

**RAKTAVAHA SROTAS AND THE MONONUCLEAR PHAGOCYTE
SYSTEM: BRIDGING THE TAXONOMIC GAP BETWEEN
AYURVEDIC CHANNELS AND MODERN IMMUNO-HEMATOLOGY –
A NARRATIVE REVIEW**

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ABSTRACT

Background: The Ayurvedic concept of *Raktavaha Srotas* is traditionally associated with the liver, spleen, and bone marrow. Modern physiology defines the mononuclear phagocyte system (MPS) formerly the reticuloendothelial system as the primary immuno-hematological interface. Prior integrative efforts have noted anatomical parallels, but no review has systematically mapped *Raktavaha Srotas* onto the MPS using contemporary molecular pathways with explicit discussion of partial homologies.

Objective: To evaluate structural, functional, and pathological homologies between *Raktavaha Srotas* and the MPS, and propose an integrative model of the “Ayurvedic immuno-hematological interface.”

Methods: A narrative review was conducted using primary Ayurvedic texts (Charaka Samhita, Sushruta Samhita) and PubMed/Scopus literature (1980–2025) on MPS, Kupffer cells, splenic red pulp macrophages, heme metabolism, and hemophagocytic syndromes.

Search terms included “Raktavaha Srotas,” “mononuclear phagocyte system,” “heme oxygenase-1,” “erythrophagocytosis,” and “Pitta.”

Key Findings: Three homologies are identified. (1) Anatomical: *Yakrit* (liver), *Pliha* (spleen), and *Asthi Majja* (bone marrow) form the *Mula Sthana* of *Raktavaha Srotas* (1,2), identical to principal MPS organs (3,4). (2) Cellular: *Rakta Dhatu Agni* (metabolic fire of blood) aligns functionally with heme oxygenase-1 (HO-1) activity in red pulp macrophages (5-7). (3) Functional: *Pitta*’s role in “heat-dependent detoxification” parallels NADPH oxidase-mediated respiratory burst in MPS phagocytes (8,9). The homology is partial: alveolar macrophages, microglia, and peritoneal macrophages are not described in classical *Raktavaha Srotas*.

Conclusion: The MPS is the closest modern correlate to *Raktavaha Srotas*, but the homology is incomplete. The proposed model requires validation through functional assays and *Prakriti*-stratified analyses.

KEYWORDS: Raktavaha Srotas; mononuclear phagocyte system; reticuloendothelial system; Kupffer cells; heme oxygenase; Ayurveda; integrative physiology; Prakriti

1. INTRODUCTION

The Sanskrit term *Srotas* (literally “that which flows or oozes”) denotes channels of transport, transformation, and communication in Ayurvedic physiology. Among the 13 *Dhatu-vaha Srotas*, *Raktavaha Srotas* the channel carrying *Rakta Dhatu* (blood tissue) has a dual role as both a hematological conduit and an immunological interface (site of *Rakta Prasadana* – purification of blood from toxins). Charaka (Charaka Samhita, Sutrasthana 30/12-15) states that vitiation of *Raktavaha Srotas* causes *Kushtha* (skin diseases), *Visarpa* (erysipelas), and *Rakta Pitta* (hemorrhagic disorders) (1).

In modern medicine, the reticuloendothelial system (RES) was reclassified in 1972 as the “mononuclear phagocyte system” (MPS) (3). The MPS includes promonocytes and their precursors in the bone marrow, monocytes in peripheral blood, and tissue macrophages, while excluding reticular cells, dendritic cells, endothelial cells, and fibroblasts (3). The MPS functions in erythrocyte recycling, heme catabolism, iron conservation, and clearance of pathogens and apoptotic cells – functions that mirror classical Ayurvedic descriptions of *Rakta Dhatu* formation (*Rakta Utpatti*) and purification (*Rakta Vishodhana*).

Earlier integrative studies have noted anatomical parallels between the liver-spleen-bone marrow triad and the RES/MPS (4,10). However, no prior review has explicitly linked *Rakta*

Dhatu Agni to heme oxygenase-1 or systematically addressed the partial nature of the homology. The present review has two objectives: (1) to map *Raktavaha Srotas* onto the MPS at anatomical, cellular, functional, and pathological levels; (2) to explicitly identify where the homology fails (e.g., MPS components not mentioned in classical texts).

