

The Neuro-Aesthetics of Rasa: A Study of Hormonal Correlates in Odia Literature

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Abstract: The foundation of Indian aesthetics is '*Rasa*', which awakens a transcendent, almost divine bliss in the human mind through the mediums of literature and art. Although there has been extensive discussion on *Rasa* in the realm of literature, there has been little to no comprehensive exploration of the complex scientific relationship between *Rasa* and the human body's endocrine system and neuroscience. This work offers a detailed analysis of how the *Nabarasa* (nine *Rasas*) described by Acharya Bharata Muni in his ancient treatise, the *Nāṭyaśāstra*, parallels and aligns with modern psychology and the emerging field of neuroaesthetics. It examines how the reading or aesthetic appreciation of Odia literature triggers the release of various hormones and neurotransmitters in the brain—such as dopamine (the hormone of motivation and pleasure), oxytocin (the hormone of love and bonding), serotonin (the hormone of calm and well-being), and cortisol (the stress hormone)—and how these biochemical agents regulate our emotions. These connections have been substantiated through numerous experimental studies. Furthermore, the physical responses generated by literary reading—such as *nāndanik śiharāṇa* (aesthetic goosebumps)—profoundly influence the body's biochemical processes and the autonomic nervous system. The primary objective of this research is to evaluate the practical dimensions of *Rasa* by drawing upon the timeless masterpieces of Odia literature while demonstrating how imaginative and fictional literature functions as a natural therapeutic tool for stress relief, the cultivation of empathy, and the overall enhancement of mental health.

Keywords: *Nabarasa, Neuroscience and Hormones: The Interrelationship of Emotion, Aesthetic Chills, and Psychology in Odia Literature, Neural Impact and Brain Regions, Physical Effects.*

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I. INTRODUCTION

Literature is not merely a lifeless collection of words and sentences; rather, it is a vibrant portrayal of human emotions and sensibilities. In Indian literary theory, this emotional experience is known as '*Rasa*', which elevates human consciousness to a higher and more sublime level (Pradhan-2018; Udgata-1978). In ancient times, the *Rasa* of literature was viewed purely from a spiritual and philosophical perspective, and it was regarded as the sibling of *Brahmānanda* (the bliss of ultimate reality). However, modern neuroscience and psychology have conclusively demonstrated that literary *Rasa* has a direct and profound connection with the body's biochemical processes and hormones (Sangwan-2024). When a reader engages with a deeply moving story or poem or watches a play on stage, multiple hormones and neurotransmitters are released from the endocrine glands in their brain. For instance, while experiencing *Śṅgāra Rasa* (erotic/romantic sentiment) in literature, the brain releases the love hormone oxytocin. In contrast, the depiction of *Bīra Rasa* (heroic sentiment) unexpectedly increases the level of adrenal hormones

(Sangwan-2024; Beld-2018; Mraz-2024). The present essay provides a detailed scientific analysis of the theoretical aspects of *Rasa* and its physical and psychological effects, drawing particularly upon the rich heritage of Odia literature. This study clearly establishes that literature functions like a medicine in fostering empathy, revitalizing memory, and significantly reducing mental stress (Kanczkowski, 2024).

II. RASA AND NEUROSCIENCE

A comparative study of Indian aesthetics and modern neuroscience reveals that Acharya Bharata Muni's *Nāṭyaśāstra* is not merely a treatise on drama or literature but a profoundly scientific document on human psychology that remains relevant even today (Pradhan-2018; Singh-2025). According to the famous sutra of the *Natyashastra*—"*Bibhābānubhāba Byābhicārī Saṃyogād Rasa Nīpattih*"—*Rasa* is manifested through the harmonious combination of *Bibhāba* (stimuli or determinants), *Anubhāba* (physical reactions), and *Byābhicārī Bhāba* (transitory emotions) (Pradhan-2018; Acharya-1964; Das-2004). In the human

subconscious mind, various emotions remain in a latent state, which Bharata calls *Sthāibhāba* (permanent emotions) (Pradhan-2018; Udgata-1978; Singh-2025). Modern neuroscience identifies these *Sthāibhābas* with neural responses linked to the brain's 'emotion center' (amygdala), 'memory center' (hippocampus), and the overall 'emotional system' known as the limbic system (Hansen-2022; Fenz-2025). When a literary situation acts as a stimulus or *Bibhāba*, these regions of the brain become activated and awaken the dormant *Sthāibhābas* (Pradhan-2018; Udgata-1978).

