

CHRONOBIOLOGICAL FOUNDATIONS IN CLASSICAL AYURVEDA: BRIDGING KALA-BHOJANA, DINACHARYA, RITUCHARYA, AND VEGA VIDHI WITH MOLECULAR EPIGENETICS AND CIRCADIAN BIOLOGY

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Article Received on 03 Sept. 2026,
Article Revised on 23 Sept. 2026,
Article Published on 01 October 2026,
<https://doi.org/10.5281/zenodo.23033550>

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How to cite this Article: ¹Dr. Suman Sarkar, ²*Dr. Mukesh Kumar (2026). Chronobiological Foundations in Classical Ayurveda: Bridging Kala-Bhojana, Dinacharya, Ritucharya, and Vega Vidhi with Molecular Epigenetics and Circadian Biology. World Journal of Pharmaceutical Research, 15(18), 320–333.

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ABSTRACT

Contemporary preventive care faces challenges from lifestyle-related disorders, metabolic syndromes, and stress-linked psychiatric conditions. Many of these issues stem from circadian misalignment and elevated allostatic load. Millennia before the discovery of transcription-translation loops, classical Ayurvedic texts (Charaka Samhita, Sushruta Samhita, and Ashtanga Hridaya) formulated an advanced chronobiological framework based on Dinacharya (daily routines), Ritucharya (seasonal routines), Kala-Bhojana Siddhanta (chrononutrition), and Vega Vidhi (impulse regulation). This paper provides an original, independent critical analysis bridging these classical frameworks with modern molecular biology and chronobiology. Specifically, we examine

- Kala-Bhojana Siddhanta alongside contemporary time-restricted feeding, focusing on peripheral metabolic

entrainment, AMP-activated protein kinase pathways, and sirtuin regulation.

- The mechanistic connections linking Dinacharya and Ritucharya to epigenetic modifications—exploring how behavioral entrainment regulates DNA methylation, histone acetylation, and non-coding RNA expression to support immunity and cellular proteostasis.

- By synthesizing classical Sanskrit science with modern empirical chronobiology, this review outlines an integrated, personalized framework for lifestyle medicine.

INTRODUCTION

Despite these insights, modern populations frequently experience circadian disruption driven by shift work, artificial lighting, irregular eating patterns, and sedentary behavior. This misalignment between internal pacemakers and daily habits contributes to metabolic dysfunction, chronic inflammation, and psychological distress.

Long before these molecular pathways were mapped, the authors of the classical Ayurvedic Brihatrayi developed an extensive preventive framework centered on temporal alignment. Ayurvedic physiology views the human micro-organism (Pinda) as a reflection of the macrocosmic environment (Brahmanda).

Yajurveda, Systemic health depends on the dynamic equilibrium of three bio-regulatory forces (Tridosha: Vata, Pitta, Kapha), structural tissues (Dhatu), and metabolic factors (Agni). These forces shift rhythmically across the diurnal cycle (Dinacharya), seasonal progression (Ritucharya), digestive stages (Avasthapaka), and human lifespan (Vaya).

Classical texts define Kala-Bhojana based on biological hunger and metabolic clearance rather than arbitrary social conventions:

— Bhavaprakasha, Purva Khanda, 5.143

Consuming food before the prior meal is digested (Adhyashana) leads to incomplete digestion (Ajrna) and the formation of Ama—an endotoxic intermediary byproduct.

Charaka Samhita, Vimanasthana, 2.9

Furthermore, Pitta Dosha—governing metabolism and enzymatic action—peaks around midday (Madhyahna, roughly 10:00 AM to 2:00 PM). Consequently, classical guidelines advise consuming the principal meal at midday when Jatharagni (gastrointestinal digestive fire) is strongest, while evening meals should be lighter and consumed early.

1.2) Modern Chrononutrition, Peripheral Clock Entrainment, and Fasting Biology Modern science confirms that while light cues entrain the central SCN(Supra Chiasmatic Nucleus) clock, peripheral metabolic clocks in organs like the liver, pancreas, and muscle are heavily entrained by feeding schedules.

When food intake aligns with daylight hours, peripheral clocks remain synchronized with the central pacemaker. Conversely, eating late at night or during the biological night causes circadian misalignment between peripheral organs and the central SCN.

