

Artificial Intelligence in Veterinary Pathology: Transforming Animal Health Diagnostics

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OPEN ACCESS

Keywords

Artificial Intelligence, Veterinary Pathology, Digital Pathology, Animal Health

How to cite this article:

Suroshe, S., Thote, E., Fulsundar, R., Mendake, A. and Tirpude, S. 2026. Artificial Intelligence in Veterinary Pathology: Transforming Animal Health Diagnostics. *Vigyan Varta* 7 (05): 243-246.

ABSTRACT

Artificial intelligence (AI) is rapidly transforming veterinary pathology by enhancing the accuracy, speed, and efficiency of disease diagnosis in animals. By applying advanced computational algorithms to histopathological images, laboratory data, and molecular information, AI supports pathologists in identifying subtle disease patterns and making more reliable diagnostic decisions. The integration of AI with digital pathology has improved standardization, reduced inter-observer variability, and enabled large-scale data analysis for disease surveillance and research. Additionally, AI contributes to personalized veterinary medicine by combining multiple data sources to guide targeted treatment strategies. Despite its promising potential, challenges such as high implementation costs, limited availability of quality datasets, the need for validation, and integration into routine workflows must be addressed. Importantly, AI serves as a supportive tool that complements human expertise rather than replacing it. Overall, the responsible adoption of AI in veterinary pathology holds significant promise for improving animal health, welfare, and disease management.

INTRODUCTION

Artificial intelligence (AI) describes the capability of computer systems to perform specialised activities which typically demanding human intelligence, including data learning, pattern recognition and decision-making. Presently, the artificial intelligence (AI) is reshaping multiple fields of research, including veterinary pathology. Veterinary pathology plays a central role in disease diagnosis, forming the foundation on which effective treatment, control, and prevention strategies are built.

Traditionally, veterinary pathology depended primarily on skilled interpretation of tissues, cells and disease patterns under a microscope. However, as the demand for quicker and more accurate animal illness detection grows, artificial intelligence (AI) is emerging as a valuable support tool. AI can help analyse microscopic tissue changes and discover disease trends in laboratory results by rapidly and precisely analysing complicated data. This breakthrough allows veterinarians and pathologists to make more accurate, dependable, and efficient diagnostic choices.

What is AI in Veterinary Pathology?

Artificial intelligence (AI) in veterinary pathology refers to the use of advanced computer algorithms to assist in diagnosing diseases in animals. It enhances the traditional practice of examining tissues, organs, and body fluids by enabling rapid and precise analysis of histopathological images, laboratory data, and molecular information. AI acts as a supportive tool for pathologists, improving the speed, accuracy, and consistency of diagnostic decisions.

How Artificial Intelligence is Transforming Veterinary Pathology

➤ **Improving Accuracy with Human–AI Collaboration:** One of the most exciting

developments is that AI does not replace the pathologist—it enhances their performance. Studies have shown that when AI is used alongside experts, diagnostic accuracy significantly improves. For example, detection of small cancerous changes becomes more reliable when AI tools assist in screening. In veterinary practice, this could mean earlier detection of tumours in pets and livestock, leading to better outcomes. (Steiner *et al.*, 2018)

- **Detecting What Humans Cannot See:** AI systems are capable of recognizing complex patterns in tissue structure and cell morphology. Beyond simple diagnosis, they can even predict underlying genetic changes or disease progression based on microscopic features. In animals, this could help in identifying breed-specific diseases, infectious agents, or predicting how a disease might evolve. (Kather *et al.*, 2019)
- **Saving Time and Reducing Workload:** Veterinary diagnostic laboratories often handle large volumes of samples, especially in herd health management and disease surveillance. AI can take over repetitive screening tasks—such as scanning slides for abnormalities—allowing pathologists to focus on complicated cases and decision-making. This not only improves efficiency but also reduces fatigue-related errors.
- **Standardization of Diagnosis:** One of the long-standing challenges in pathology—both human and veterinary—is **inter-observer variability**, where different pathologists may interpret the same tissue slide slightly differently based on experience, workload, or subjective judgment. This variability can lead to inconsistencies in diagnosis, grading of lesions, and ultimately treatment decisions. AI applies the same criteria uniformly

across all cases. This leads to more standardized and reproducible diagnoses across laboratories.

- **Advancing Personalized Veterinary Medicine:** The future of veterinary pathology lies in integrating multiple types of data—histopathology, molecular findings, and clinical records. AI has the potential to combine all this information to provide more precise diagnoses and tailored treatment plans. For example, it could help predict which therapy will work best for a particular animal based on its disease profile. (Mobadersany *et al.*, 2018)
- **Research and Drug Development:** AI accelerates research by identifying disease patterns, analysing genomic data, and predicting responses to treatments. This is particularly valuable in developing vaccines and therapeutics for animal diseases.

Key Challenges and Considerations

While artificial intelligence holds immense potential to transform veterinary pathology, its adoption is accompanied by a range of practical, technical, and ethical challenges that must be carefully addressed to ensure its safe, effective, and responsible use.

- 1. High Implementation Costs:** The adoption of AI requires significant investment in digital pathology infrastructure and advanced computing systems. Ongoing costs such as maintenance, software updates, and data storage add to the financial burden. This can limit accessibility, especially for smaller veterinary practices and laboratories.
- 2. Limited Availability of Quality Data:** AI systems depend on large, well-annotated datasets for accurate performance. In veterinary pathology, data is often scarce, diverse, and not well standardized across

species. This can affect the reliability and generalizability of AI-based diagnoses.

- 3. Need for Validation and Reliability:** AI tools must be rigorously tested to ensure consistent and accurate diagnostic results. Variations in sample preparation and imaging can impact AI performance. Without proper validation, there is a risk of incorrect diagnosis.
- 4. Integration into Routine Practice:** Incorporating AI into existing diagnostic workflows can be challenging and time-consuming. Many laboratories still rely on conventional methods and may face transition difficulties. Effective integration requires user-friendly systems and proper training.
- 5. Human Expertise Remains Essential:** AI should support, not replace, veterinary pathologists in diagnostic decision-making. Complex cases and unexpected findings still require human interpretation and judgment. A balanced approach ensures better accuracy and responsible use of technology.

CONCLUSION

Artificial intelligence is rapidly transforming veterinary pathology by enhancing diagnostic accuracy, improving efficiency, and enabling faster and more reliable disease detection in animals. Its ability to analyse complex data and integrate histopathological, molecular, and clinical information is paving the way for more precise and personalized veterinary care. However, challenges such as high costs, limited data availability, and the need for proper validation and integration must be addressed for its successful adoption. Importantly, AI should be viewed as a supportive tool that complements the expertise of veterinary pathologists rather than replacing it. With continued advancements and responsible implementation, AI holds great

promise in improving animal health, welfare, and overall disease management.

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