

纳米塑料通过重塑胆汁酸-微生物群轴驱动肝肠代谢紊乱

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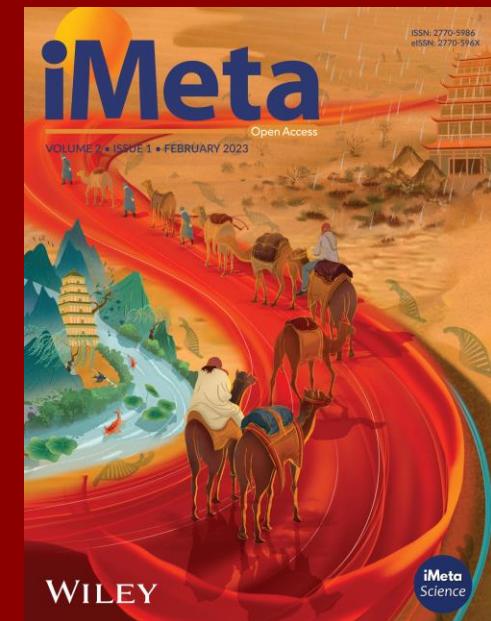
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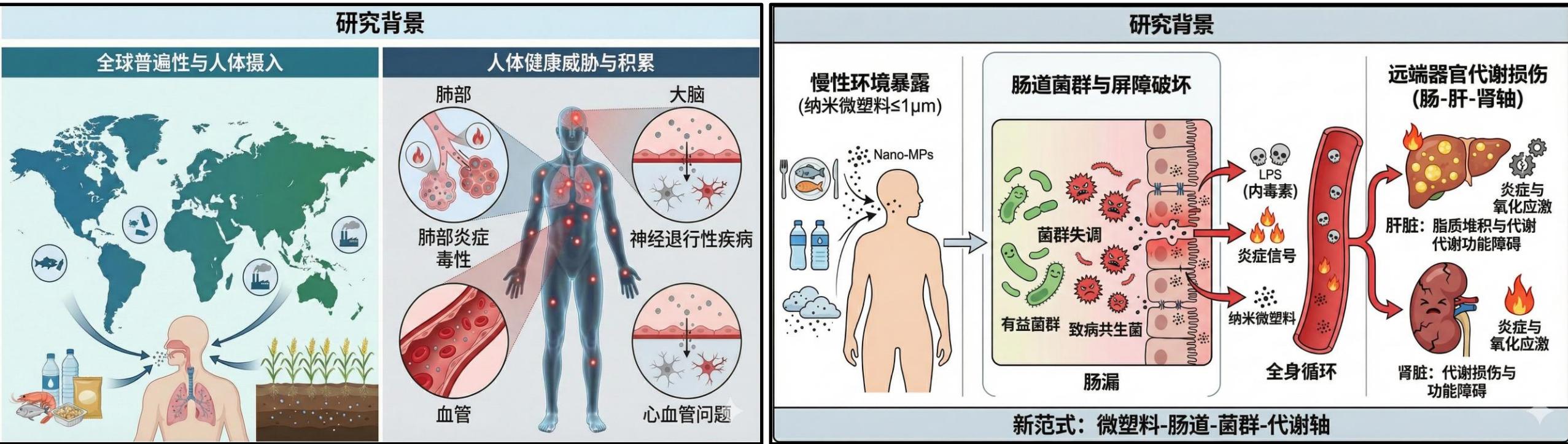


Yi Zhang, Zheng Lin, Runtong Huang, Yang Zhang, Lei Wang, Zan Fu, Chao Wang, et al. 2025. Nano-plastics disrupt systemic metabolism by remodeling the bile acid–microbiota axis and driving hepatic–intestinal dysfunction. *iMeta* 4: e70103.

