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Reviving Ancient Knowledge: Integrating Indigenous Knowledge Systems in Biological Education

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Abstract: *Indigenous Knowledge Systems (IKS) are the knowledge assets that have evolved in India. It offers a rich understanding of the natural world with holistic and integrated perspectives on biological phenomena and ecological sustainability. This article deals with the importance of incorporating the Indian Knowledge system in contemporary science curriculum, especially in life sciences which will enhance a greater understanding of key concepts and sustainable practices in students. The Indian traditional knowledge available in our scriptures like Charak Sanhita, Sushruta Sanhita, Vedas, and Ayurvedas offers elaborative descriptions of medicinal plants, anatomy and life processes, taxonomy and classification, ecology and biodiversity conservation, and sustainable resource management. This knowledge provides accurate solutions for many social, economic, and ecological problems even today. Integrating views of IKS in contemporary science education can inculcate a more holistic, culturally appropriate, and sustainable approach to biological science in the students. It will enhance the respect for indigenous knowledge and its use in modern society.*

Key Words: *Indian Knowledge system, IKS, biology, biodiversity conservation, taxonomy.*

1. INTRODUCTION:

Indigenous knowledge systems address in-depth common and shared knowledge, beliefs, and regulations regarding the physical resources, social norms, health, ecosystem, culture, and livelihood of the people who engage with the environment in rural and urban areas (Singh, 2016). Integration of IKS with teaching science strengthens and preserves Indigenous knowledge and makes concepts more meaningful and understandable for students from multicultural backgrounds (Handayani et al., 2018; Mavuru & Ramnarain, 2020), influences students' interest and passion in science and allows them to appreciate and conserve the Indigenous knowledge (Handayani et al., 2018). Integrating IKS in the science curriculum offers alternative methods of ensuring sustainable development in poor rural communities and enables students to compare and analyze different sources of information for their own and society's advantage. As stated by Okpokwasili and Oladipupo (2019), IKS forms the basis of local decision-making regarding agriculture, medicine, food preparation, education, and other types of activities in a community, and thus, it requires the use of appropriate teaching approaches to communicate the specific aims to the learners. Indian knowledge system includes a profound understanding of biology, particularly in the fields of botany and zoology. For instance, the Charaka Samhita, contains thorough descriptions of medicinal plants and their characteristics, Sushruta Samhita, gives knowledge about surgical techniques such as plastic surgery, cataract surgery, and various other surgical procedures that are remarkable for their time and has had a lasting impact on the development of surgical techniques. Indian scientists also categorized the animal species and observed their habits, following various traditional practices of environmental sustainability, conservation of biodiversity, and management of resources. Hereafter is the discussion on our traditional text from Vedic times providing knowledge on various aspects of biological sciences if implemented in our modern science curriculum would assist students in increasing interest and logical thinking towards the subject. It will also cultivate deep respect and inclination towards the conservation of the Indian knowledge system and its use for society's welfare.

2. HOLISTIC SYSTEMS THINKING:

One of the principal features of IKS is holistic thinking in terms of understanding biological phenomena. Unlike the reductionist approach that has been the hallmark of Western science until recently, Indian knowledge systems

focused on the interrelatedness between organisms and their environment. The concept of "sarva bhuta hita" (well-being of all beings) indicates an ecological awareness, which is aware of interdependence within ecosystems (Rastogi, 2010). Traditional Indian models, therefore, perceived living forms as dynamic systems in continuous interaction with the environment. The concept of "Sarvam Khalvidam Brahma" (everything in the universe is linked) from the Chandogya Upanishad is an early expression of what contemporary science understands as complex systems theory. This is the view that biological objects are not solitary items but a part of immense webs of relation. This is increasingly practiced today in modern systems biology.

3. TAXONOMIC CLASSIFICATIONS IN ANCIENT INDIAN TEXTS:

Ancient Indian literature evolved advanced systems of classification for plants and animals. The Charaka Samhita classifies plants into 50 categories according to their medicinal properties, as well as morphological and ecological features (Sharma, 2013). Likewise, some Ayurvedic texts classify animals according to habitat (jalachara, sthalchara, khechar) (Nair, 2012), modes of reproduction (andaja, pindaja, jarayuja, svedaja), and other features that exhibit striking similarities with contemporary taxonomic concepts. Jalachara refers to dwelling in water, sthalchara refers to dwelling on the land, and khechar refers to moving in the sky. This categorization is equivalent to aquatic, terrestrial, and aerial classes of animals respectively in the modern classification. The categories animals like andaja signify birth by eggs, pindaja signifies born of the physical form of the body, jarayuja signifies giving birth to young ones (placentals), svedaja signifies derive from the sweat of other animals or vapours of the earth including insects, worms, etc.). (Unnikrishnan, 1998). These terms are similar to oviparous, viviparous, and ovoviviparous classes of animals in the contemporary taxonomic system. Another class of animals described in Ayurveda is Udbhija. It comprises those animals that pass some part of their life in sleep-like states without any activities within the ground and emerge after a certain duration (Unnikrishnan, 1998). This state in the current system is termed aestivation and hibernation which is manifested by animals such as red flies or fireflies and frogs. The Buddhist scripture Jataka Tales (300 BCE) has precise descriptions of animal behavior and ecological associations, which demonstrate a complex appreciation of biodiversity. Such classification systems included morphological, functional, and ecological associations, a multi-parameter system presently appreciated for its merits in modern systematic biology. Ethnotaxonomy and Folk Biology is the superb technique of categorizing the organisms. Indian indigenous taxonomic systems tended to identify cryptic ecological patterns that Linnaean taxonomy ignored. For instance, indigenous fishermen along India's coast can identify several hundred fish species not just on morphology but also on behavior, habitat, and ecological function. Comparisons of these folk categories with genetic information tend to reveal striking congruence, implying that traditional classification identified significant biological differences (Srinivasan et al., 2011; Ramanujan et al., 2014). Analogously, eastern Himalayan tribal societies categorize bamboo species on the basis of functional characteristics and applications instead of morphological analogies, a system that sometimes more accurately expresses evolutionary ties than did conventional taxonomy in the past (Puri, 2017; Gupta et al., 2019).

