and Standards. *International Journal of Agricultural Extension*. 2021. Special Issue (02). P.83-91.

4. Авдєєва Л.В., Лазаренко Л.М., Мельниченко Ю.О. Імуномодулюючі властивості синбіотичних композицій пробіотичних штамів Bacillus subtilis, лактиту або лактулози. *Мікробіологічний журнал.* 2015. 77(1). 20-25.

5. Косташ В. Б., Приліпко Т. М. Вплив синбіотичного препарату «Біомагн» на динаміку живої маси і відтворну здатність корів. *Подільський вісник: сільське господарство, техніка, економіка* 2025. Випуск 1 (46). С. 67-71 DOI: https://doi.org/10.37406/2706-9052-2025-1.8 .

6. Методологія та організація наукових досліджень у тваринництві : навчальний посібник. За ред. Ібатулліна І.І., Жукорського О.М. Київ: Аграр. наука, 2017. 328 с.

7. Приліпко Т. М., Ткачук В. П., Косташ В. Б. Продуктивні та забійні показники курчат-бройлерів кросу за включення до раціону препаратів імунокоригувальної та біоцидної дії. *Таврійський науковий вісник. Серія: Сільськогосподарські науки*. 2023. Вип.129. С.229-233. DOI https://doi.org/10.32851/2226-0099.2023.129.29. .

8. Приліпко Т. М., Косташ В. Б. Вплив синбіотичного препарату «Біомагн» у комплексі з водним розчином дезінфікуючого засобу «діолайд» на динаміку живої маси піддослідних телят упродовж періоду вирощування. *Таврійський науковий вісник. Серія: Сільськогосподарські науки.* 2024. № 140. С. 488-493. DOI https://doi.org/10.32782/2226-0099.2024.140.60

9. Чечет О. М., Коваленко В. Л. Гайдей О. С. Доклінічні випробування препарату “Біомагн” на лабораторних тваринах та з використанням культури інфузорій Tetrahymena pyriformis. *Медична та клінічна хімія*. 2021. Т. 23. № 3. С. 48- 56.

CLINICAL PATHOPHYSIOLOGY AND BIG DATA AS A FOUNDATION FOR THE DIGITAL TRANSFORMATION OF ANIMAL HUSBANDRY

Lishchuk S.G., PhD in agricultural sciences
assistant professor of the Department of Normal and Pathological Morphology and Physiology Higher educational institution «Podillia State University»,
Kamianets-Podilskyi, Ukraine

Modern animal husbandry is undergoing a profound digital transformation in which, alongside the automation of housing and feeding processes, technologies for collecting and analyzing large volumes of biological information are coming to the forefront. This shift is changing the approach to veterinary medicine: instead of reacting to already manifested diseases, it becomes possible to conduct early diagnostics, predict pathologies, and manage animal health in a personalized way. The scientific foundation of these changes is clinical pathophysiology, which explains the mechanisms of disease development, while its integration with modern Big Data approaches allows these insights to be scaled and deepened.

Clinical pathophysiology traditionally analyzes organ and system changes caused by pathogenic factors such as infections, toxins, radiation, and metabolic disorders. However, classical methods rely on limited sample sizes and a relatively small set of manually assessed parameters. Big Data technologies overcome these constraints: sensors and biomonitoring systems can record hundreds of parameters every second, including heart rate, temperature, activity, and behavioral responses. Laboratory systems generate massive datasets of hematological, biochemical, and hormonal analyses, while digital pathology produces gigapixel tissue images available for automatic detection of morphological alterations [1].

Integrating these heterogeneous data streams into unified large-scale repositories makes it possible to create digital health profiles for animals. Such profiles combine medical history, laboratory test results, imaging data, and information on housing conditions, diet, and behavior. Based on these datasets, artificial intelligence systems learn to identify hidden patterns – for example, specific combinations of serum protein fractions and activity levels that precede inflammatory or metabolic disorders. These technologies already enable the prediction of mastitis and ketosis in dairy cattle several days before clinical signs appear and help identify the risk of respiratory infections in pigs [2].