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简介

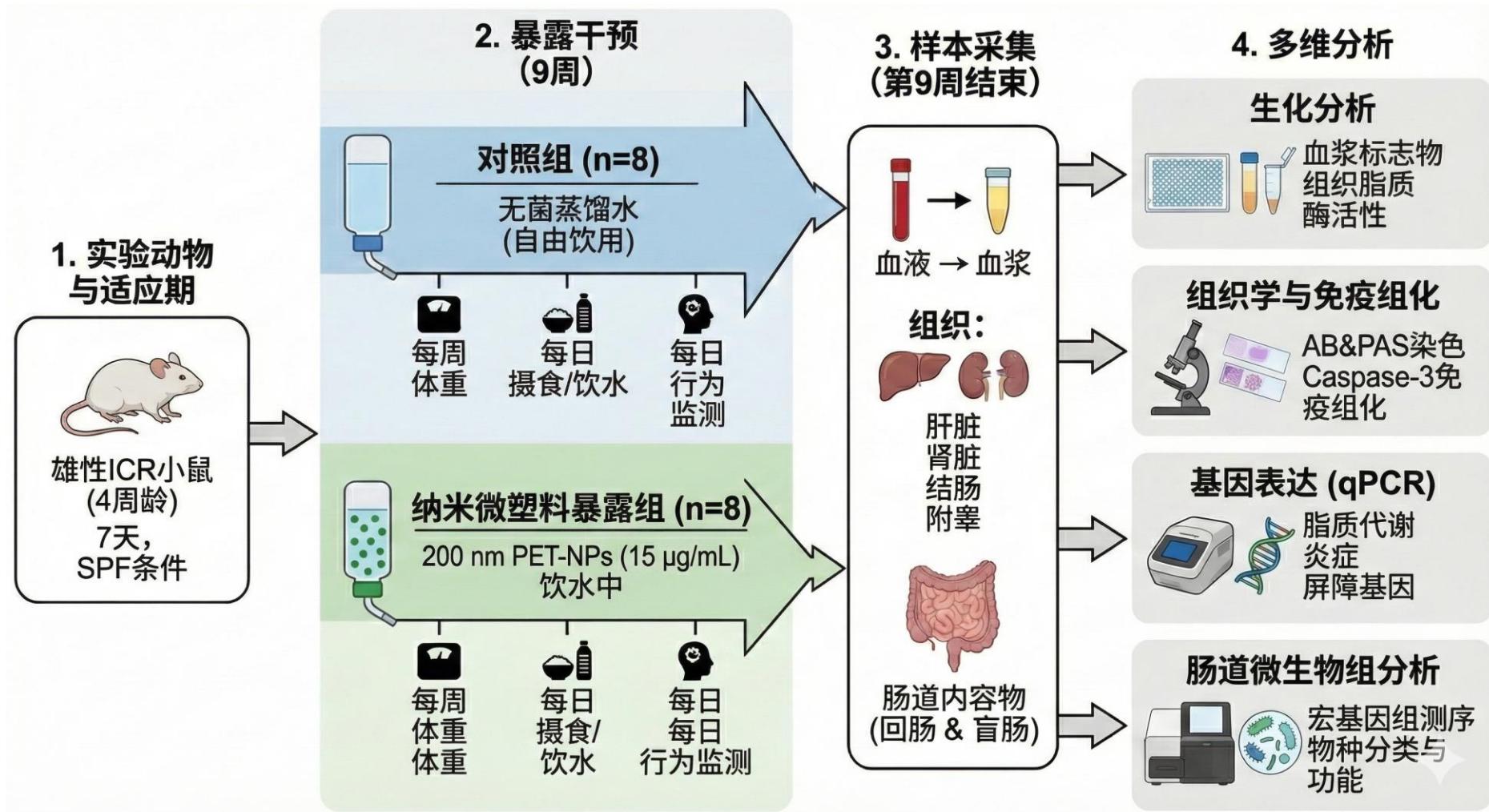


人类通过日常途径（食物、饮水、空气等）长期、慢性地摄入纳米微塑料！

