Academic Article

INTERNAL BIOTECHNOLOGY OF THE SELF: A PSYCHONEUROIMMUNOLOGICAL MODEL LINKING CONTEMPLATIVE PRACTICES TO MOLECULAR AGING

Phramaha Pattaradech Siripattanayan[1*], Phra Vajraphuttibundit Preeda Buamuang[1], Direk Nunklam[1], Pairat Chimhad[1], Pattarakorn Kongthep[2], Phra Thirapong Thiramanus[3]

[1]Faculty of Social Sciences, Mahachulalongkornrajavidyalaya University Nakhon Si Thammarat Campus, Nakhon Si Thammarat, Thailand

[2]Police General Hospital, Royal Thai Police, Bangkok, Thailand

[3]Dhammakaya Temple (Wat Phra Dhammakaya), Pathum Thani, Thailand

[*]Corresponding author E-mail: 6703104005@mcu.ac.th

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Abstract

Background: The relentless global pursuit of longevity has catalyzed profound advancements in biomedical sciences. However, a paradox remains: While the human lifespan has extended, the healthspan, the functional period of life spent in good health, has not kept pace. Contemporary gerontology largely operates within a materialist, reductionist paradigm, prioritizing "External Pharmacology" such as senolytics, gene editing, and stem cell therapies, to repair the cumulative cellular damage. However, this approach frequently treats aging organisms as purely mechanical entities, neglecting the significant impact of psychosocial stressors and existential distress on physiological decline. Current evidence in Psychoneuroimmunology (PNI) indicates that psychological states are not merely epiphenomena but potent drivers of biological aging processes through allostatic load and immunosenescence mechanisms. Specifically, chronic psychological stress, driven by maladaptive cognitive patterns, triggers the dysregulation of the Hypothalamic Pituitary Adrenal (HPA) axis and the Sympathetic Nervous System (SNS), leading to a systemic pro-inflammatory state known as "Inflammaging." Consequently, there is a critical need for integrative models that address the "Upstream" psychological causes of this "Downstream" cellular pathology to bridge the widening gap between biological longevity and existential well-being.

Involvement to Buddhadhamma: To address the critical gap between biological longevity and existential well-being, this article situates itself within the domain of Applied Buddhism, specifically focusing on Buddhist innovations in health science. We propose a novel framework termed "Internal Biotechnology," implemented through the methodology of "Buddhist Therapeutics." This approach reinterprets the classical "Threefold Training" (Tri-Sikkhā) not merely as religious praxis, but as a precise Buddhist innovation in bio-regulatory processes. The framework posits a causal transduction from mental cultivation to cellular resilience: 1) Morality (Sīla) functions as a behavioral regulation mechanism that reduces psychosocial stress exposure and prevents the onset of allostatic load by fostering social safety signals; 2) Concentration (Samādhi) acts as an autonomic regulation mechanism that enhances vagal tone and parasympathetic dominance,

inducing a physiological relaxation response that counteracts the catabolic effects of chronic sympathetic arousal; and 3) Wisdom (Paññā) serves as a cognitive regulation mechanism that alters the perception of stress through interoception and equanimity, effectively uncoupling the psychological experience of adversity from the physiological stress response. By systematically extinguishing the "Three Poisons" (Akusala Mūla, Greed, Hatred, and Delusion), this Applied Buddhism model demonstrates how the practitioner activates a "Restorative Metabolic Switch." This process downregulates chronic HPA axis activation and systemic "Inflammaging," while potentially upregulating restorative mechanisms, such as DNA repair, NAD+ conservation, and telomerase activity. Thus, this section elucidates how the cessation of mental defilements (Kilesa) translates into genomic stability, proposing a systematic methodology for human development that aligns with contemporary scientific needs.

Conclusions: This synthesis challenges the prevailing biocentric view of aging, suggesting that consciousness is a fundamental determinant of molecular vitality. Through the application of "Buddhist Therapeutics," this "Internal Biotechnology" framework offers a non-invasive, sustainable, and empowering modality for healthspan extension, shifting the paradigm from treating aging as inevitable decay to viewing it as a malleable process influenced by mental discipline. The integration of these disciplines suggests that longevity is not merely a matter of preserving the flesh through external intervention but is intrinsically linked to the cultivation of wisdom. By reframing spiritual development as a potent, autogenous biotechnology, this model offers a holistic roadmap for the 21st century, where the pursuit of Nirvana and the preservation of biological youthfulness converge into a unified science of human thriving.

