics. These types are known as *vata*, *pitta*, and *kapha prakriti*.

With respect to personality or mental characteristics, *vata* type individuals have a tendency toward being sharp and quick, but when imbalance is present they may demonstrate unsteadiness of mind and anxiety. *Pitta* types tend to be warm and extroverted;

however, when imbalance arises they may show anger or hostility. Kapha types have good memories and tend toward stability; but imbalances may bring out a tendency toward dullness (Sharma & Dash, 1976).

Studies on Maharishi Ayurveda Tridosha Theory

Several studies have examined this theory of Maharishi Ayurveda, which is known as *tridosha* theory, referring to the three *doshas*, or impurities, that result from imbalance in the relation or amount of vata, pitta, and kapha in the individual constitution. The studies test the validity of constitutional typing, and the relevance of this system to modern clinical practice.

Correlation of subjective preferences, cognitive styles, and behavior with physiognomy according to principles of Maharishi Ayurveda tridosha theory. A study by Glaser (1987) investigated the traditional method of diagnosis used in Maharishi Ayurveda. Ninety-five healthy male graduate students age 26 to 48 were scored on a standardized subjective history and an objective physical examination by two independent investigators, according to Maharishi Ayurveda diagnostic principles. A technician asked each patient 17 questions pertaining to his individual subjective preferences, cognitive style, and behavior. These included questions relating to food preferences and eating habits; patterns of memory, fear, and coping mechanisms; working and learning speed; and sleep, dream, and digestive patterns.

A different examiner experienced in Maharishi Ayurveda examined each subject according to traditional Maharishi Ayurveda diagnostic methods and scored each subject on 23 objective physical criteria, including skin color, texture, and markings; qualities of sclerae, orbits, teeth, joints, veins, tendons, and hair; body physiognomy; and qualities of the radial pulse. Each response or physical sign was judged to correspond to one of the three principle dosha prakritis (vata, pitta, or kapha).

Glaser found significant positive correlation between subjective and objective scores for both vata and kapha prakriti ($r=.458$ and $.304$ respectively, $p < .05$). The correlation for pitta was insignificant ($.134$). Objective scores for vata prakriti were highly correlated with vata subjective patterns in 8 of the 17 subjective categories.

These results support the internal consistency of Maharishi Ayurveda tridosha theory. They are important since tridosha theory also describes the relationships between specific constitutional traits, behavior, and vulnerabilities to disease. One implication is that certain clinical signs and symptoms which formerly were considered insignificant or irrelevant may be of clinical importance, since Maharishi Ayurveda prescribes specific preventive regimens for the different constitutional types. Further research is needed to correlate dosha prakriti type with various disorders, immune tissue typing (histocompatibility), lipoprotein patterns, risk for common serious disorders such as cancer and coronary disease, and other relevant preventive factors.

Physiological and psychological correlates of Maharishi Ayurveda psychosomatic types. Another study, by Schneider, Wallace, Kasture, Averbach, and Robinson (1985), investigated possible physiological and psychological correlates of the three main Maharishi Ayurveda psychosomatic types, each of which, as noted above, has predicted qualities and clinical characteristics.

Subjects were evaluated for Maharishi Ayurveda psychosomatic type by standardized clinical protocol. In Study 1, 37 subjects were administered the Jenkins Activity Survey (JAS) for Type A behavior. In Study 2, 110 subjects had blood sampled for a battery of hematological and biochemical parameters. The results showed that high pitta subjects scored significantly higher on Type A behavior ($p < .04$), while high kapha subjects demonstrated higher Type B scores ($p < .04$).

In the second study, hemoglobin and hematocrit levels were higher in the pitta group ($p < .03$), while the kapha group had a higher mean white blood cell count ($p = .05$). Total protein and albumin was higher in kapha and pitta and lower in vata type ($p = .01$ and $.05$). Significant differences were also found between psychosomatic types in uric acid, calcium, creatinine, and BUN (all p 's $< .05$).

Kapha types had higher blood lipids (cholesterol [$p < .04$] and triglycerides). Blood lipids tended to be lower in pitta and vata types. These findings correlated with predictions of Maharishi Ayurveda, since kapha types are predicted to have higher body lipid, and may benefit from decreasing their intake of unctuous (oily) foods, while vata types are classically held to benefit from a more unctuous diet.