现有研究局限：多关注单器官毒性，缺乏对全身代谢互作的理解。



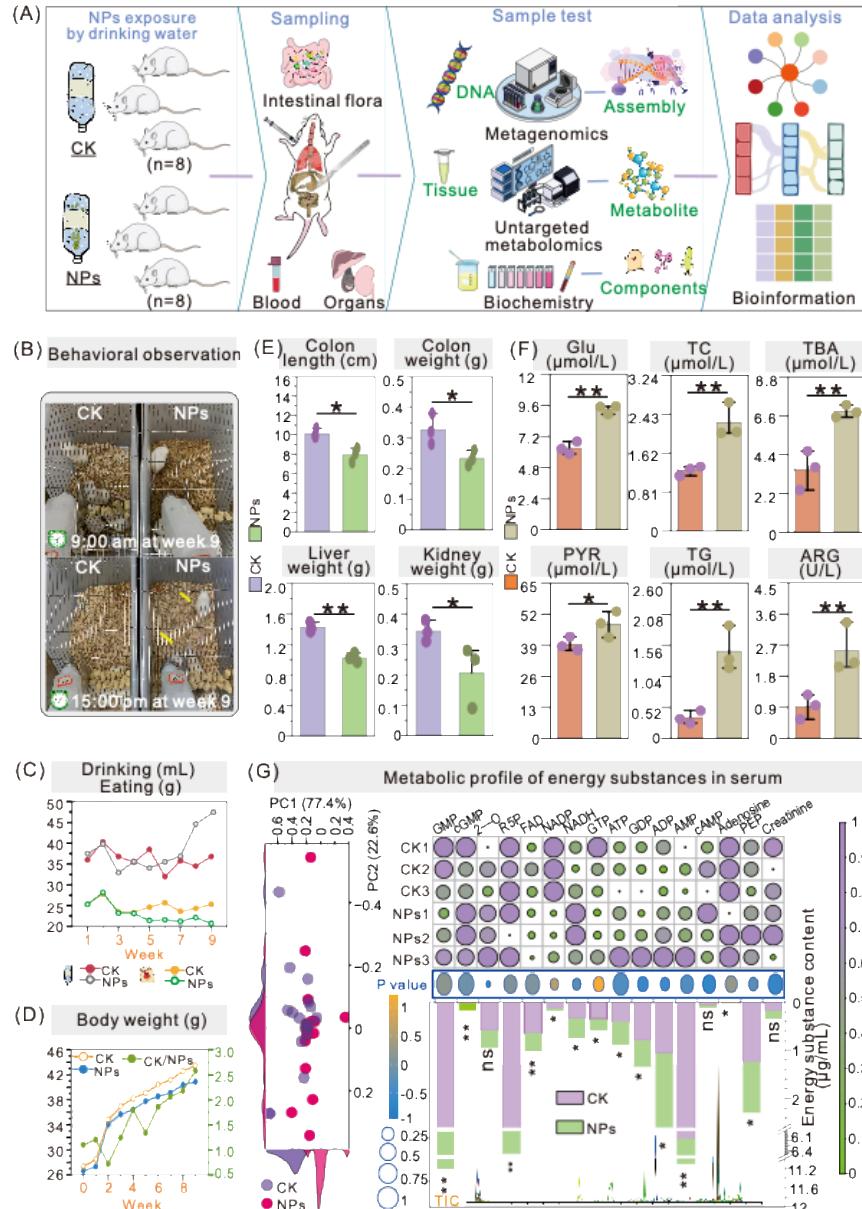
试验设计



构建了一个通过饮用水长期暴露微塑料的小鼠实验模型

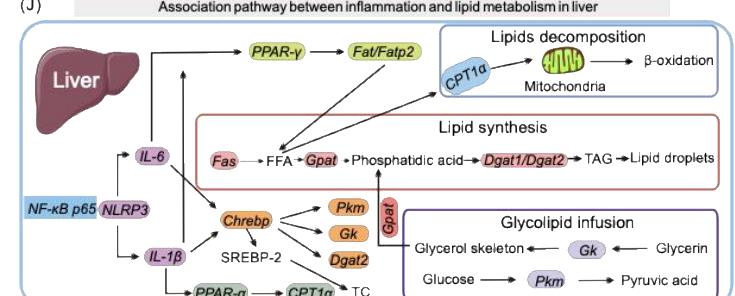