During literary reading, the brain's Default Mode Network (DMN) becomes particularly active (Tamir-2016; Ghosson-2025). This special network governs human imagination, memory, and especially the theory of mind. Through the theory of mind, a reader can perceive and experience the mental states, intentions, and sufferings of the fictional characters from their own perspective (Tamir-2016; Schindler-2017). Furthermore, research suggests that the core concept of Indian poetics—Universalization—is largely made possible by the brain's Mirror Neuron System (MNS) (Singh-2025; Beermann-2021). Mirror neurons form a sophisticated neural network that fires in much the same electrochemical pattern whether we ourselves perform an action, witness someone else performing it, or even read about it in a story (Patel, 2024; Ramaprasad, 2013). As a result, an empathetic reader of literature temporarily transcends their own selfish ego and completely immerses themselves in the emotions of the poetic characters (Singh-2025).

In the rich tradition of Oḍiā literature, the extensive application of the *Nabarasa* (nine *Rasas*) is clearly evident. Each *Rasa* is responsible for triggering distinct hormonal secretions in the reader's body (Acharya-1964; Das-2004; Sangwan-2024). For instance, the supreme examples of *Śṛṅgāra Rasa* (romantic love and attraction) can be found in Kābisamrāta Upendra Bhañja's '*Lābanyabatī*' and Abhimanyu Sāmanta Singhāra's '*Bidagdha Cintāmañi*' (Pradhan-2018; Udgata-1978). The unparalleled beauty of description, ornate imagery, and the portrayal of union and separation of the hero and heroine in these works activate the mesolimbic reward pathway in the reader's brain, leading to a significant release of oxytocin (the love hormone), dopamine (the pleasure and motivation hormone), and estrogen (the feminine chemical messenger). Oxytocin enhances feelings of attraction, trust, and emotional intimacy between individuals (Sangwan, 2024; Fenz, 2025).

Hāsyā Rasa (comic sentiment) is not merely an emotion but a powerful medicine for the body (Acharya-1964; Das-2004). It increases the secretion of serotonin (the calmness hormone), endorphins (natural painkillers), and dopamine in the brain (Pradhan-2018; Sangwan-2024; Fenz-2025). This process blocks stress pathways while activating pleasure centers, resulting in mental relief, peace, and joy. It also helps strengthen the body's immune system (Pradhan-2018; Fenz-2025; Kanczkowski-2024).

Similarly, *Karuṇā Rasa* (pathetic or compassionate sentiment) liberates human beings from selfish worldly interests and immerses them in an ocean of compassion and empathy. When one reads Fakirmohan Senapati's short story '*Rebatī*' or Gangadhar Meher's poem '*Tapasvinī*', the heart-wrenching cries of *Rebatī* or *Sītā* spontaneously bring tears to the reader's eyes (Udgata-1978; Samal-1990; Patnaik-1988). From a neuroscientific perspective, *Karuṇā Rasa* rapidly increases the levels of prolactin and oxytocin in the brain, which awaken empathy and transform mental pain and suffering into sublime aesthetic pleasure (Sanjana-n.d.). During this process, the left angular gyrus and the medial temporal lobe become active, linking semantic language processing with deep emotional experience (Tamir, 2016).

The war scenes depicted in Ādikabi Sāraḷā Dās's '*Mahābhārata*' and Bhaktacaraṇā Dās's '*Mathurāmaṅgaḷa*', as well as Godābariśa Mohapatra's '*Uṭha Kamkāḷa*' from the Satyabādī era, evoke unparalleled feelings of patriotism, *Bīra Rasa* (heroic sentiment), and *Rōdra Rasa* (furious sentiment) (Mohanty-1965; Pradhan-2018). These emotions stimulate the sympathetic nervous system, triggering the release of adrenaline, noradrenaline, and testosterone. As a result, blood circulation accelerates, muscles gain strength, and the body experiences an extraordinary surge of enthusiasm and courage (Sangwan-2024; Beld-2018).