Dr. Schneider and his colleagues state that these physiological and psychological results are generally consistent with predictions of classical Ayurveda and may have clinical utility in accounting for individual predisposition to disease and responses to therapy.

The findings are especially interesting in light of the work of a group in India, who found that different neurotransmitters predominated in the peripheral blood of individuals with different constitutional types. Kapha types had elevated histamine, vata types had elevated acetylcholine, and pitta types had elevated catecholamines. This pattern was consistent with predictions based on a modern understanding of the roles of these different neurotransmitters (Singh, Singh, & Udupa, 1980).

Another way Maharishi Ayurveda can be tested is by investigating whether therapeutic programs described in the ancient texts give the predicted results. Examples of this are given below.

Improvements in memory, intelligence, psychomotor speed, and alertness in normal subjects from an Ayurvedic medicinal herbal-based rejuvenal therapy. A study by Chandler, Orme-Johnson, Dillbeck, & Glaser (1987) examined cognitive performance in 43 healthy male volunteers to determine the intervention effects of the Maharishi Rejuvenation program, a systematic set of physiological purification procedures designed to prevent illness and promote mental and physical health. Subjects were blind to the research design and were randomly assigned to treatment or control groups. They completed matched pre- and posttest versions of a cognitive test battery that included Raven's Advanced Progressive Matrices, digit-span forwards, verbal memory, visual memory, and visual and verbal speed-accuracy tasks. Posttesting occurred two weeks after experimental subjects completed a standardized 7-day treatment program. Analyses of covariance revealed that the experimental group scored higher at posttest than the control group on principal components associated with general intelligence, short-term memory, and long-term memory (all p 's $< .05$). No difference was apparent on a speed component. Treatment subjects also reported higher subjective alertness ($p < .05$). The results are consistent with classical Ayurvedic theory and are relevant to modern theory that emphasizes the relationship between physiological and cognitive functioning.

Improvements in mental and physical health with the Maharishi Ayurveda Panchakarma Program. A study by Schneider, Kasture, Rothenberg, Averbach, Cavanaugh, Robinson, and Wallace (1985) assessed the effects of the Maharishi Ayurveda Panchakarma program on mental health and physical health symptoms.

In Study 1, 62 consecutive subjects were tested with a standard psychological test, the Profile of Mood States, before and after a 1-2 week Maharishi Ayurveda Panchakarma program, and compared to 71 controls participating only in a didactic class on Maharishi Ayurveda. In Study 2, 142 subjects were surveyed before and after Maharishi Ayurveda Panchakarma for health symptom changes and compared to 60 control subjects participating only in the class over the same time period. In both studies, the treatment program consisted of traditional physical therapies and elimination procedures.

The results showed that the actively-treated, Maharishi Ayurveda subjects demonstrated improved mental health characterized by significant reductions in negative moods (including anxiety, depression, fatigue, and confusion) and increased vigor.

Schneider's group also found that the Maharishi Ayurveda subjects showed significantly greater physical improvements in energy/vitality, well-being, strength/stamina, appetite and digestive patterns, previous complaints generally, rejuvenation, and youthfulness than control subjects ($p = .05$ to $<.0001$).

These findings suggest that the Maharishi Ayurveda Panchakarma treatment is associated with improvements in mental and physical health. The authors hold that this treatment program appears to be highly relevant to national needs for prevention and health promotion.

Electroencephalographic (EEG) studies on Maharishi Ayurveda Shirodara.

In 1986, Dr. Alaric Arenander and colleagues investigated through electroencephalographic (EEG) studies the influence on brain activity of the *shirodara* procedure, a part of the Maharishi Ayurveda Panchakarma program (Arenander, personal communication, July 1986). Shirodara, in which warm, herbalized oil is poured on the forehead, is prescribed for alleviating both neurological and psychological disorders, and is nearly universally reported by individuals undergoing the procedure to be extremely relaxing and soothing.