Keywords: Internal Biotechnology, Buddhist Therapeutics, Psychoneuroimmunology, Epigenetic Aging, Contemplative Science

Introduction

Throughout history, the quest for longevity has spurred innovation across cultures, ranging from ancient alchemical elixirs to modern biotechnological ventures (Phramaha Wichit Akkhachito et al., 2022). In the 21st century, this aspiration has bifurcated into two distinct pathways. The prevailing biomedical paradigm predominantly focuses on "External Pharmacology," treating the aging organism as a mechanical entity requiring extrinsic repair through interventions such as senolytics and gene therapies (Covarrubias et al., 2021). While promising, this reductionist approach often overlooks the "Upstream" psychosocial drivers of physiological decline. This creates a critical gap in our understanding: How subjective consciousness influences objective cellular health. To address this, this article proposes a novel framework termed "Internal Biotechnology," implemented through the methodology of "Buddhist Therapeutics." Instead of viewing spiritual cultivation merely as a religious pursuit, we posit that the Threefold Training functions as a precise bio-regulatory system. This study hypothesizes that this "Autogenous Biotechnology" can mitigate "Inflammaging" by directly modulating the HPA axis and restoring cellular resilience, effectively bridging the divide between biological longevity and existential well-being.

In contrast, Buddhist teachings advocate for what can be understood as "Internal Pharmacology." Here, the goal is a fulfilling life culminating in the cessation of suffering (Nirvana), achieved by extinguishing the mental "Fires" of greed, anger, and delusion (Thanissaro Bhikkhu, 1993). This perspective aligns with the maxim: "Mind is The Forerunner... All Things Are Led by The Mind" (Phrabrahmagunabhorn (P. A. Payutto), 2016). Consequently, spiritual purification is not merely ritualistic but serves as primary medicine for well-being (Salguero, 2017). The alleviation of mental distress is posited not just as spiritual liberation but also as a physiological necessity for sustaining life.

This article proposes that the Buddhist path constitutes a profound "Autogenous Biotechnology" that can modulate molecular substrates. This hypothesis is grounded in Psychoneuroimmunology (PNI), which studies bidirectional communication between the mind, nervous system, and immune function. PNI provides a scientific basis for understanding how subjective mental states translate into objective cellular health. We propose a novel framework termed "Internal Biotechnology," implemented through a methodology we refer to as "Buddhist Therapeutics." This approach suggests that the mental cultivation of the Threefold Training (Tri-Sikkhā) directly counters "Inflammaging," the chronic, low-grade inflammation characteristic of aging. By systematically reducing the psychological "Three Poisons," one effectively reduces the biological "Fire" of inflammation, transforming the body from a vessel of stress into a vessel of resilience. This paper elaborates on the "Internal Biotechnology" framework, demonstrating how "Buddhist Therapeutics" reinterprets the Threefold Training not just as a path to spiritual enlightenment but as a systematic, non-pharmacological intervention for biological restructuring. We hypothesize that Threefold Training functions as an effective mechanism for mitigating "Inflammaging" by directly modulating the HPA axis and reducing cellular stress markers.

Biological Mechanisms of Senescence: Targets for Psychosocial Intervention

Recent shifts in medical aging research have moved beyond simple wear-and-tear theories to identify intricate biological pathways that are susceptible to intervention. This study delineates four major lines of inquiry aligned with Buddhist perspectives, demonstrating how mental states may influence one's physical destiny.

1. NAD+ Metabolism and Sirtuins

NAD+ (Nicotinamide Adenine Dinucleotide) is a crucial coenzyme found in all living cells that declines significantly with age, impairing the sirtuin protein family (SIRT1-7), often referred to as "Guardians of The Genome" (Covarrubias et al., 2021); (Imai & Guarente, 2016). Sirtuins require NAD+ to repair DNA and regulate cellular function. However, chronic inflammation upregulates enzymes such as CD38, which aggressively consume NAD+, creating a deficit that accelerates aging. While pharmacological restoration remains a subject of debate due to complexity and bioavailability issues, mind-body practices may offer a "Metabolic Switch." By reducing the metabolic demand of chronic stress responses, meditation may conserve the NAD+ pool, ensuring that energy is available for cellular repair rather than for fighting constant, low-level stress.