Within the limbic system, the amygdala serves as the primary center for processing fear (Ressler, 2010; Kanczkowski, 2024). It can be described as the body's "anxiety switch," which activates instantly upon perceiving danger (Gruber, 2019; Kanczkowski, 2024). During the experience of *Bhayānaka Rasa* (the terrible or fearful sentiment), the central nucleus (CeA) and lateral nucleus (LA) of the amygdala play critical roles. This leads to increased heart rate, rapid breathing, and muscle tension (Pradhan-2018). The feeling of fear is primarily governed by stress hormones. In *Bhayānaka Rasa*, the Hypothalamic-Pituitary-Adrenal (HPA) axis becomes activated (Sangwan-2024; Peléšková-2024; Kanczkowski-2024). Simultaneously, the adrenal medulla releases epinephrine (adrenaline), norepinephrine, and cortisol. These hormones prepare the body for immediate action, heighten alertness, regulate blood flow, and ready the organism for prolonged threats (Kanczkowski-2024; Ross-2021; Munshi-2025). High levels of these hormones create a state of hyper-arousal, producing physical manifestations typical of fear *Rasa*, such as trembling, dryness of the mouth, and profuse sweating (Das, 2004; Pradhan, 2018; Sangwan, 2024).

The fundamental emotion of *Bibhatsa Rasa* (disgust) is *Jugupsā* (repulsion). This *Rasa* arises from the perception or contact with anything unpleasant, impure, or repulsive (Acharya-1964; Das-2004; Pradhan-2018). According to brain science, disgust is not merely a social emotion but part of the human behavioural immune system, whose primary purpose is to protect the body from infection and parasites (Peléšková-2024; Sangwan-2024). During the experience of this *Rasa*, the insula region of the brain becomes highly active. The insula is responsible for interoception—the perception of the body's internal state (Vaisvaser-2026).

Activation of the anterior insula during disgust produces a sensation of nausea (Khanna, 2022). This is entirely different from fear because it prepares the body to avoid harm. Unlike fear, which increases heart rate with low dopamine, disgust is a “quiet” yet profound emotion. During *Bibhatsa Rasa*, parasympathetic activity may cause heart rate deceleration, which helps conserve bodily energy (Peléšková-2024). Gastrointestinal hormones associated with the digestive system are also activated, prompting the body to expel potentially toxic substances (Peléšková-2024; Sangwan-2024).

The permanent emotion (*Sthāibhāba*) of *Adbhuta Rasa* (the marvelous or wondrous sentiment) is ‘*Bismaya*’ (wonder or astonishment). It is a mental state that arises upon witnessing something extraordinary, unprecedented, or supernatural (Pradhan, 2018; Das, 2004). From the perspective of neuroscience, it is closely associated with epistemic curiosity. During the experience of *Adbhuta Rasa*, the prefrontal cortex (PFC) plays a pivotal role (Gruber-2019; Korniluk-2025). This region helps in analyzing complex information and making decisions. When we encounter something ‘wondrous,’ an information gap is created in the brain. To fill this gap, the prefrontal cortex generates heightened attention and focus (Gruber, 2019; Korniluk, 2025). The rostralateral prefrontal cortex (rIPFC)

and orbitofrontal cortex (OFC) regulate curiosity-driven behavior (Korniluk, 2025). At such moments, the brain processes unexpected information or ‘surprise’ and stores it effectively in memory (Gruber, 2019; Ligneul, 2018). This process is extremely important for learning and the development of new thought patterns. When we learn or witness something novel and astonishing, the ventral striatum releases dopamine and endorphins (Gruber-2019; Korniluk-2025). This produces a joyful experience, physical comfort, and relief from distress, which in turn makes us more eager to know more about the subject (Gruber-2019; Korniluk-2025; Pradhan-2018). Additionally, oxytocin—the ‘love hormone’—also aids in generating wonder. It enhances social bonding and mutual trust, thereby deepening the experience of collective wonder (Sangwan-2024; Fenz-2025).

On the other hand, the finest examples of *Śānta Rasa* (the peaceful sentiment) are found in Atibaḍi Jagannāth Dās’s *Oḍiā Bhāgabata* and saint-poet Bhīma Bhoi’s *Stuticintāmaṇi* (Pradhan-2018). *Śānta Rasa* significantly reduces stress hormones while increasing pain-relieving endorphins, the calming neurotransmitter GABA, and serotonin levels. It fully activates the parasympathetic nervous system, enabling a person to attain supreme peace and tranquility (Zehra-2025; Kanczkowski-2024).

