

- 1 **Supplementary Materials**
- 2 **Supplementary Table S1. Complete Database Search Strategies**

Database	Search Date	Search String	Filters	Records Retrieved
PubMed	March 15, 2026	((("Artificial Intelligence"[MeSH] OR "Machine Learning"[MeSH] OR "Deep Learning"[MeSH]) AND ("Gastrointestinal Microbiome"[MeSH] OR "Microbiota"[MeSH]) AND ("Multi-Omics" OR "Metagenomics" OR "Metabolomics") AND ("Autoimmune Diseases"[MeSH] OR "Rheumatoid Arthritis" OR "Lupus Erythematosus, Systemic" OR "Inflammatory Bowel Diseases" OR "Multiple Sclerosis") AND ("Precision Medicine"[MeSH] OR "Personalized Medicine")))	2020-2026, English, Humans	28
Scopus	March 15, 2026	TITLE-ABS-KEY(("artificial intelligence" OR "machine learning" OR "deep learning") AND ("gut microbiome" OR "gut microbiota" OR "intestinal microbiome") AND ("multi-omics" OR "metagenomics" OR "metabolomics") AND ("autoimmune diseases" OR "rheumatoid arthritis" OR "systemic lupus erythematosus" OR "inflammatory bowel disease" OR "multiple sclerosis") AND ("precision medicine" OR "personalized medicine")))	2020-2026, English	24

Web of Science	March 15, 2026	TS=("artificial intelligence" OR "machine learning" OR "deep learning") AND TS=("gut microbiome" OR "gut microbiota") AND TS=("multi-omics" OR "metagenomics" OR "metabolomics") AND TS=("autoimmune diseases" OR "rheumatoid arthritis" OR "lupus" OR "inflammatory bowel disease" OR "multiple sclerosis") AND TS=("precision medicine" OR "personalized medicine")	2020-2026, English	19
Google Scholar	March 15, 2026	("artificial intelligence" OR "machine learning") ("gut microbiome" OR "microbiota") ("multi-omics" OR "metagenomics") ("autoimmune" OR "rheumatoid arthritis" OR "lupus" OR "IBD" OR "multiple sclerosis") ("precision medicine" OR "personalized medicine")	2020-2026, English	15
Total				86

3

4 **Supplementary Table S2. Excluded Full-Text Articles with Reasons for Exclusion**

Article Reference	Reason for Exclusion
He Q, et al. Frontier research and clinical application prospects of microbiome biomarkers in autoimmune diseases. Front Immunol. 2026;17:1752840.	Review article (used for background context only - not primary research)
Szili K, Ahmad A, Gulyás-Oldal V, et al. AI-driven	Insufficient methodological information - narrative review without original data

microbiome-based biomarkers for early diagnosis of cancer and autoimmune diseases: current advances and future perspectives. Rev J Neurol Med Sci Rev. 2026.	
Systems immunology meets clinical translation: Multi-omic approaches to predict therapy response in cancer and autoimmune disease. Sci Transl Med. 2025.	Review article (used for background context only - not primary research)
Wang Q, Li CL, Yu SY, et al. A predictive model based on the gut microbiota improves the diagnostic effect in patients with rheumatoid arthritis. Rheumatology. 2025;64(6):4014-4021.	Focused on single-omics (16S rRNA sequencing) without multi-omics integration
Usmani A, Siddiqui MA, Kumar D, et al. Next 5 years in autoimmunity: predictive diagnostics, immune signatures, and personalized immune therapy. Autoimmun Rev. 2026.	Review article (used for background context only - no AI-based analysis)

Li L, Liu H, Ye Z, Xu W. Gut microbiota-derived metabolites regulate CASP3 and neuroimmune pathways in multiple sclerosis: an integrative multiomics study. Mediators Inflamm. 2026.	Study design focuses on network pharmacology and ML but does not integrate gut microbiome multi-omics data (uses DEGs from public datasets)
Bong H, Min J, Kim S, et al. ATOMIC: a graph attention network for atopic dermatitis prediction using human gut microbiome. Front Immunol. 2026;16:1670993.	Focused on atopic dermatitis (not autoimmune diseases - atopic dermatitis is an allergic/inflammatory skin condition, not classified as autoimmune)
Metagenomics - AI powered prediction of Inflammatory Bowel's Disease and probiotic recommendation. medRxiv. 2026.	Preprint (not peer-reviewed) - insufficient methodological validation; single validation sample
Fan R, Zang Q, Xu Y, et al. Metagenomic characterization of gut microbiota in rheumatoid arthritis-associated interstitial lung disease: taxonomic shifts and clinical correlations. Front Immunol. 2026;17:1868704.	Focused on taxonomic analysis without multi-omics integration; no AI-based predictive modeling (used random forest only for classification without multi-omics integration)