2. Epigenetic Clocks

"Biological Age," quantified by DNA methylation patterns, offers greater depth than chronological age. It measures the rate at which a person ages internally, independent of their birth year. Chronic stress accelerates the accumulation of these methylation markers, effectively advancing the "Horvath Clock" (Horvath, 2013). A landmark study by Chaix et al. (2017) demonstrated that meditation acts as a buffer against age-related acceleration. Importantly, this protective effect was dose-dependent on the total years of practice, and sporadic practice yielded fewer benefits than sustained discipline. This aligns with the Buddhist concept of bhāvanā (Cultivation), suggesting that benefits manifest through consistent, lifelong practice rather than immediate intervention.

3. Telomere Maintenance

Telomeres, the protective caps on chromosomes, shorten with each cell division, a process significantly accelerated by psychological stress and cortisol exposure (Blackburn et al., 2015). When telomeres become critically short, cells undergo senescence or apoptosis. Rigorous meta-analyses have indicated that meditation supports telomere length preservation by potentially enhancing telomerase activity (Hoge et al., 2013); (Dasanayaka et al., 2022); (Santosa et al., 2024). Crucially, these benefits are predominantly observed in long-term practitioners rather than novices in short-term trials. This supports the Threefold Training model, which prioritizes profound, sustained transformation over temporary symptom relief, suggesting that the "Biological Dividend" of practice compounds over decades of practice.

4. The Gut-Brain Axis

The gut-brain axis connects the central nervous system to the gastrointestinal microbiota and serves as a critical highway for immune signaling (Cryan et al., 2019). Long-term deep meditation has been shown to significantly alter microbial signatures, promoting diversity and reducing pathogenic bacteria (Sun et al., 2023). Conversely, psychological stress increases gut permeability (Leaky Gut), allowing toxins (Lipopolysaccharides) to enter the bloodstream and trigger systemic inflammation (Zannas et al., 2015). By calming the mind, practitioners may physically "Seal" the gut barrier and prevent this cascade of toxicity.

Summary: These four domains are interconnected through stress and inflammation. Chronic psychological stress activates the Hypothalamic Pituitary Adrenal (HPA) axis (Obeyesekere, 2002), elevating cortisol and driving "Inflammaging." This insidious inflammation depletes NAD+, disrupts the microbiome, and shortens the telomeres. Therefore, addressing the psychological roots of stress via Buddhist practice offers a unified therapeutic approach that targets the upstream cause rather than merely the downstream symptoms.