4. PANCHAMAHABHUTA THEORY AND BIOLOGICAL COMPOSITION:

All matter is formed of five elements (Prithvi/earth, Jal/water, Agni/fire, Vayu/air, and Akasha/space) as per Panchamahabhuta theory provides a basic understanding of biological composition and transformation. In the context of contemporary science, this can be interpreted as appreciation for the fact that biological processes consist of material components (earth), fluid components (water), energy and changing processes (fire), gaseous components and motion (air), and arrangements in space under which structure and function are feasible (space). Based on such a framework, ancient Rushi-Munis were able to formulate testable hypotheses regarding ways in which interference with these pieces could influence biological processes. **Tridosha Concept as a Biological Regulatory Model (Physiology):**
Ayurvedic Tridosha concept categorizes Vata (movement/nervous functions), Pitta (metabolism/enzymatic functions), and Kapha (structure/immune functions) as the three biological regulatory processes (Hankey, 2001) that are a complex model of physiological regulation. These doshas regulate various biological functions (physiology) and are in equilibrium with homeostasis when in balance. Recent studies propose fascinating parallels between the dosha theory and contemporary biological ideas. Vata functions, for instance, are correlated with nervous system functions and cellular transport (Seshadri and Choudhary, 2016); Pitta is correlated with metabolic processes and enzymatic reactions (Sharma and Chandola, 2014); and Kapha is correlated with structural proteins and immune response (Raghunandan and Gupta, 2019). Although not exactly translatable into contemporary biological terms, these results offer a model for interpreting the integrated regulation of multifarious physiological processes. Ayurvedic theories of physiology demonstrate significant similarity with contemporary discoveries. Agni in Ayurveda is the metabolic energy or the digestive fire that controls all processes of physiology such as digestion, absorption, and transformation. 13 are the various varieties of Agni, each having a role and function in the body. They are, Jatharagni (Fire of Digestion), Bhutagni

(Fire of the Elements), Dhatvagni (Tissue Fire), Prana Agni (Life-Sustaining Fire), Sadhaka Agni (Fire of the Intellect), Ranjaka Agni (Blood Fire), Pachaka Agni (Fecal Fire), Alocaka Agni (Fire of Seeing), Kledaka Agni (Moistening Fire), Vyadana Agni (Fire of Fevers), Bodhaka Agni (Oro-Faciale Fire), Vishama Agni (Erratic Fire), and Samskar Agni (Transformation Fire). These 13 forms of Agni function to sustain health and equilibrium in the body, and any disturbance in any one of them can cause physical or mental disorders. It is believed in Ayurveda that maintaining robust and balanced Agni is essential for good health. The Srotas (channel) model has explained specialized physiological routes for the transport of substances, nutrients, and wastes, conceptually analogous to contemporary circulatory, lymphatic, and excretory systems (Lad, 2002). The concept of Dhatus (Tissues) deals with the progressive conversion of nutrients into seven tissue types (Rasa, Rakta, Mamsa, Meda, Asthi, Majja, and Shukra) explained in Ayurveda resembles contemporary knowledge on nutrient assimilation and tissue metabolism. An in-depth understanding of marma points (life-giving junctions of muscles, vessels, ligaments, bones, and joints) exhibited advanced anatomy relevant to both therapeutic procedures and the prevention of injuries (Joshi, 2010).