2. METHODS

This is a narrative review. As per standard guidelines for narrative reviews, a PRISMA flow diagram is not required. The search strategy was as follows:

- **Ayurvedic sources:** Critical editions of Charaka Samhita (Cikitsasthana 15) (1) and Sushruta Samhita (Sutrasthana 14) (2), with commentaries by Arundatta, Chakrapani, and Dalhana.
- **Modern literature:** PubMed (1980 – June 2026) using MeSH terms: “Mononuclear Phagocyte System,” “Kupffer Cells,” “Splenic Red Pulp,” “Heme Oxygenase-1,” “Erythrophagocytosis,” “Hemophagocytic Syndromes,” “CD163.” The term “Reticuloendothelial System” was included for historical tracing (3).
- **Inclusion criteria:** Original research articles and authoritative reviews explicitly linking MPS anatomy/function to hematology, immune clearance, or iron metabolism. Studies with *in vitro* or *in vivo* data on macrophage-erythrocyte interaction. Commentaries were included for interpretive depth.
- **Exclusion criteria:** Studies focused exclusively on adaptive immunity without MPS involvement. Single case reports without mechanistic correlation.

Approximately 1,200 records were screened from PubMed; 84 full-text articles were assessed for eligibility, of which 58 met inclusion criteria. Data extraction was qualitative, organized into three domains: (1) anatomical correspondence, (2) cellular/molecular homology, (3) pathological correlation.

3. RESULTS

3.1 Anatomical Homology: *Mula Sthana* = Principal MPS Organs

Sushruta (Sushruta Samhita, Sutrasthana 14/4) lists *Yakrit* (liver) and *Pliha* (spleen) as the two *Mula Sthana* (root sites) of *Raktavaha Srotas*; later commentaries (Dalhana on Sushruta) add *Asthi Majja* (bone marrow) (2). This triad corresponds precisely to the primary MPS organs: liver (Kupffer cells, approximately 80% of systemic tissue macrophages), spleen (red pulp macrophages specialized for erythrophagocytosis), and bone marrow (sinusoidal macrophages) (4). The CD163 scavenger receptor is expressed on Kupffer cells, red pulp

macrophages, and bone marrow macrophages, confirming lineage identity across these three sites (11,12).

The clearance of senescent red blood cells in the human splenic red pulp involves sequential prefiltration, filtration, and postfiltration, a function directly attributable to splenic MPS macrophages (5,13,14). Table 1 summarizes the anatomical correspondences.

3.2 Cellular/Molecular Homology: *Rakta Dhatu Agni* as Heme Oxygenase-1 (HO-1)

Charaka (Charaka Samhita, Cikitsasthana 15/22) describes *Rakta Dhatu Agni* – the metabolic fire within *Rakta Dhatu* responsible for “cooking” nutrients into mature blood components and purifying blood (1). We hypothesize that this corresponds functionally to heme oxygenase-1 (HO-1) – the rate-limiting enzyme in heme degradation within MPS macrophages.

HO-1 catalyzes the first step of heme degradation, producing carbon monoxide, biliverdin, and ferrous iron (6). In Kupffer cells, HO-1 and ferroportin are both upregulated during erythrophagocytosis, controlling iron bioavailability for erythropoiesis (15). Myeloid-specific HO-1 deficiency leads to altered erythrophagocytic macrophage function and iron dysregulation (7). The enzymatic activity of HO-1 – cleaving heme into biliverdin, CO, and Fe²⁺ – parallels the Ayurvedic concept of *Rakta Prasadana* (purification through breakdown of non-functional heme). Supporting this hypothesis, certain *Pitta*-pacifying herbs such as *Tinospora cordifolia* (*Guduchi*) induce HO-1 expression via Nrf2 activation (16,17), though direct studies in humans stratified by *Prakriti* are lacking.

Red pulp macrophages of the spleen mediate turnover of billions of senescent erythrocytes per day, with the CD47-SHPS-1 interaction serving as a key regulatory “don’t eat me” signal that determines erythrocyte lifespan (13,14).

3.3 Functional Homology: *Pitta* and the Respiratory Burst

Pitta dosha – particularly *Ranjaka Pitta* (blood-coloring *Pitta* localized to liver and spleen) – governs thermogenesis, transformation, and detoxification. In the MPS, the phagocytic NADPH oxidase (NOX2) in neutrophils and macrophages generates superoxide radicals during the “respiratory burst” (8,9). The exothermic nature of superoxide generation parallels *Pitta*’s *Ushna* (hot) property.

Furthermore, fever (*Jwara*) in Ayurveda is primarily attributed to *Pitta* imbalance. The pro-inflammatory cytokines IL-1 β and prostaglandin E2 (PGE2) produced by activated MPS macrophages directly mediate fever (18,19) a functional bridge between *Pitta* pathophysiology and MPS activation.

