MODERN METHODS OF LABORATORY DIAGNOSTICS

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Abstract
Laboratory diagnostics plays a key role in modern medicine, providing more than 70% of the information needed for diagnosis, monitoring the course of diseases and assessing the effectiveness of therapy. Modern technologies are rapidly evolving, expanding the possibilities of diagnostics and increasing its accuracy, specificity and speed. This article discusses the main directions of laboratory diagnostics development, including molecular genetic methods, high-throughput sequencing, immunochemical technologies, process automation and the integration of artificial intelligence [1,2,3,4].

Keywords: laboratory diagnostics, sequencing, serological tests, immunological tests, genetic mutations, biomarkers;

Laboratory diagnostics plays a key role in modern medicine, providing more than 70% of the information needed for diagnosis, monitoring the course of diseases and assessing the effectiveness of therapy. Modern technologies are rapidly developing, expanding the possibilities of diagnostics and increasing its accuracy, specificity and speed. This article reviews the main directions of laboratory diagnostics

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development, including molecular genetic methods, high-throughput sequencing, immunochemical technologies, process automation and artificial intelligence integration [5,6,7,8].

Modern medical practice is unthinkable without laboratory diagnostics, which is the basis of evidence-based medicine. Traditional methods such as microscopy, biochemical analysis and serological tests are complemented by innovative technologies that allow detection of minimal concentrations of biomarkers, detection of genetic mutations and prognosis of disease course. Increasing demands for personalised medicine are driving the adoption of increasingly accurate and informative diagnostic solutions [9,10,11,12].

Molecular genetic methods. Molecular diagnostics occupies one of the leading positions among modern trends. Polymerase chain reaction (PCR) remains the 'gold standard' in the detection of infectious agents and mutations. Classical PCR is being replaced by more sensitive and highly specific methods such as digital PCR (dPCR) and loop isothermal amplification (LAMP) [13,14,15].

Additionally, next-generation sequencing (NGS) methods allow analysing the entire genome or transcriptome, which significantly expands the diagnostic possibilities for cancer, hereditary and infectious diseases.

Immunochemical and biosensor diagnostics. Enzyme-linked immunosorbent assay (ELISA), chemiluminescence and immunochromatography methods provide high sensitivity in the detection of antigens, antibodies and other biomolecules [16,17,18,19,20].

Modern biosensors, including nanotechnology platforms and biochips, enable rapid real-time diagnostics. An example is the use of point biochips (lab-on-a-chip) in the diagnosis of COVID-19, oncopathologies and cardiovascular diseases.

Automation and robotisation of laboratory processes. The development of automated analysers and laboratory information systems (LIS) is improving reproducibility and reducing the impact of human error. High-throughput laboratories use robotic platforms that provide 24/7 sample processing, as well as automatic interpretation and archiving of results [21,22,23,24].

Artificial intelligence and digital diagnostics

Artificial Intelligence (AI) and machine learning based systems are being actively implemented in the interpretation of laboratory data, especially in haematology and microbiology. AI algorithms can recognise pathological cells, perform differential analysis and predict clinical outcomes.

In addition, telediagnostics and the integration of laboratory data with electronic medical records contribute to increasing accessibility and personalisation of care.

Immunochemical and Biosensor Diagnostics

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Conclusion

Modern laboratory diagnostic methods are a synthesis of innovative biotechnology, automation and digital solutions. Their implementation significantly increases the efficiency of healthcare, allowing not only to detect diseases faster and more accurately, but also to predict their development. The prospects for the development of this field are associated with further improvement of technologies, reduction of their cost and expansion of clinical application.

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