A promising direction is the development of *digital twins* – virtual models of individual animals that are continuously updated with real-time physiological and pathological data. Digital twins are grounded in pathophysiological principles and allow the prediction of responses to diet changes, vaccination, therapeutic interventions, or stressors. As a result, farmers and veterinarians gain a powerful tool for planning herd management strategies without risking productivity or animal health. Research has demonstrated successful use of such models for forecasting growth, feed conversion, and disease outcomes in swine and cattle, as well as simulating infectious disease dynamics [3, 4].

Another crucial component of digitalization is *early warning systems*. Combining data from wearable and stationary sensors with Big Data analytics allows detection of subtle physiological changes often invisible to humans. For example, increased heart rate and body temperature, reduced mobility, or feed intake can signal the onset of inflammation or intoxication. Prompt response helps reduce the use of antibiotics, prevent disease spread, and lower treatment costs [5].

However, the large-scale adoption of Big Data in veterinary medicine also faces significant challenges. Foremost is data quality and standardization – laboratories and sensor manufacturers often use different formats and measurement units. Another critical issue is interoperability: for analytics platforms to function effectively, databases, software, and hardware must integrate seamlessly. Additionally, privacy and cybersecurity are vital, as vast amounts of biological and production data have commercial value and require robust protection against unauthorized access. Finally, there is a shortage of professionals who combine expertise in pathophysiology, biostatistics, and data analytics, limiting the full potential of these technologies [6].