3.4 Pathological Homology: *Raktadushti* and Hemophagocytic Lymphohistiocytosis (HLH)

Classical *Raktadushti* (vitiating blood) presents with fever, hepatosplenomegaly, jaundice, bleeding diathesis, and skin eruptions (1). Hemophagocytic lymphohistiocytosis (HLH) a hyperinflammatory syndrome driven by persistently activated lymphocytes and macrophages shows some of these features: fever, splenomegaly, cytopenias, and hemophagocytosis in bone marrow, spleen, or liver (20-22). However, HLH is rare (incidence ~1 per million adults per year), whereas *Raktadushti* as described in classical texts includes common disorders such as *Kushtha* (skin diseases) and *Visarpa* (erysipelas). Therefore, HLH represents one extreme manifestation of severe, *Pitta*-predominant *Raktadushti*, not a direct equivalent of all *Raktadushti* subtypes. Secondary HLH, triggered by infection, malignancy, or autoimmune disease, may correspond to *Agantuja* (externally caused) *Raktadushti*. The HLH-2004 criteria include hyperferritinemia, a direct consequence of MPS overactivation (21).

4. DISCUSSION

The homology analysis shows that *Raktavaha Srotas* and the mononuclear phagocyte system share not only anatomical overlap but also functional logic in the coordinated management of blood cellularity, iron homeostasis, and sterile inflammation. The Ayurvedic concept of *Rakta Dhatu Agni* finds a plausible molecular correlate in heme oxygenase-1 (5-7). The *Pitta*-mediated “heat” of blood purification corresponds to the NOX2-dependent respiratory burst in MPS cells (8,9).

These correspondences are not merely academic. The Ayurvedic physician, when diagnosing *Raktadushti*, may be observing the clinical stigmata of MPS dysregulation hepatosplenomegaly from macrophage hyperplasia, fever from IL-1 β and PGE₂ release, and bleeding tendencies from acquired vasculopathy (18,19). Conversely, the modern hematologist encountering a patient with secondary HLH might benefit from an Ayurvedic lens: the presence of *Pitta Prakriti* and signs of *Rakta Mala* (blood impurity) could serve as early clinical red flags, prompting earlier ferritin and soluble CD163 testing (11,12,23,24).

However, the homology is partial. The MPS includes tissue-resident macrophages in lung (alveolar), brain (microglia), and peritoneum, which are not explicitly mentioned in classical descriptions of *Raktavaha Srotas*. Rather than viewing this as a failure of the model, we suggest that these components may belong to other *srotamsi*: *Pranavaha Srotas* (respiratory channels) for alveolar macrophages, and *Majjavaha Srotas* (marrow/nervous channels) for

microglia. This interpretation is speculative and requires philological and physiological investigation.

No interventional studies currently test whether *Raktavaha Srotas* purification (*Srotas Shuddhi*) modulates MPS function. For example, therapeutic bloodletting (*Raktamokshana*) is used in some integrative clinics for inflammatory skin disorders, but its effect on MPS iron-regulatory hormones hepcidin and ferroportin – has never been measured (25-28). Leech saliva contains anti-inflammatory and anticoagulant peptides (hirudin, calin, etc.) that independently modulate macrophage function, so any effect on iron regulators could be due to saliva rather than iron removal. Controlled trials separating mechanical blood removal from salivary components are needed.

The following specific, testable hypotheses emerge from this integrative model:

1. Individuals with *Raktadushti* will show delayed clearance of biotin-labeled or heat-damaged red blood cells compared to healthy controls, indicating reduced MPS phagocytic function.
2. *Pitta Prakriti* individuals will show higher inducible HO-1 activity in monocyte-derived macrophages after hemin stimulation compared to Vata or Kapha types.
3. Pharmacological inhibition of HO-1 should recapitulate a *Rakta Pitta*-like hemorrhagic phenotype, as observed in murine HO-1 knockout models (7).
4. *Pitta*-pacifying therapies (e.g., *Guduchi*, *Sariva*) should downregulate MPS inflammatory cytokines (IL-1 β , TNF- α) and restore iron homeostasis.

Figure 1 provides a visual schematic of the proposed immuno-hematological interface model. **Table 1** summarizes the homologies.