Table-1: *Rasa, Sthāibhāba, Associated Hormones & Neurotransmitters, Neural Impact, and Examples from Oḍiā Literature.*

<i>Nabarasa & Sthāibhāba</i>	Main Hormones & Neurotransmitters	Neural Impact and Brain Regions	Examples from Oḍiā Literature
Śṛṅgāra (Rati)	Love hormone (Oxytocin), Dopamine (motivation & pleasure), Estrogen, Testosterone (Sangwan-2024)	Activation of the mesolimbic reward network; creation of empathy in the prefrontal cortex (Schoeller-2024; Sumpf-2015)	Upendra Bhanja’s <i>Lābanyavatī</i> and Premasudhānidhi; Sachi Routray’s <i>Bhānumatira Deśa</i> (Routray-1966; Mishra-1994)
Hāsyā (Hasa)	Serotonin (calmness), Endorphins (pain relief), Dopamine (Sangwan-2024)	Blocks stress pathways; activates pleasure centers	Batsā Dās’s <i>Kalasācautiśā</i> ; Brajnāth Baḍajenā’s <i>Rajanāṅku Chalokti</i> ; Baladeba Rath’s <i>Jagate Kebaḷa</i> and <i>Hāsyā Kalloḷa</i> ; Jadumani Mahapatra’s humorous poems; Fakirmohan Senapati’s <i>Patent Medicine</i> ; Phaturānanda’s <i>Famālocanā</i> ; Laxmikānta Mohapatra’s <i>Nilathā Kabi</i> (Raut-1982)
Karuṇā (Śoka)	Prolactin, Oxytocin, Reduced serotonin (Sangwan-2024)	Activation of the Amygdala and Medial Temporal Lobe (MTL); stimulation of self-reflection centers (Tamir-2016)	Radhanath Ray’s <i>Duryodhanāṅka Raktanadī Santaraṇa</i> ; Fakirmohan’s <i>Rebatī</i> and <i>Rāṅḍipua Anantā</i> ; Gangadhar Meher’s <i>Tapasvinī</i> and <i>Indumatī</i> (Patnaik-1977; Mohanty-1955; Samantaray-1964)
Rōdra (Krodha)	Adrenal hormones, Testosterone, Noradrenaline, Reduced serotonin (Sangwan-2024)	Intense stimulation of the sympathetic nervous system; activation of heart rate control centers (Sumpf-2015)	Sāraḷā Dās’s <i>Mahābhārata</i> (war scenes)
Bīra (Utsāha)	Dopamine, Adrenaline, Testosterone (Sangwan-2024)	Increased self-confidence; activation of alertness centers and Motor Cortex (Barth-2015; Orlandi-2025)	Sāraḷā Dās’s <i>Mahābhārata</i> ; Godābariś Mohapatra’s poem <i>Uṭha Kaṅkāḷa</i> (Mohanty-1965)
Bhayānaka (Bhaya)	High levels of stress hormones (Cortisol), Adrenaline, Noradrenaline (Sangwan-2024)	Full activation of the Amygdala (Fight or Flight response) (Barth-2015; Orlandi-2025)	Sāraḷā Dās’s <i>Mahābhārata</i> (Gada Parva); Pitāambar Dās’s <i>Nṛsimha Purāṇa a</i> (bloody narratives) (Mohanty-1995)
Bibhatsa (Jugupsā)	Gut-related hormones, Low dopamine (Sangwan-2024)	Intense activation of the Insula; sensation of nausea	Sāraḷā Dās’s <i>Mahābhārata</i> (<i>Gadā Parva</i>); Pitāambar Dās’s <i>Nṛsimha Purāṇa</i> ; Kānhu Charaṅ