5. MEDICINAL PLANTS IN DISEASE TREATMENT:

Herbal medicines have been utilized for thousands of years across various cultures to treat a wide range of ailments. These herbal medicines usually contain bioactive compounds that have therapeutic benefits. The application of these medicines in conventional systems like Ayurveda, Traditional Chinese Medicine (TCM), and Indigenous medical systems is based on empirical evidence passed on through generations. These ancient systems are scientifically proven through various research and stringent testing to confirm the efficacy, safety, and mode of action of herbal (plant-based) remedies. For example, curcumin, the active ingredient in turmeric is well studied for its antioxidant and anti-inflammatory properties (Aggarwal et al., 2007). Kava (Piper methysticum) is used in the treatment of anxiety but it has the risk of causing liver injury, therefore it is under strong regulation and monitoring (Teschke et al., 2011). Ashwagandha, used in Ayurveda as a natural adaptogen (stress resistance), was found to reduce stress and anxiety. Clinical trials have proved that ashwagandha supplementation causes a decrease in cortisol levels and an overall increase in stress resistance (Chandrashekhar et al., 2012). Hence, herbal medicines are a promising way for the treatment of numerous health conditions, and scientific proof is discovering their potential.

6. CHRONOBIOLOGY AND CIRCADIAN RHYTHMS:

Ayurveda appreciated the significance of daily and seasonal biological rhythms centuries ago when modern chronobiology was still an emerging science. Dinacharya (daily routine) and ritucharya (seasonal routine) in Ayurveda are based on the observations that different biological processes are carried out at different times. It is now proved that various physiological processes in the body like hormone secretion, metabolism, and immune responses follow the circadian rhythm which validates many observations mentioned in Ayurveda.

7. INDIAN ECOLOGICAL KNOWLEDGE AND BIODIVERSITY CONSERVATION:

Vedic ecology perspectives of sustainability in the Indigenous Indian system, emphasize the interdependence of humans and nature. Ideas like "Vasudhaiva Kutumbakam" (the world is one family) speak about conservational views to ensure harmony with nature. Indian indigenous practices (knowledge) therefore provide ecologically friendly methods of agriculture, biodiversity conservation, and natural resource management. Native traditions in India are grounded on ancient knowledge which offers ecofriendly approaches to agriculture, biodiversity preservation, and resource management. These traditions evolved among indigenous and local communities over several generations based on their actual experiences, observations, and profound knowledge of local ecosystems, species, and sustainable resource utilization. Embracing and incorporating this knowledge within mainstream conservation efforts will not only conserve biodiversity but also sustain the cultural heritage of the local populace. Some of the major contributions of Traditional Ecological Knowledge (TEK) to biodiversity conservation in India are:

Sacred Groves and Biodiversity Hotspots: Traditional ecological Indian knowledge did not only notice the significance of protecting intact environments based on sacred groves (Devrai, Kavu, or Sarnas) ideas. The sacred groves represent the patchy forests kept protected because of faith and cultures, and are endemic and rare species reservoirs (Malhotra et al., 2001). They occur throughout India, from the Jaintia and Khasi hills of Meghalaya to the Western Ghats, these groves are undisturbed gene pools (Gadgil & Vartak, 1976). Recent ecological surveys have substantiated that many sacred groves have rare, endemic, and endangered species and also serve as key genetic reservoirs. For instance, research in the Western Ghats has indicated that sacred groves have much higher tree diversity and biomass than the surrounding landscapes. The religious taboo against harming these ecosystems de facto established a traditional conservation network that predated modern protected area systems by millennia.

Traditional farming practices: The indigenous farming practices, like Nagaland's Zabo farming and Uttarakhand's Barahnaja (twelve-grain) system, ensure crop diversification and conservation of soil (Altieri, 2004). Farmers' own seed banks and local crops preserve genetic diversity and food security (Nautiyal et al., 2008).

Water Conservation Measures: Traditional methods of water management, including step wells (baolis), Johads (Rajasthan's rainwater harvesting tanks), and Arunachal Pradesh's Apatani wet rice growing system, have made water harvesting sustainable (Agarwal & Narain, 1997). These provide support to aquatic life and lessen the effects of drought (Sharma et al., 2010).

Community-Based Conservation Initiatives: Local people are an important force in the conservation of wildlife through projects such as the Bishnoi community's protection of blackbucks in Rajasthan and the Maldhari pastoralists' living with lions in Gir Forest (Robbins, 1998). Joint Forest Management (JFM) schemes engage local people in forest conservation to use the resources sustainably (Poffenberger & McGean, 1996). These activities usually represented sustainable principles that did not allow resource exhaustion and supported biodiversity. Such principles are now more desirable in contemporary conservation biology.

8. CONCLUSION:

As shown in the diverse heritage of Indian knowledge systems, an integrated method of studying biological phenomena, ecology, and conservation of biodiversity, offers special insights that harmonize with contemporary ecological and biological paradigms. Sacred groves, traditional farming systems, and local conservation initiatives have been successful examples of sustainable management of resources and environmental conservation and provide a wealth of information that can be applied to contemporary conservation practice. The incorporation of Indigenous Knowledge Systems (IKS) into modern science education and environmental practices not only maintains and respects these traditional systems but also adds value to the learning experience of students, enabling them to appreciate scientific inquiry as well as cultural heritage more meaningfully. Since the world is confronted with various environmental and health issues, harnessing the intelligence contained in Indigenous knowledge systems may offer sustainable remedies for the advantage of society and the world at large. Recognizing and incorporating IKS into contemporary scientific paradigms is important for developing an inclusive, more diverse, and more effective paradigm of science and environmental management for the 21st century.

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