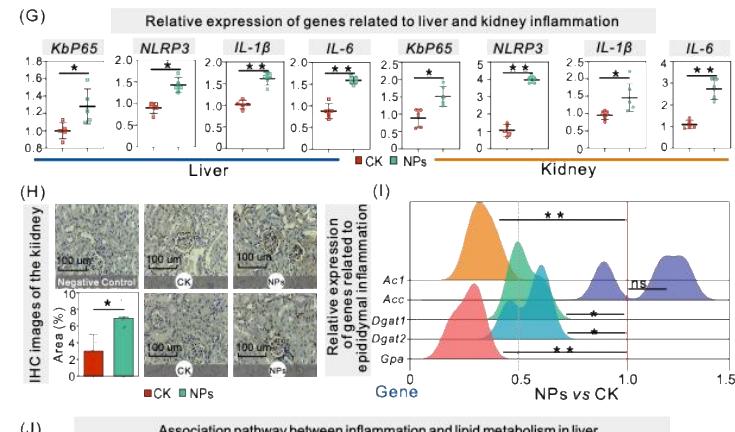
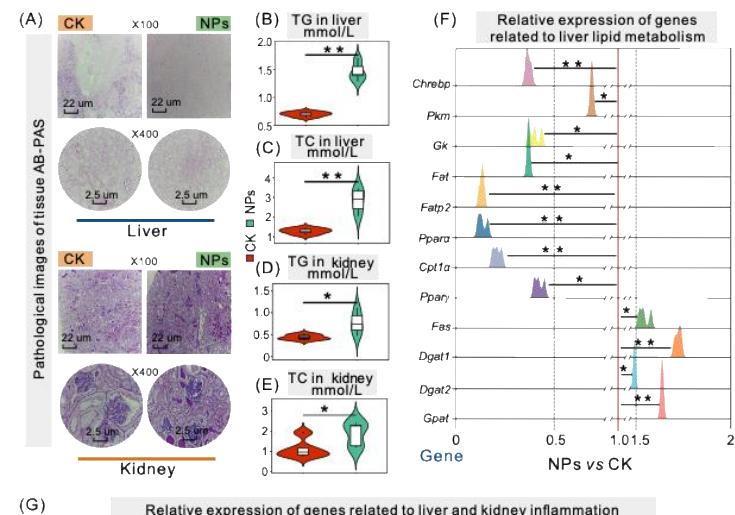
结合组织病理学、生化分析、靶向代谢组学和宏基因组学进行了系统性评估