Arenander's group found EEG patterns that suggest a coexistence of two different styles of neurophysiological functioning. First, they found high levels of frontal coherence, which are usually seen only during the Transcendental Meditation technique, when the mind is in its least excited state yet is completely alert (Banquet & Sailhan, 1974; Badawi, Wallace, Orme-Johnson, & Rouzeré, 1984; Hebert & Lehmann, 1977). They also noted a significant, unexpected level of coherence in the beta frequency, between the parietal areas of the brain. Beta activity is usually associated with excited states of mental activity. Thus it was interesting that these two usually exclusive states were found coexisting in all the subjects during the shirodara procedure, suggesting an integrated state of awareness consistent with classical descriptions of higher states of consciousness. This further suggests that Maharishi Ayurveda shirodara may be beneficial for improving neurophysiological function, particularly patterns of brain activity which would support experiences and benefits of higher states of consciousness.

Studies test Ayurvedic prevention techniques for skin and mouth. Sesame oil is the primary ingredient in traditional Ayurvedic procedures for preventive care of the skin and mouth. Reductions in bacterial colony counts were found in scrapings taken from the sulcus between the tooth and gum in healthy dental technicians who performed

daily morning mouthwash according to the routines prescribed by Maharishi Ayurveda (Smith & Stevens, 1988).

Dr. Smith has also found a reduced bacterial colony count in touch plates taken from the skin in men who performed another preventive technique prescribed in the Maharishi Ayurveda daily routine: morning sesame oil massage prior to shower. The reduced bacterial count suggests that the skin is more effective in resisting infection. Dr. Smith hypothesizes that linoleic acid, which comprises 40% of the fatty acids in sesame oil, may be metabolized into a natural anti-bacterial agent by the skin. He reports that sesame oil by itself does not appear to have endogenous anti-bacterial properties (personal communication, March 1988).

CONCLUSION

This perspective on recent research on Maharishi Ayurveda has examined two themes: that Maharishi Ayurveda rasayanas are mediators of balance and intelligence in the physiology, and that Maharishi Ayurveda is internally consistent. The initial results tend to confirm these themes. Maharishi's revival of ancient Ayurveda in the context of contemporary research methods offers a new outlook on health and clinical practice which has implications for all aspects of health care delivery. The increasing momentum of interest among scientists and physicians in investigating Maharishi Ayurveda and presenting it to the medical community in the language of modern science guarantees that it will soon enter the mainstream of modern medical practice.

APPENDIX A

CURRENT MAHARISHI AYURVEDA RESEARCH PROJECTS

Studies at Biomedical Research Institutions Other than Maharishi International University

Any scientist interested in learning more about the design or methods involved in these projects should contact the Institute for Ayurvedic Studies at Maharishi International University. For a list of institutional affiliations of scientists collaborating with the Institute of Ayurvedic Studies, see Appendix B.

In Vitro Studies

Effect of Maharishi Amrit Kalash on lymphocyte transformation and T-lymphocyte natural killer activity in 3 groups: normal patients, AIDS patients, and immunocompromised cancer patients.

Screen for ability of Maharishi Ayurveda rasayanas to prevent T cell infection with AIDS virus.

Effect of Maharishi Ayurveda rasayanas on cultures of the HIV (AIDS) retrovirus. HIV virus reactivity of lymphocytes and monocytes from healthy individuals administered rasayanas.

- Assay of the ability of Maharishi Ayurveda rasayanans to induce gamma interferon from human lymphocytes.
- Automated in vitro screen of cancer chemotherapeutic effects of Maharishi Ayurveda rasayanans using a variety of cell lines including carcinoma of colon, lung and breast.
- Direct anti-tumor effect of Maharishi Amrit Kalash with selectivity distinguishing anti-cancer activity from cell toxicity.
- Effect of Maharishi Ayurveda rasayanans as enhancers of immune response to tumor, using flow-cytometer-fractionated samples of whole blood cells (natural killer lymphocytes, granulocytes, etc.).
- Measurement of the affinity of Maharishi Amrit Kalash for the naloxone (opioid) receptor on brain neurons and peripheral blood lymphocytes
- Whole blood test for effect of Maharishi Amrit Kalash on platelet aggregation with and without thromboxane/prostacycline.

Animal Studies

- Effect of Maharishi Amrit Kalash on life span, age-related performance, and stress in senescent rats.
- Effect of Maharishi Ayurveda rasayanans on delayed hypersensitivity, natural killer activity, and other immune parameters in rats.
- Effect of Maharishi Amrit Kalash pre-treatment on isoproterenol-induced myocardial infarction in rats.
- Effect of Maharishi Amrit Kalash on DMBA-induced mammary gland carcinoma in rats.
- Prevention of atherogenesis by Maharishi Ayurveda rasayanans versus other prophylactic regimens in genetically hyperlipidemic rabbits.