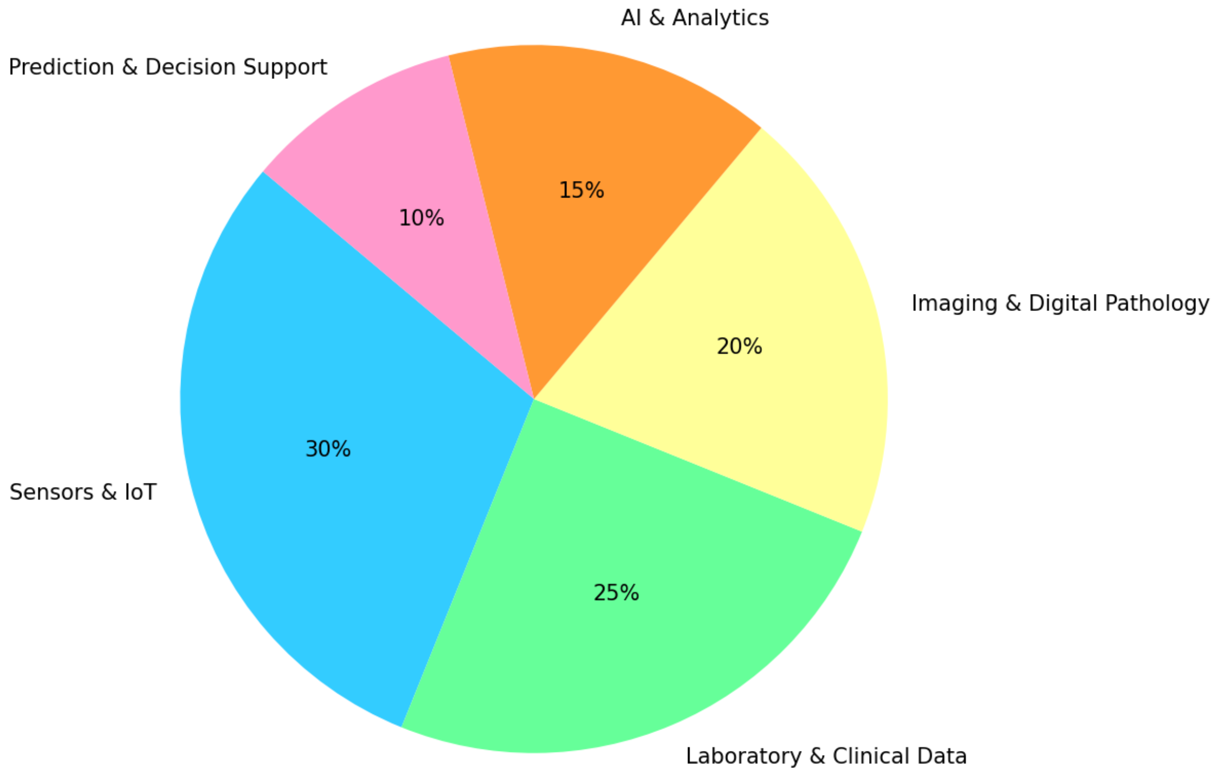

Figure. Big Data components in veterinary medicine

Despite these challenges, international experience shows a rapid increase in production efficiency after implementing digital health monitoring systems (Fig. 1***)***. Technologies help reduce juvenile mortality, better predict treatment needs, optimize feed and medication usage, and improve food safety. Collaboration between scientists, digital solution developers, and veterinarians is a crucial success factor, ensuring that systems are based on real pathophysiological knowledge and adapted to the specifics of different animal production systems.

Thus, integrating clinical pathophysiology with Big Data technologies creates a new paradigm for veterinary science and practice. It allows a transition from descriptive disease analysis to precise prediction and personalized health management of livestock. Digital twins, intelligent analytics platforms, and early warning systems not only improve animal welfare but also make animal husbandry more economically resilient, environmentally sustainable, and globally competitive.

References:

1. VanderWaal K., De Paso R., Kaplon J. Translating Big Data into Smart Data for Veterinary. *Frontiers in Veterinary Science*. 2017. Vol. 4. Article 110. DOI: 10.3389/fvets.2017.00110.

2. McCue M. E., McKinley C., Ruple A., Paynter A. The Scope of Big Data in One Medicine. *Frontiers in Veterinary Science*. 2017. Vol. 4. Article 194. DOI: 10.3389/fvets.2017.00194.

3. Neethirajan S., Kemp B. Digital Twins in Livestock Farming. *Animals*. 2021. Vol. 11, No. 4. Article 1008. DOI: 10.3390/ani11041008.

4. Brown-Brandl T. M., Rohrer G. A., Campler M. L. Precision Livestock Farming: Real-Time Data and Digital Twins. *Animals*. 2021. Vol. 11, No. 12. Article 3563. DOI: 10.3390/ani11123563.

5. Paynter A. N., Dunbar M. D., Creevy K. E., Ruple A. Veterinary Big Data: Opportunities and Challenges. *Animals*. 2021. Vol. 11, No. 7. Article 1872. DOI: 10.3390/ani11071872.

6. Lustgarten J. L., et al. Veterinary Informatics: Forging the Future Between Big Data and Clinical Practice. *Frontiers in Veterinary Science*. 2020. Vol. 7. Article 23. DOI: 10.3389/fvets.2020.00023.

ARTIFICIAL INTELLIGENCE IN VETERINARY EDUCATION, INNOVATIONS FOR PRECLIINICAL DISCIPLINES

Savchuk L., candidate of Agricultural Sciences, Associate Professor
Danchuk V., Doctor of Agricultural Sciences, Professor
Krykun D., 4th year student, Master`s degree program in Veterinary Medicine
Higher Education Institution “Podilskyi State University”,
Kamianets-Podilskyi, Ukraine

Artificial intelligence (AI) is no longer science fiction – it has become part of our everyday lives. From smartphones and smart homes to medicine and law, Artificial intelligence is changing the way we work, learn, communicate and even make decisions. The world has embraced AI as a technology that can make our lives easier and drive economic development [1]. The rapid development of Artificial intelligence and cybersecurity often outpaces the legislative process, making many regulatory measures obsolete before they are fully implemented [2].

The use of Artificial intelligence is gradually taking over a wide variety of areas in human life, displacing outdated approaches. In history, only four technologies are known that have changed human life as profoundly as AI: steam power, which gave rise to the industrial revolution; electricity, which changed everything; the discovery of antibiotics and the medical understanding of biochemical transformations and treatment in general; computers and Artificial intelligence software, which created the information age [3].