能量代谢变化和肝肾炎症反应



- 表型: 体重减轻、过度兴奋、器官萎缩。
- 代谢: 高血糖、高血脂。
- 能量: 线粒体功能。

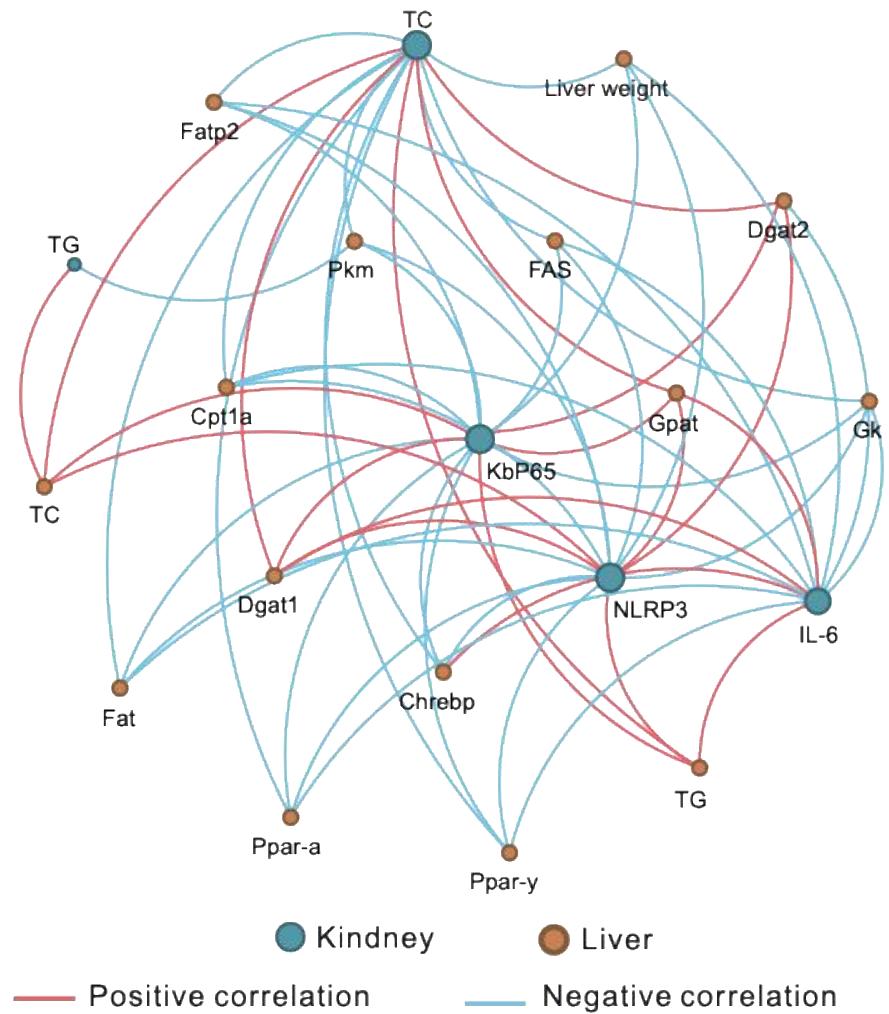