Human Studies

- Assay of thymosin alpha-1 and other thymic hormones in healthy subjects taking Maharishi Amrit Kalash.
- Effect of the Maharishi Ayurveda Panchakarma (purification and rejuvenation) program on blood lipids.
- Assay of immunoglobulins, lipids and liver enzymes in subjects taking Maharishi Amrit Kalash.
- Hypersensitivity-related serological assays in allergic subjects taking Ayurvedic immune modulators.
- Assay of serum dehydroepiandrosterone sulfate, Cortisol, and thyroxine in healthy subjects taking Maharishi Ayurveda rasayanans.
- Alpha-1 acid glycoprotein levels in subjects taking Maharishi Amrit Kalash.
- Double-blind study of effect of Maharishi Ayurveda rasayanans on a standardized clinical scale of cognition and memory in nursing home residents.
- Double-blind study of Maharishi Amrit Kalash versus placebo in improving rehabilitation of young patients with major neurological trauma or hemiplegia.
- Effect of Maharishi Amrit Kalash as an adjunct to the management of AIDS.
- Randomized controlled study of severely depressed or psychotic patients using a special Ayurvedic psychiatric protocol (including herbs, diet, patient education, behavioral treatments, etc.), versus standard psychiatric protocol.

Current Maharishi Ayurveda Research Studies at MIU

- R. Keith Wallace, Ph.D., J. Glaser, M.D., K. Walton, Ph.D., P. Tomlinson, M.A., C. Barker, T. Hauser:
1. Mitogen response and natural killer activity of lymphocytes with Maharishi Ayurveda rasayanas.
 2. Human platelet and lymphocyte receptors for plant alkaloids.
 3. Human neurotransmitter analogs of botanical principles.
- R. Schneider, M.D.: Effect of Maharishi Amrit Kalash on hypertension.
- P. Gelderloos, Ph.D., S. Löliger: Correlation of urinary neurotransmitter metabolites and subjective measures of well-being in subjects taking Maharishi Amrit Kalash.
- B. Guthrie, Ph.D.: Nutritional assessment of women following an Ayurvedic diet for specific constitutional type, correlating with lipid profile and trace elements.
- J. Fagan, Ph.D., D. Pasco, Ph.D.: Effect of Ayurvedic rasayanas on gene regulation and tumor cell growth.
- D.E. Smith, M.D.: Studies of Maharishi Ayurveda purification procedures (panchakarma) including effect of sesame oil and ghee (clarified butter) on skin and mouth bacterial flora and naturally occurring antibacterial lipids; effects of oleation therapy (*snehana*) on blood lipids.
- B. Boyer, Ph.D., P. Gelderloos, Ph.D., J. Glaser, M.D.: EEG effects of Maharishi Ayurveda primordial sound and Gandharva Veda music therapy.

APPENDIX B

**INSTITUTIONAL AFFILIATIONS OF SCIENTISTS
COLLABORATING WITH THE INSTITUTE OF AYURVEDIC STUDIES
AT MAHARISHI INTERNATIONAL UNIVERSITY**

National Cancer Institute, Bethesda, MD
Ohio State University Medical College, Dayton, OH
University of Colorado Health Science Center, Denver, CO
MIT, Cambridge, MA
UCLA, Los Angeles, CA
Orentreich Foundation for the Advancement of Science, New York, NY
University of Manitoba School of Medicine, Winnipeg, Manitoba, Canada
American Cyanamid, Ramapo, NJ
Akbar Clinic, Panama City, FL
State University of New York at Stonybrook School of Medicine, Long Island, NY
Private nursing home in Los Angeles, CA
George Washington University School of Medicine, Washington, DC
University of Guelph, Ontario, Canada
Hilltop Rehabilitation Center, Grand Junction, CO
Hines VA Hospital, Hines, IL
Triton Biosciences, Inc., Tarrytown, NY
University of Texas School of Medicine, Dallas, TX
Houston Ayurvedic Research Center, Houston, TX

University of Montreal School of Medicine, Quebec, Canada
 Louisiana State University School of Medicine, New Orleans, LA
 Roswell Center Laboratories, Buffalo, NY
 University of Otago Medical School, Dunedin, New Zealand

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