



TRIDOSHA AND MOLECULAR BIOLOGY: AN INTEGRATIVE REVIEW

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Abstract

Ayurveda, the ancient Indian system of medicine, sees health as the balance of three basic physiological principles known as *Tridosha*: *Vata*, *Pitta*, and *Kapha*. These *Doshas* control biological, psychological, and pathological processes in the body. Modern molecular biology and systems biology have started to explore similarities between these traditional ideas and genetic, biochemical, and metabolic profiles. This review aims to connect *Ayurvedic* concepts of *Tridosha* with molecular mechanisms, gene expression, and cellular regulation. It provides a link between traditional physiology and modern biomedical science. [1], [2]

Introduction

The concept of *Tridosha*, *Vata*, *Pitta*, and *Kapha*, forms the foundation of *Ayurvedic* physiology (*Sharira Kriya*). It is described in *Charaka Samhita* (*Sutra Sthana* 1/57-60) and *Sushruta Samhita* (*Sharira Sthana* 4/4-5). These three entities are responsible for maintaining homeostasis, metabolic activity, and structural stability in living organisms [3, 4]. *Vata* governs movement and neural transmission. *Pitta* regulates digestion and transformation. *Kapha* ensures cohesion and stability. [5, 6]

Recent studies in molecular biology describe similar regulatory systems, such as neurological signalling, enzymatic catalysis, and structural matrix regulation. These systems work together to maintain the integrity of organisms. [7, 8] Therefore, the *Tridosha* system can be seen as a holistic model of these dynamic molecular interactions. [9]

Ayurgenomics is an emerging field that combines *Ayurvedic* constitutional types (*Prakriti*) with molecular and genetic frameworks. This supports the biological relevance of *Dosha*-based classifications. [10] Researchers have shown that individuals with different *Prakriti* types have varying gene expression, metabolic activity, and immune responses. This aligns with *Ayurvedic* typologies. [11, 12]

Methodology

This review was based on a systematic analysis of classical *Ayurvedic* texts, *Charaka Samhita*, *Sushruta Samhita*, and *Ashtanga Hridaya*, and modern biomedical research from PubMed, Scopus,

and AYUSH portals. Keywords used included *Tridosha*, *Vata*, *Pitta*, *Kapha*, Ayurgenomics, Gene Expression, and Systems Biology. Modern studies correlating Prakriti and genomics (2008–2024) were included. *Chakrapani* and *Dalhana* extracted the *Ayurvedic* conceptual framework from *Samhita* commentaries and used systems biology analogies to interpret it. (13, 14)

RESULTS

1. *Vata Dosha* Molecular Analogues

Motion, fluctuation, and nerve control are characteristics of *Vata Dosha*. At the cellular level, it is related to ion channel function, neuro-signalling, and transcription regulation [15]. People with a *Vata*-dominant *Prakriti* exhibit notable variations in the neurotransmission-regulating genes COMT, DRD4, and SLC6A3 [16], [17]. Molecular similarities include ATPase pumps, microtubule dynamics, and vesicular transport, highlighting *Vata*'s energetic and communicative nature [18].

2. Molecular Analogues of *Pitta Dosha*

Pitta Dosha, which focuses on transformation, is linked to metabolic and enzymatic processes. These processes include energy production, thermoregulation, and oxidation-reduction reactions [19]. It closely relates to mitochondrial activity, liver enzyme functions, and hormonal feedback systems [20]. Genes like PPAR- γ , CYP450, and NRF2 are highly active in *Pitta*-dominant individuals, which aligns with a high basal metabolic rate and increased oxidative capacity [21]. Inflammatory mediators such as IL-6 and TNF- α also show higher baseline levels, reflecting *Pitta*'s pro-metabolic and pro-inflammatory characteristics [22].

3. Molecular Analogues of *Kapha Dosha*

Kapha Dosha represents structure, growth, and lubrication. It links to pathways that promote building, immune response, and the extracellular matrix (ECM) [23]. Genes related to collagen production, fat processing, and immune response regulation, such as COL1A1, APOE, and IL10, are more active in people with a *Kapha*-dominant profile [24]. This shows the stable, endurance-focused nature of *Kapha*, which is often seen in individuals with a higher BMI and stronger immune response. [25]

4. Prakriti and Gene Expression

Ayurgenomic research has shown that *Vata*, *Pitta*, and *Kapha Prakriti* groups have different gene expression patterns [26]. Microarray studies revealed different control of genes involved in energy use, immune signalling, and response to stress. [27] This supports the idea that *Tridosha* may represent large regulatory networks that connect various molecular pathways. [28]

Discussion

The *Tridosha* concept offers a practical model of balance that resembles modern molecular feedback systems. *Vata* is like neuronal and genetic signalling networks. *Pitta* parallels enzymatic and metabolic feedback. *Kapha* reflects anabolic and immune-maintenance mechanisms [29]. These three principles work together to maintain dynamic equilibrium. Biochemically, this state is known as systems homeostasis, while genetically, it is referred to as gene-environment synchrony [30], [31]. Classical *Samhitas* describe this balance as *Dosha Samya*, which is the essential state of health. In molecular biology, it relates to the stability of gene expression, enzyme activity, and cytokine regulation. *Charaka* states: “*Samadosha samagnischa samadhatu malakriyah, prasannatmendriyamanah swasth ityabhidhiyate*” (*Ca. Su. 9/4*). This indicates the same state of physiological balance that modern molecular systems define through regulatory balance [32]. Moreover, the *Ayurvedic* view of disease as *Dosha Vaishamy*, or imbalanced regulation, aligns with modern understanding of oxidative stress, inflammation, and genetic dysregulation [33]. Combining these viewpoints offers a richer and more personalised insight into biological individuality, laying the groundwork for predictive and preventive healthcare [34].

Conclusion

The convergence of *Ayurvedic* physiology and molecular biology illustrates the timeless relevance of the *Tridosha* concept. *Vata*, *Pitta*, and *Kapha* represent not only philosophical constructs but also functional analogues of regulatory molecular systems governing communication, metabolism, and structure. As modern science continues to map gene expression and biochemical pathways, the *Tridosha* framework offers a holistic and individualised lens for interpreting these findings. The integration of *Samhita*-based wisdom with molecular evidence has immense potential for advancing *Ayurgenomics*, personalised medicine, and preventive healthcare. This synthesis reinforces *Ayurveda*'s status as a sophisticated system of systems biology, one that anticipated genomic individuality millennia before its molecular discovery.

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