		(Barth-2015; Orlandi-2025)	Mohanty's <i>HāAnna</i> ; Pratibhā Rāy's <i>Magnamāṭi</i> (descriptions of impurity, filth, and cremation)
<i>Adbhuta (Bismaya)</i>	Dopamine, Oxytocin (Sangwan-2024)	Increased curiosity and attention; information integration in the Prefrontal Cortex (Tamir-2016)	Upendra Bhanja's <i>Subhadra Pariṇaya</i> ; Rādhānāth Ray's <i>Chilikā</i> and <i>Mahayātrā</i> (nature descriptions)
<i>Śānta (Śama)</i>	GABA, Serotonin, Reduced cortisol (Zehra-2025; Kanczkowski-2024)	Activation of the parasympathetic nervous system; regulation of blood pressure; balancing of the Default Mode Network (Tamir-2016)	Atibaḍi Jagannāth Dās's <i>Oḍiā Bhāgaāata</i> ; Bhīma Bhoi's <i>Chautiśā</i> and <i>Stuticintāmaṇi</i>

III. PHYSICAL EFFECTS

Literature reading does not merely influence a person's inner emotional world; it also exerts a profound effect on external bodily functions and biological responses. When a reader becomes completely immersed in an engaging poem or novel, they enter a unique mental state that modern psychology terms the "flow state" (Singh-2025; Schindler-2017). In Indian aesthetics and yogic philosophy, this state is compared to "Ekāgratā" (one-pointed concentration) or "Samādhi." Neuroimaging studies and neuroscientists have demonstrated that during this state of deep concentration, there is temporary deactivation in the prefrontal cortex—a phenomenon known as "transient hypofrontality" (Singh-2025; Hartung-2020, 2021). In this condition, individuals lose their self-referential thinking, sense of time, and everyday anxieties. They become fully absorbed in the aesthetic experience, attaining a state akin to *Brahmānanda* (supreme bliss) (Singh, 2025). In this context, modern assessment tools such as the AESTHEMOS scale are used to evaluate literature-induced aesthetic emotions by dividing them into five key components: appraisal, physiological response, motivational tendency, expression, and subjective feeling (Beermann-2021; Hartung-2020, 2021).

At the pinnacle of the *Rasa* experience, the transcendent thrill that manifests in the reader's or viewer's body is termed "aesthetic chills" or "psychogenic shivers" in neuroscience (Schoeller-2024, 2025; Sumpf-2015). Extensive research using EEG, biofeedback, and heart rate monitoring has shown that during peak emotional moments in literature, the brain's mesocortical reward pathway becomes highly activated. This triggers a massive release of dopamine in the striatum, which, through the autonomic sympathetic nervous system, causes the piloerection of hair follicles—scientifically known as piloerection or goosebumps (Schoeller-2024, 2025; Sumpf-2015). Acārya Bharata Muni, the founder of literary theory, described these physical manifestations in the *Nāṭyaśāstra* as "Sāttvika Anubhāba" (involuntary physical responses)—including stupor (*stambha*), perspiration (*sveda*), horripilation (*romaṅca*), voice tremor (*svarabhāṅga*), trembling (*Bepathu*), change of color (*Bābarṇya*), tears (*aśru*), and fainting (*praḷaya*). These descriptions align remarkably with today's physiological and medical parameters (Singh-2025; Pradhan-2018).

Particularly during the arousal of *Karuṇa*, *Rōdra*, *Bīra*, or *Bhayānaka Rasas*, intense changes occur in the Autonomic Nervous System (ANS) (Wang-2018). Researchers have observed significant variations in heart rate (HR), Galvanic Skin Response (GSR), and respiratory frequency (Sumpf-2015). For example, reading heroic patriotic calls or terrifying descriptions causes adrenaline to surge into the bloodstream, rapidly increasing heart rate and elevating skin conductance due to muscle tension (Sumpf, 2015; Beld, 2018). Furthermore, based on Indian yogic psychology, the four primary modifications of the mind — *Pallabana* (expansion), *Bistāra* (spreading), *Kṣobha* (agitation), and *Bikṣepa* (distraction) — have been linked to specific *Rasas*. *Śṅgāra* and *Hāsyā Rasas* induce *Pallabana*, while *Bīra* and *Adbhūta Rasas* bring about *Bistāra* in the mind (Singh-2025).

The practical significance of the interplay between *Rasa* and hormones extends far beyond literary criticism. It has given rise to a new scientific discipline called "aesthetic endocrinology" (Gruber-2002; Borse-2025). Prolonged elevation of cortisol (the stress hormone) damages collagen-producing cells in the skin, disrupts endocrine balance, and accelerates premature aging and hair loss (Mraz-2024). In contrast, regular reading of *Rasa*-rich literature keeps the brain calm, dramatically reduces stress hormones, relaxes muscles, and slows the aging process (Schoeller, 2024, 2025). In modern psychotherapy, literature reading is increasingly prescribed as a complementary treatment — or "arts-based therapy" — for patients suffering from depression, anxiety, and Alzheimer's disease (Sanjana-n.d.).