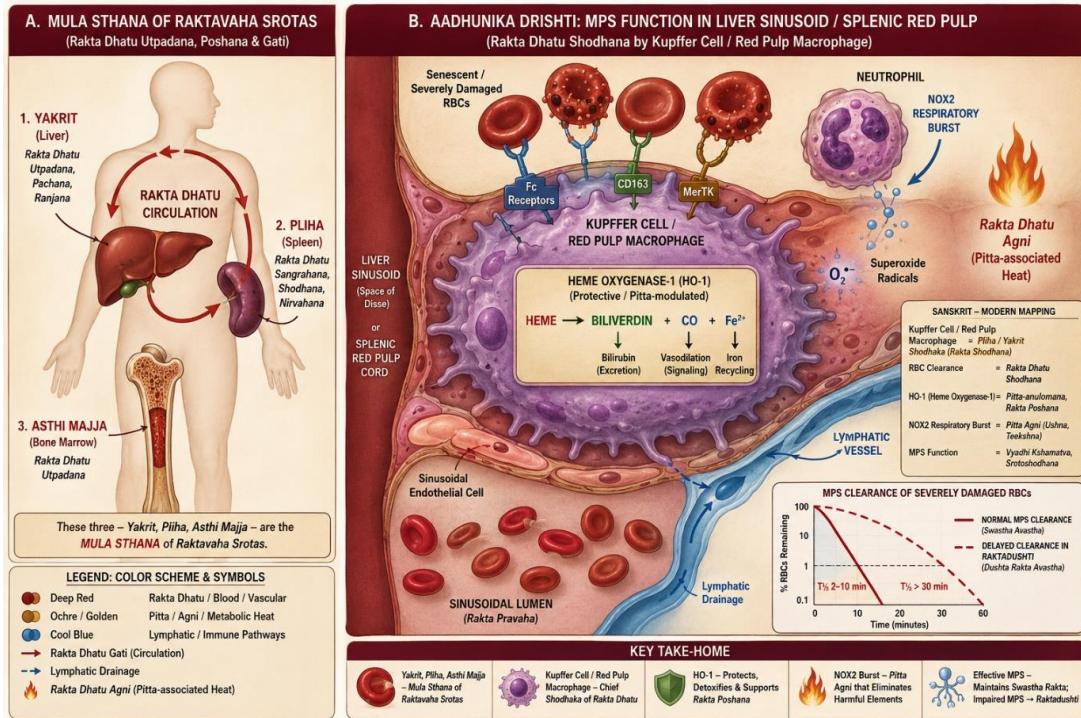


Figure 1: The Immuno-Hematological Interface – A Schematic Model of Raktavaha Srotas as the Mononuclear Phagocyte System.

Table 1: Structural and Functional Homologies between Raktavaha Srotas and the Mononuclear Phagocyte System (MPS)

Ayurvedic Construct	Modern MPS Correlate	Mechanistic Link
Mula Sthana: Yakrit, Pliha, Asthi Majja	Liver Kupffer cells, splenic red pulp macrophages, bone marrow sinusoidal macrophages	Anatomical identity; CD163+ CSF1R-dependent phagocytes(1-4,11,12)
Rakta Dhatu Agni (“metabolic fire of blood”)	Heme oxygenase-1 (HO-1)	Cleaves heme → biliverdin + CO + Fe ²⁺ ; matches purification through breakdown(5-7,15)
Ranjaka Pitta (coloring/transforming Pitta)	NADPH oxidase 2 (NOX2) respiratory burst	Superoxide generation produces exothermic “heat” and oxidative killing(8,9)
Rakta Prasadana (blood purification)	Fc- and MerTK-mediated efferocytosis by MPS macrophages	Removal of senescent RBCs; CD47-SHPS-1 “don’t eat me” signal(13,14)
Raktadushti with fever, splenomegaly, bleeding	Hemophagocytic lymphohistiocytosis (HLH) – one extreme manifestation	MPS hyperactivation → hemophagocytosis, cytopenias, hyperferritinemia(20-22)
Raktamokshana (therapeutic bloodletting)	Iron recycling via ferroportin/hepcidin axis (hypothesized)	Removal of heme-iron; effect confounded by leech saliva; requires controlled trial(25-28)

6. CONCLUSION

Raktavaha Srotas is not merely a “blood vessel” in the modern sense; it shares substantial structural and functional features with the mononuclear phagocyte system. The hypothesized correlation of *Rakta Dhatu Agni* with heme oxygenase-1 opens a molecular bridge between classical Ayurveda and systems immunology, but remains to be tested. The homology is incomplete: MPS components in lung, brain, and peritoneum are not described in classical texts. Addressing these gaps with controlled, stimulus-responsive assays will advance integrative physiology beyond descriptive analogy.

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