Modern chrononutrition models share strong parallels with Kala-Bhojana

- Time-Restricted Eating (TRE): Limiting daily caloric intake to an 8- to 10-hour window, followed by a 14- to 16-hour fasting period.
- Early Time-Restricted Eating (eTRE): Shifting the daily feeding window to earlier hours of the day (e.g., finishing meals by late afternoon), avoiding caloric intake close to sleep.
- Cellular adaptations during the fasting window of Kala-Bhojana and TRE include:
 - AMPK and mTOR Signaling: Nutrient deprivation lowers glucose, insulin, and IGF-1, raising the cellular AMP/ATP ratio. This activates AMP-activated protein kinase (AMPK) and suppresses the mechanistic target of rapamycin (mTOR), shifting cellular focus from anabolism to repair.
 - Autophagy (Langhana): Ayurvedic practice emphasizes Langhana (depleting or lightening therapies) to clear metabolic toxins. At the cellular level, suppressed mTOR and active AMPK trigger ULK1 and TFEB, initiating autophagosome formation to clear dysfunctional proteins and damaged mitochondria (mitophagy).
 - Sirtuins and Mitochondrial Adaptation: Prolonged fasting depletes hepatic glycogen, shifts metabolism toward fatty acid beta-oxidation, and elevates ketone bodies. Increased cellular NAD⁺ levels activate sirtuins (SIRT1, SIRT3), which deacetylate targets like PGC-1 α , enhancing mitochondrial biogenesis and reducing oxidative stress.
 - Diurnal Insulin Sensitivity: Human insulin sensitivity peaks earlier in the day and drops during the biological night. Late-night meals coincide with high nocturnal melatonin release, which suppresses insulin secretion via MTNR1B receptors on pancreatic beta cells, resulting in prolonged postprandial hyperglycemia and impaired lipid clearance.

1.3) Comparative Analysis: Classical Principles vs. Modern Intermittent Fasting Protocols

Comparing classical Kala-Bhojana Siddhanta with modern intermittent fasting reveals several important distinctions:

- Circadian Placement: While modern TRE protocols often permit flexible fasting windows (e.g., noon to 8:00 PM), classical Ayurveda emphasizes solar alignment, requiring the main meal to coincide with midday Pitta dominance.

- **Individualized Approach:** Modern IF often applies uniform fasting intervals to diverse populations. In contrast, Ayurveda adjusts fasting protocols according to individual constitution (Prakriti) and digestive capacity (Agni). For instance, prolonged fasting can harm Vata-predominant individuals prone to tissue depletion, whereas it benefits Kapha-predominant individuals with sluggish digestion.
- **Biomarker Awareness:** Modern protocols rely heavily on rigid clock-based tracking, whereas Ayurveda emphasizes real-time physiological indicators, such as clear eructation (Udgara Shuddhi), lightness (Laghavata), true hunger (Kshut), and proper waste evacuation (Utsarga).
- **Substrate Quality:** While early IF models focused solely on caloric windows, Kala-Bhojana emphasizes that the quality (Guna), preparation (Karana), and biological compatibility (Satmya) of food are vital to prevent the generation of Ama.

Dinacharya, Ritucharya, and Molecular Epigenetics

2.1 Dinacharya: Diurnal Regimens and Molecular Synchronizers

Dinacharya is a structured behavioral system designed to optimize human physiology across the 24-hour day. The Brihatrayi divides the day into six distinct four-hour doshic phases.

- 06:00 to 10:00: Kapha phase (Anabolic activity, stability, mucosal dominance)
- 10:00 to 14:00: Pitta phase (Thermogenesis, metabolic transformation)
- 14:00 to 18:00: Vata phase (Kinetic signaling, nervous activity)
- 18:00 to 22:00: Kapha phase (Cellular consolidation, rest induction)
- 22:00 to 02:00: Pitta phase (Cellular repair, hepatic biotransformation)
- 02:00 to 06:00: Vata phase (Elimination cascades, cognitive lucidity)

Maintaining health requires aligning daily actions with these natural shifts.

A. Brahma Muhurta Jagrana (Pre-Dawn Awakening)

Classical texts recommend:

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☒ ☐ ☐ ☐ ☐ ☐ ☒ ☐

☐ ☐ ☐ ☐ ☐ ☐

Ashtanga Hridaya, Sutrasthana, 2.1

"A healthy person seeking longevity should wake during the Brahma Muhurta (the final hour and a half before sunrise.)"

B. Mukha Prakshalana, Gandusha, and Dantadhavana (Oral Hygiene)

C. Abhyanga (Cutaneous Mechanotransduction)

[illegible]

From a modern neurobiological standpoint, Abhyanga acts as a form of full-body mechanotherapy. Slow, rhythmic touch stimulates unmyelinated C-tactile mechanoreceptors in the skin, sending signals to the insular cortex that lower sympathetic activity and reduce circulating cortisol. Furthermore, transdermal absorption of plant lipids supports the epidermal lipid barrier and local cellular defense mechanisms.

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"Physical lightness, work capacity, stimulated digestion, fat reduction, and muscular definition result from exercise."

Exercise (Vyayama) is specifically advised during the early morning Kapha phase (06:00 to 10:00), limited to half of one's maximum capacity (Ardhashakti), signaled by light perspiration. Morning exercise acts as a powerful non-photic synchronizer, triggering muscle contraction-induced myokines (such as transient IL-6), AMPK activation, and increased brain-derived neurotrophic factor (BDNF) expression, which supports neuroplasticity and cognitive function.