- 肝肾: 脂质堆积、炎症因子上调。



NPs暴露对小鼠生长性能、器官和能量代谢的影响

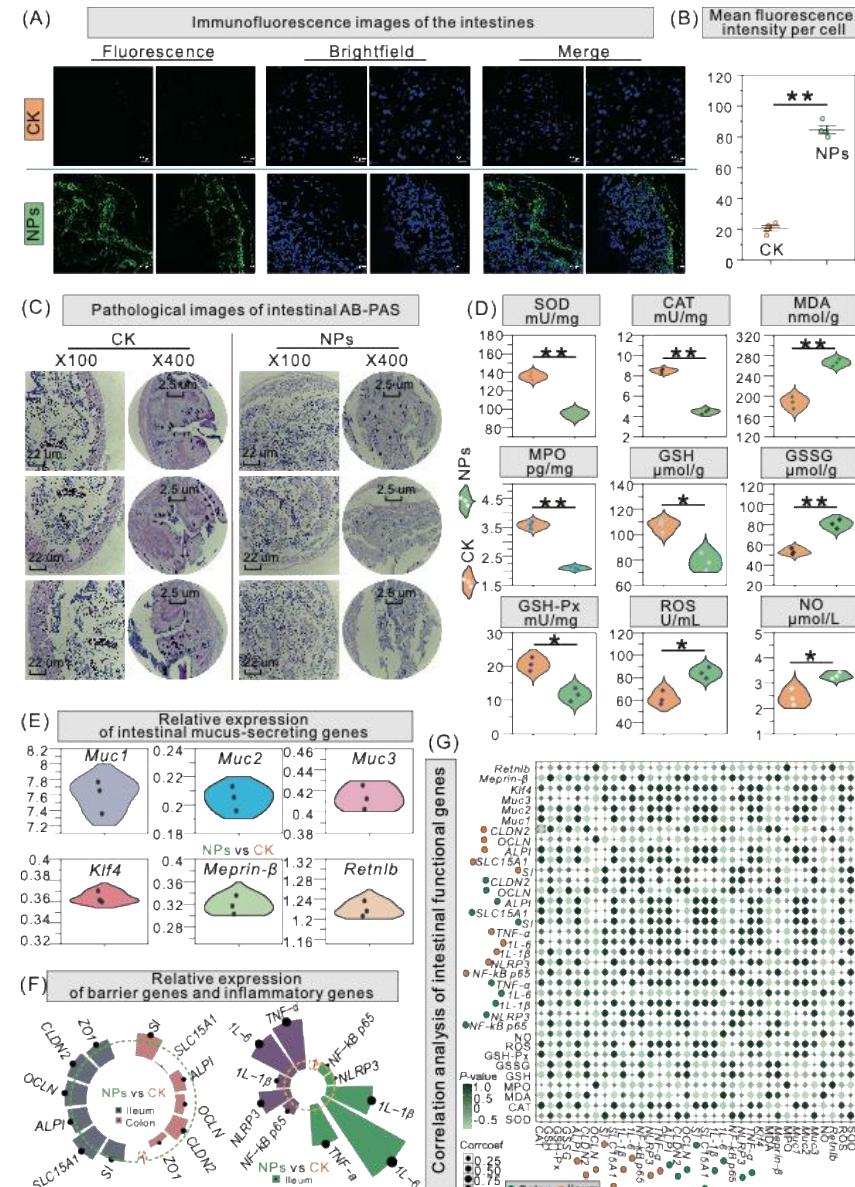
NPs暴露重塑肝脏和肾脏脂质代谢并诱导炎症反应

肠道屏障损伤和炎症爆发