Studies show that reading traditional paper books (as opposed to digital media) significantly reduces mental anxiety among college students and improves sleep quality (Liu Y.-2024). While neuroplasticity declines in Alzheimer's disease, the emotional *Rasa* of literature plays a powerful role in forming new synaptic connections and restoring hormonal flexibility (Barth-2015; Orlandi-2025). Ultimately, the emotional experience of literature provides a safe and non-violent medium for preserving mental balance. This concept, which Aristotle called "catharsis" in his *Poetics*, now stands firmly validated on neuroscientific and endocrinological grounds (Sanjana-n.d.).

The following **Table-2** provides a detailed and comparative overview of the physical symptoms, heart rate

patterns, and psychological processes associated with each mental state (*Mānasika Bṛtti*) and corresponding *Rasa*:

Table-2: Physical and Neurological Effects of *Rasa*

Mental State (Manasika Vritti)	Associated <i>Rasa</i>	Heart Rate	Galvanic Skin Response (GSR) / Skin Conductance	Respiration & Other Effects
Pallabana (Expansion)	<i>Śṛṅgāra, Hāsya</i> (Aesthetic chills & horripilation)	Moderate increase and stability	Sudden sharp increase due to intense emotional arousal (Boncsarovszki-2025)	Breathing becomes deep; produces goosebumps or aesthetic chills. Face glows due to dopamine release (Schoeller-2024; Sumpf-2015)
Bistāra (Spreading)	<i>Bīra, Adbhūta</i> (Sweating & Excitement)	High and rapid increase	High arousal with rapid changes in skin conductance, regulated by the Autonomic Nervous System (ANS) without conscious control (Boncsarovszki-2025)	Rapid breathing, muscle tension, sweating due to adrenal hormone surge (Sumpf-2015)
Bikṣepa (Distraction)	<i>Karuṇa, Bibhatsa</i> (Tears & Change in complexion)	Decrease or slowing	Moderate to high level of empathy and emotional sensitivity (Bartolomé-2020)	Breathing becomes slow and laboured; activation of lacrimal glands causes tears; pallor or change in facial complexion appears (Sangwan-2024)
Kṣobha (Agitation)	<i>Raūdra, Bhayānaka</i> (Trembling & Fear)	Extremely irregular and rapid	Highest level of GSR, indicating intense mental stress or fight-or-flight response (Kyriakou-2019)	Short and rapid breathing, trembling or shivering, elevated blood pressure along with increased stress hormones (Sangwan-2024)
Śama (Equilibrium)	<i>Śānta</i> (Stupor or Fainting)	Completely normal and balanced	Lowest GSR levels, indicating deep relaxation and restorative parasympathetic activity (Markiewicz-2022)	Very steady and slow breathing; body becomes still, often leading to a state of stupor; significant reduction in stress hormones (Sangwan-2024)

IV. CONCLUSION

A profound, logical, and scientifically robust connection exists between the *Nabarasa* described in ancient Indian poetics and the endocrine hormones of the human body as understood through modern neuroscience. The enjoyment of literary *Rasa* is not merely an imaginary or intellectual process at the ordinary mental level. Rather, it directly activates the brain's mirror neuron system and the default mode network, thereby stimulating key endocrine glands such as the pituitary. This results in transformative physical changes, including aesthetic chills, temporary alterations in heart rate, and a significant reduction in harmful stress hormones. The emotional depth embedded in the timeless creations of Oḍiā literature—from *Sāraḷā Dās's Mahābhārata* to the stories of Fakirmohan Senapati—has been scientifically validated as capable of bringing peace, emotional catharsis, and renewed vitality to both the reader's mind and body. It is hoped that in the coming years, interdisciplinary research combining advanced neuroimaging techniques such as fMRI with Oḍiā literature will open new and promising horizons. Such studies can contribute meaningfully to the treatment of mental health disorders and the advancement of positive psychology in society, offering a culturally rooted, holistic, and benevolent path toward human well-being.

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