2.2 Ritucharya: Seasonal Synchrony and Epigenetics

Ritucharya expands chronobiology across the annual cycle (Samvatsara), divided into two solstitial periods:

Adana Kala (Uttarayana): Encompassing Shishira (late winter), Vasanta (spring), and Grishma (summer), characterized by drying solar energy and diminishing physical strength (Bala).

Visarga Kala (Dakshinayana): Encompassing Varsha (monsoon), Sharada (autumn), and Hemanta (early winter), characterized by cooling conditions and restored physical strength.

Within this cycle, biological humors follow a predictable trajectory of accumulation (Chaya), aggravation (Kopa), and pacification (Prashama).

Spring (Vasanta): Kapha accumulated during cold months liquefies under warming spring sun, provoking Kapha Prakopa and dampening digestive fire. Management includes bitter/astringent foods, active exercise, and therapeutic cleansing (Vamana).

Autumn (Sharada): Post-monsoon heat provokes Pitta Prakopa, leading to inflammatory and skin conditions. Recommendations include cooling dietary adjustments and therapeutic elimination (Virechana).

The Epigenetic Bridge: Seasonal Environmental Signals and the Genome Epigenetics explains how seasonal cues—such as temperature, humidity, and photoperiod length—alter gene expression via DNA methylation, histone modifications, and non-coding RNAs without changing the underlying DNA sequence.

- Adjusting diet (Ahara) and lifestyle (Vihara) to seasonal changes helps prevent aberrant epigenetic drift, allowing Ritucharya to function as a framework for metabolic and immune homeostasis.

3.1) The Taxonomy of Human Urges in Ayurveda

- Adharaniya Vega: Somatic, physiological urges that must never be voluntarily suppressed.
- Dharaniya Vega: Destructive psychological and behavioral impulses that must be actively restrained through intellect and discipline.

Classical texts identify thirteen primary somatic urges that should never be repressed, including micturition, defecation, seminal emission, flatulence, vomiting, sneezing, eructation, yawning, hunger, thirst, tears, sleep, and physical exhaustion.

[illegible]

Charaka Samhita, Sutrasthana, 7.3-4

Physiological Impacts of Suppressing Key Urges

- ### 3.3) The Psychological Imperative: Dharaniya Vega and Mental Health

[illegible]

Charaka Samhita, Sutrasthana, 7.27-28

Failure to restrain these destructive mental impulses constitutes Prajnaparadha (intellectual error), which is considered the root cause of disease:

Charaka Samhita, Sharirasthana, 1.98

Neurobiological and Psychological Effects of Unchecked Impulses:

- Mindful restraint of Dharaniya Vega through intellect (Buddhi), willpower (Dhriti), and memory (Smriti) acts as a powerful behavioral therapy. Strengthening prefrontal cortical control over limbic structures reduces allostatic load, tempers systemic inflammation, and preserves cellular integrity.

Synthesizing Kala-Bhojana Siddhanta, Dinacharya, Ritucharya, and Vega Vidhi demonstrates that classical Ayurveda functioned as an advanced system of chronobiology and behavioral

epigenetics. Rather than viewing organs in isolation, the Brihatrayi framed human health as an integrated equilibrium connecting cellular metabolism with environmental rhythms.

Modern lifestyle medicine increasingly recognizes that chronic non-communicable diseases stem from circadian desynchrony, epigenetic mismatch, and chronic allostatic load. Classical chrononutrition (Kala-Bhojana) aligns directly with modern metabolic insights: timing food intake to coincide with midday metabolic peaks optimizes insulin sensitivity and digestion, while early evening fasting activates AMPK and cellular autophagy (Amapachana).

Similarly, Dinacharya acts as an environmental entrainment protocol. Practices such as early awakening, oral oil pulling, oil massage, and morning exercise serve as robust photic and non-photoc synchronizers that align peripheral clocks, support autonomic balance, and enhance endothelial health.

Seasonally, Ritucharya provides a framework for preventive epigenetics. Adapting diet and routines across solar solstices modulates DNA methylation and histone modifications, fine-tuning seasonal immune responses and protecting mucosal barrier integrity.

Finally, the regulation of urges (Vega Vidhi) establishes a comprehensive psychosomatic model: somatic reflexes must remain unimpeded to prevent autonomic dysfunction, whereas psychological impulses require conscious prefrontal oversight to prevent chronic stress and inflammation.

CONCLUSION

The chronobiological frameworks preserved within the Brihatrayi offer a robust model for lifestyle medicine. Concepts such as Kala-Bhojana Siddhanta, Dinacharya, Ritucharya, and Vega Vidhi anticipated modern discoveries in circadian biology, peripheral clock entrainment, autophagy, and neuroendocrine regulation.

Translating these classical principles into contemporary clinical protocols enables preventive medicine to move beyond single-target interventions toward a comprehensive chronomedical approach. Future research should prioritize clinical trials measuring epigenetic markers before and after standardized lifestyle routines, deep-phenotype metabolic studies of chrononutrition, and neurobiological evaluations of impulse regulation.

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