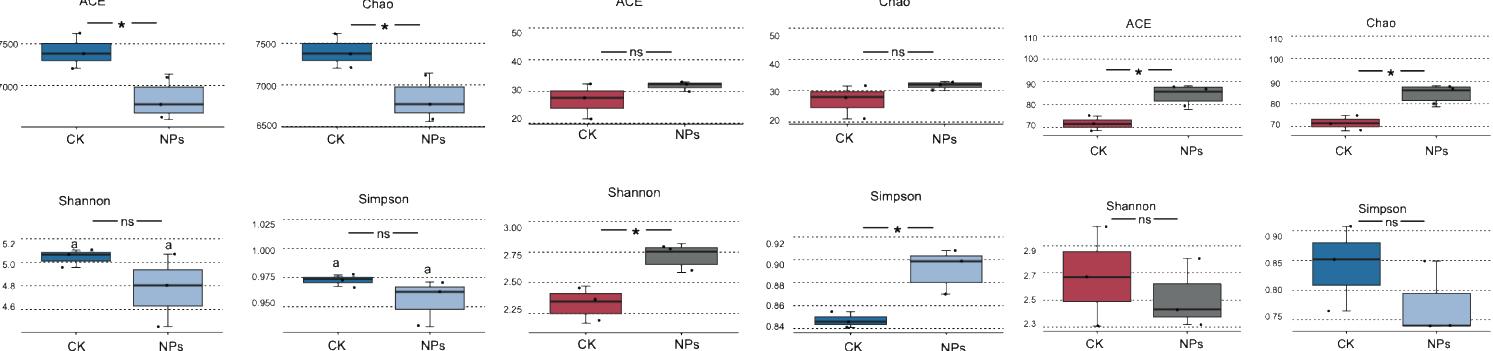
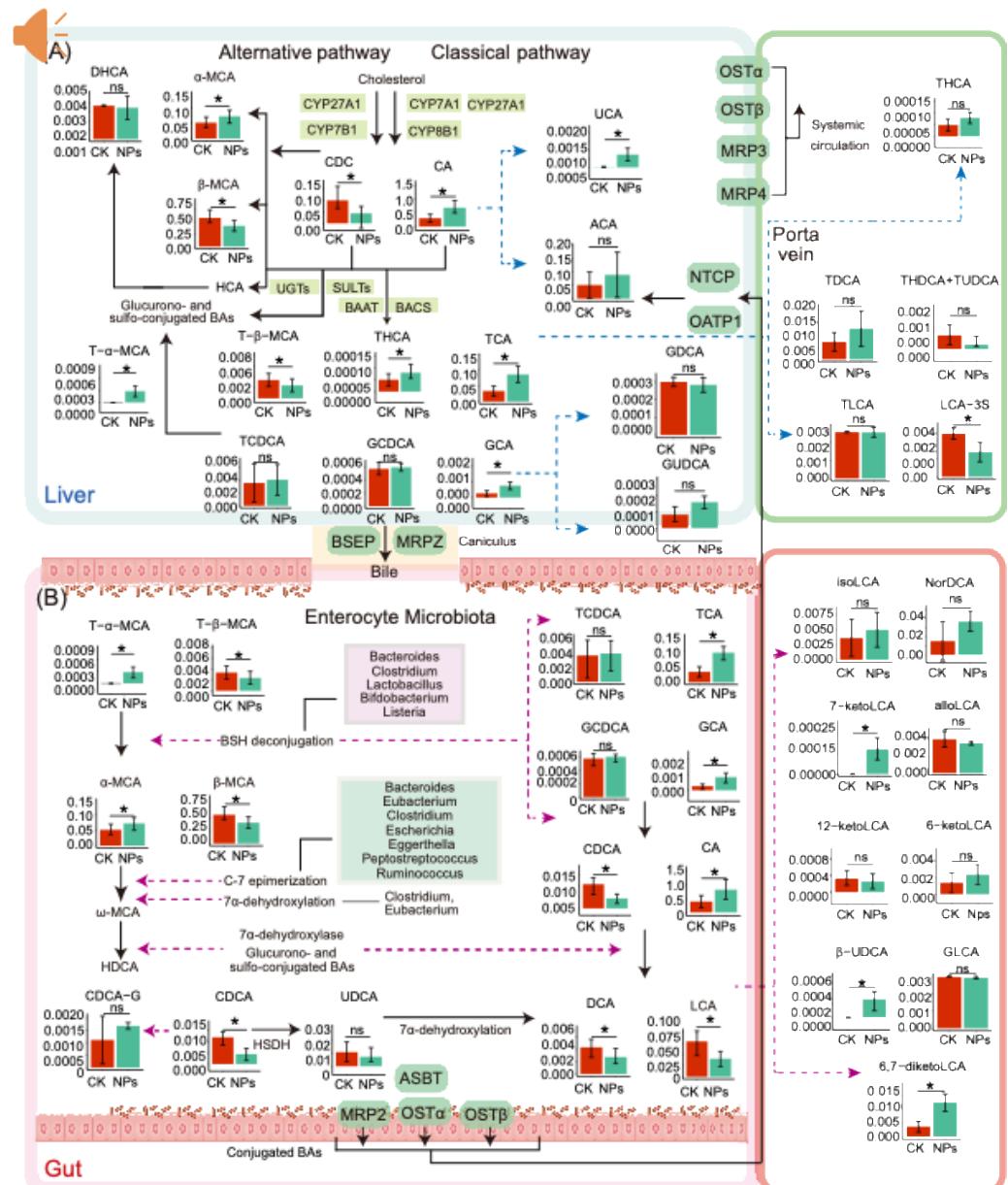
NPs暴露肝脏和肾脏中TC和TG含量、脂质代谢相关基因和炎症因子的共现网络