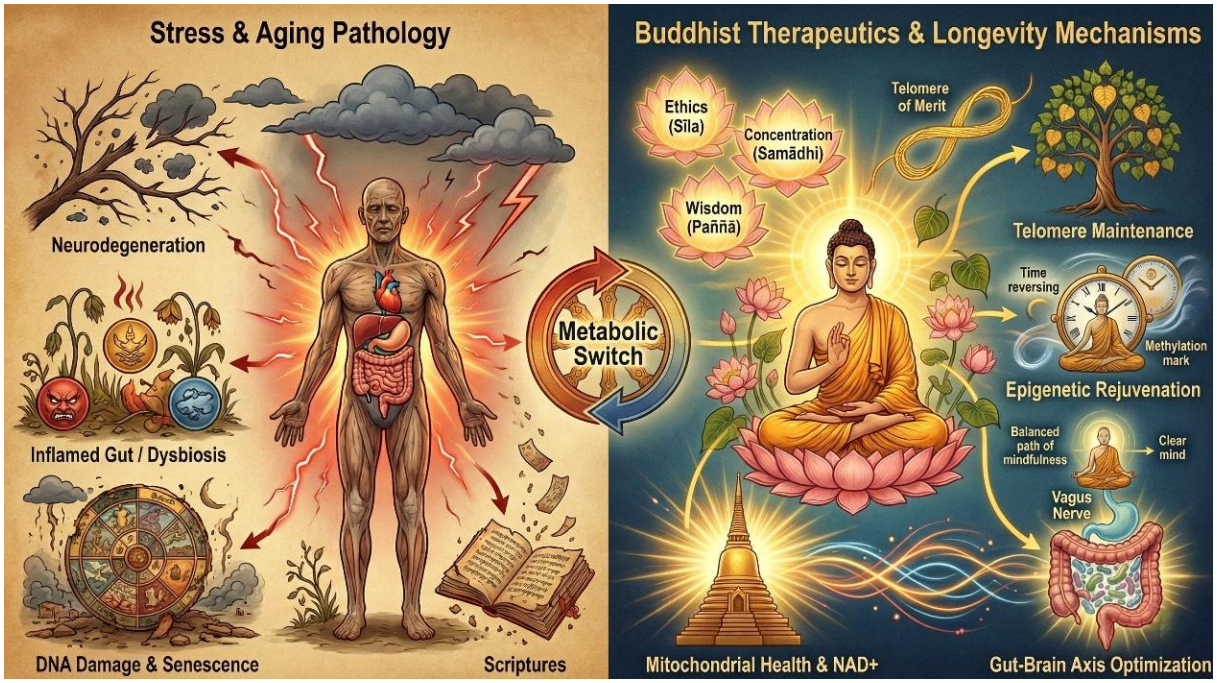

Figure 1 Foundations of Cellular Aging

In Figure 1 the Psychoneuroimmunological Transduction Model of Buddhist Therapeutics. This schematic illustrates the proposed "Internal Biotechnology" framework: 1) Threefold Training (Input): Sīla (Morality) reduces psychosocial stress exposure; Samādhi (Concentration) enhances vagal tone and parasympathetic dominance; and Paññā (Wisdom) facilitates cognitive reappraisal, uncoupling stress perception from physiological reactivity; 2) The Restorative Switch (Mechanism): These practices collectively downregulate the HPA axis (Cortisol) and inhibit the mTOR pathway while activating the Vagus Nerve and AMPK pathway; and 3) Molecular Outcomes (Output): The metabolic shift promotes four key anti-aging domains: 1) Preservation of Telomere length; 2) Deceleration of the Epigenetic Clock (DNA Methylation); 3) Conservation of NAD+ pools via reduced inflammation (CD38 Inhibition); and 4) Restoration of Gut Microbiota diversity (Gut-Brain Axis).

Buddhist Therapeutics: The Threefold Training as Bio-Restructuring

If Buddhism is medicine, the Noble Eightfold Path is the prescription (Bodhi, 2010); (Granoff, 2011). Condensed into the Threefold Training: Sīla, Samādhi, and Paññā, this framework represents a practical psychobiological intervention that remodels the practitioner's physiology.

Sīla (Ethical Conduct): The Discipline of the Social Environment

Sīla functions as "Mental Hygiene," neutralizing external stressors through ethical behavior and harm reduction. Biologically, this manifests as prosocial behavior and compassion, which are potent antidotes to social stress. Research indicates that self-compassion and practices such as Loving-Kindness Meditation are associated with attenuated inflammatory responses, specifically lower levels of C-Reactive Protein (CRP) and Interleukin-6 (IL-6) during psychosocial stress (Breines et al.,

2014); (Le Nguyen et al., 2019); (Pace et al., 2009). By reducing guilt, remorse, and interpersonal conflict, Sīla acts as a behavioral "Circuit Breaker." It creates a safe psychological environment that downregulates the HPA axis, preventing the initial spark of inflammation that typically arises from social friction and anxieties.

Samādhi (Concentration): The Quieting of the Nervous System

Samādhi, or Focused Attention (FA) meditation, establishes a stable physiological foundation. Neurologically, it strengthens top-down regulation from the prefrontal cortex and activates the Parasympathetic Nervous System (PNS) via the Vagus Nerve. This "Vagal Tone" shift moves the body from a sympathetic "Fight-Or-Flight" state to a restorative "Rest-and-Digest" mode, significantly improving Heart Rate Variability (HRV) (Tolahunase et al., 2017). Conceptually, this can be visualized as the vagus Nerve acts as a brake on the heart and inflammation reflex. This physiological quieting is essential; Without it, the body remains in a catabolic state in which cellular repair mechanisms are suppressed. Samādhi provides the metabolic calmness required for regeneration.

