

probiotics can contribute to ecological aquaculture by reducing waste output, stabilizing culture water, and improving the economic efficiency of feed use (Ajamhasani et al., 2023). In this case-study perspective, compound probiotic preparations show clear potential to improve growth, gut health, and system sustainability in grass carp aquaculture. Their most practical value appears when feed efficiency, immune stability, and water-quality management are evaluated together rather than as isolated outcomes (Figure 3).

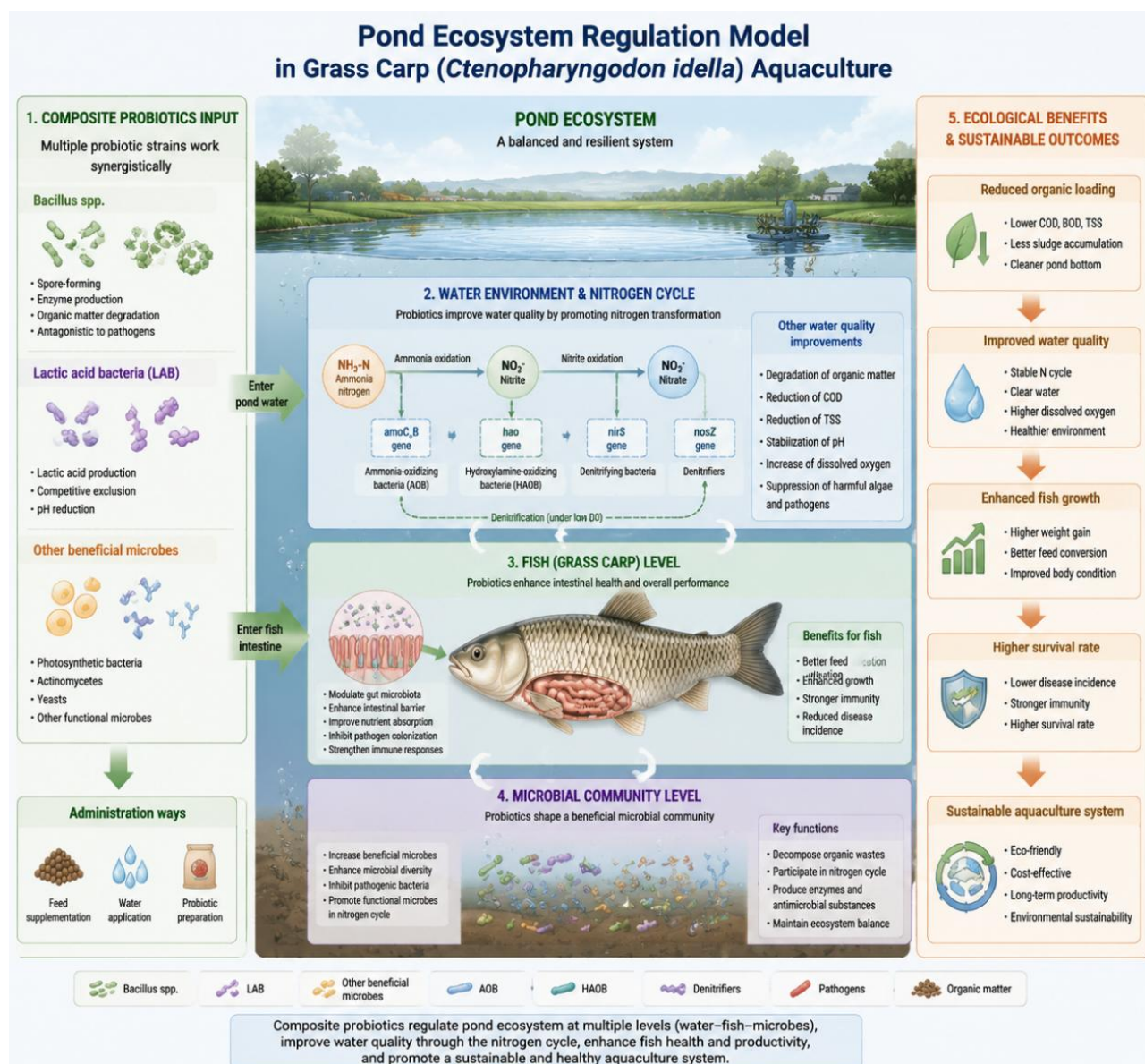


Figure 3 Ecological regulation mechanisms of compound probiotics in grass carp aquaculture system

8 Key Issues and Future Perspectives of Probiotic Applications

8.1 Probiotic strain selection, functional evaluation, and optimization of stability

A core issue in future grass carp probiotic development is that strain efficacy is species- and environment-dependent, so candidate strains cannot be selected only by taxonomic identity. Reviews of aquaculture probiotics emphasize that a strain beneficial in one host may not provide the same benefit in another, and may even become unsuitable under different rearing conditions, which makes extensive host-oriented testing essential before field use. This concern is consistent with newer overviews stressing that strain selection for aquaculture must account for safety, functional performance, and species-specific dosing, because predictable large-scale application remains a major bottleneck (Elsegeny et al., 2025).