Paññā (Discernment): Reflections on Self and Stress

Wisdom (Paññā), developed through Vipassanā or Open Monitoring (OM), fosters interoception, which is the refined awareness of internal bodily states. This is linked to increased connectivity in the insula and anterior cingulate cortex (Kaliman et al., 2014). By observing stress-producing mental states non-judgmentally, practitioners disrupt the reactivity feedback loop. Instead of reacting to a thought with immediate hormonal panic, the practitioner observes it as a transient event. This cognitive reappraisal is the mechanism that likely confers long-term cellular protection, such as telomere maintenance, by preventing psychological "Secondary Stress" (The Stress About Being Stressed) that typically follows physical or emotional pain (Nicholson, 2022). It effectively uncouples psychological triggers from biological damage.

The Restorative Metabolic Switch Hypothesis

We propose a "Restorative Metabolic Switch Hypothesis." The human body operates on a finite bioenergetic budget (i.e., Energy Homeostasis). Chronic stress prioritizes immediate survival (Fight-or-Flight), diverting resources away from "Luxury" long-term maintenance processes, such as DNA repair, immune surveillance, and autophagy. Deep contemplative practice acts as a master switch, suspending the resource-heavy stress response and redirecting energy toward restorative programs (Crosswell et al., 2024). This explains why inflammation, mitochondrial function, and telomeres improve concurrently; They are downstream beneficiaries of a fundamental metabolic re-prioritization. The energy wasted on ruminative anxiety is now invested in cellular longevity.

Furthermore, this metabolic shift is likely mediated by the antagonism between two signaling pathways: mTOR (Mechanistic Target of Rapamycin) and AMPK (AMP-Activated Protein Kinase). Chronic psychological stress typically drives mTOR activation, which promotes cellular growth and resource consumption at the expense of maintenance, a state analogous to accelerated aging. Conversely, the physiological quiescence achieved during deep Samādhi mimics a state of metabolic conservation, similar to caloric restriction. We hypothesize that this state activates AMPK, which

inhibits mTOR, thereby inducing autophagy and mitochondrial biogenesis. Thus, the cessation of mental proliferation (Papañca) is not merely a cognitive event but also a bioenergetic signal that permits the organism to transition from a catabolic state of "Constant Defense" to an anabolic state of "Deep Repair."

Limitations and Future Directions

This model has several limitations. First, much of the existing research is correlational, making causal inferences challenging. Second, publication bias and small sample sizes have historically plagued this field (Dunne & Schubert, 2021). To address this, future research should move beyond simple associations. Recommendations for Future Research: 1) Longitudinal Clinical Trials: Studies should focus on integrated Threefold Training practice rather than isolated mindfulness techniques to understand the synergistic effects of ethics, concentration, and wisdom; 2) Advanced Biomarkers: Future studies should utilize sophisticated markers, such as DNA methylation (Epigenetic Clocks) and gene expression profiles (Transcriptomics), rather than relying solely on self-reports or basic cortisol measurements; and 3) Comparative Effectiveness: Research should compare Buddhist Therapeutics with established interventions, such as intermittent fasting or exercise, to validate their efficacy as distinct anti-aging modalities and determine whether combined approaches yield additive benefits.

Conclusions

This study challenges the biocentric view of aging by establishing "Internal Biotechnology" as a viable scientific framework. Rather than reiterating the specific mechanisms of the Threefold Training, the synthesis presented here confirms that consciousness is a fundamental determinant of molecular vitality. The integration of "Buddhist Therapeutics" into modern gerontology suggests a paradigm shift; longevity is not merely a matter of preserving the flesh through external intervention but is intrinsically linked to the cultivation of wisdom. For the future of healthcare, this model offers profound implications. It moves beyond the passive treatment of decay toward an active, empowering modality of health span extension that is sustainable and accessible. We envision a future where "Contemplative Hygiene" becomes a pillar of public health policy, parallel to diet and exercise. Ultimately, this research proposes that the pursuit of Nirvana and the preservation of biological youthfulness converge into a unified science of human thriving, revealing that in the 21st century, the most potent anti-aging intervention may be the cultivation of the mind itself.

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