肠道屏障严重受损，粘液层变薄，氧化应激标志物显著升高。

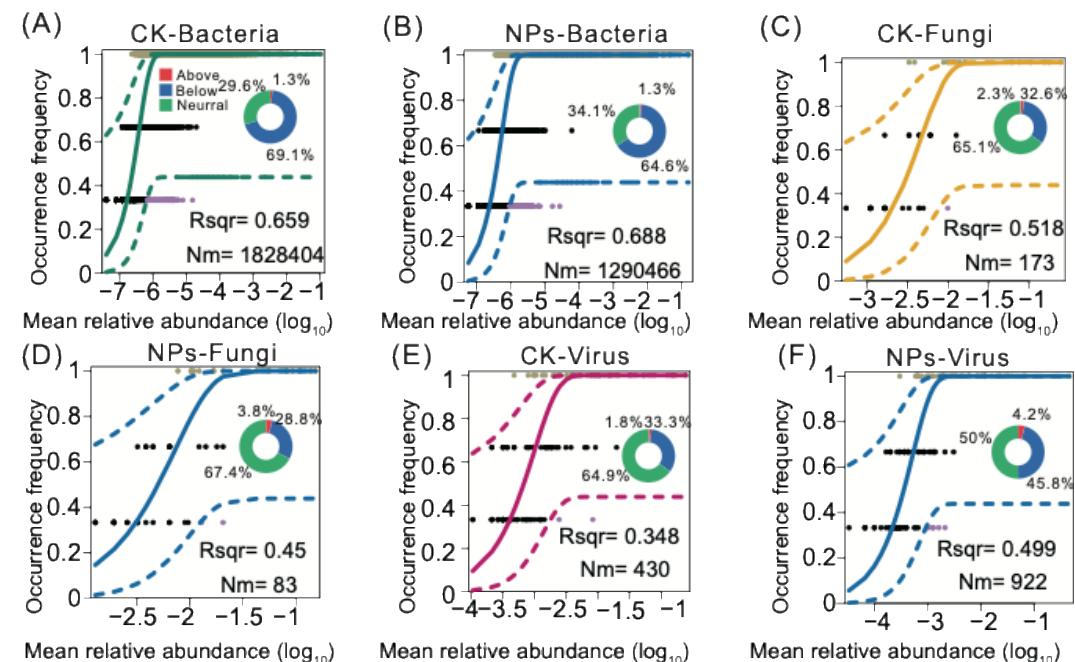


NPs暴露引起肠道氧化还原失衡、屏障损坏和炎症爆发

肝—肠胆汁酸谱和肠道菌群多样性

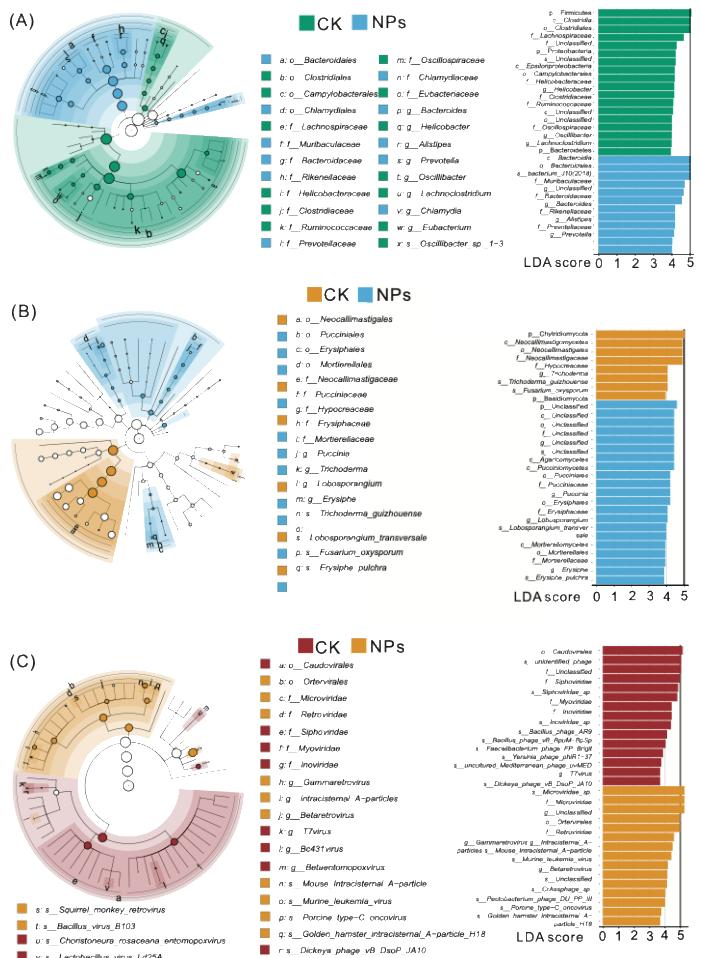
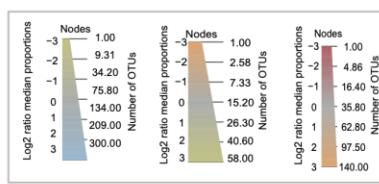
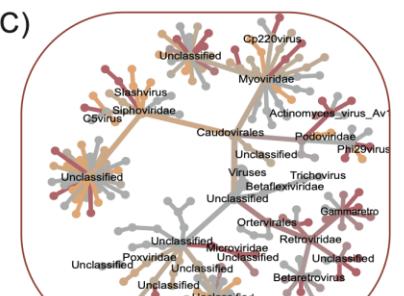
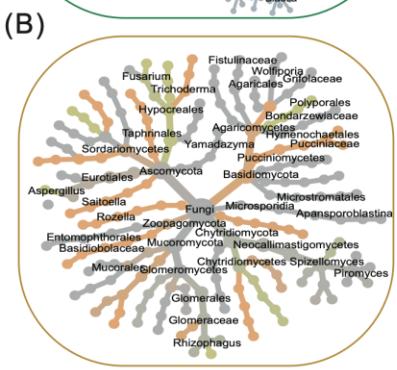
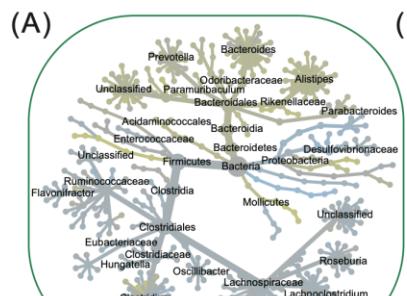


NPs暴露后小鼠肠道细菌、真菌和病毒群落的 α 多样性



肠道菌群的中性模型分析

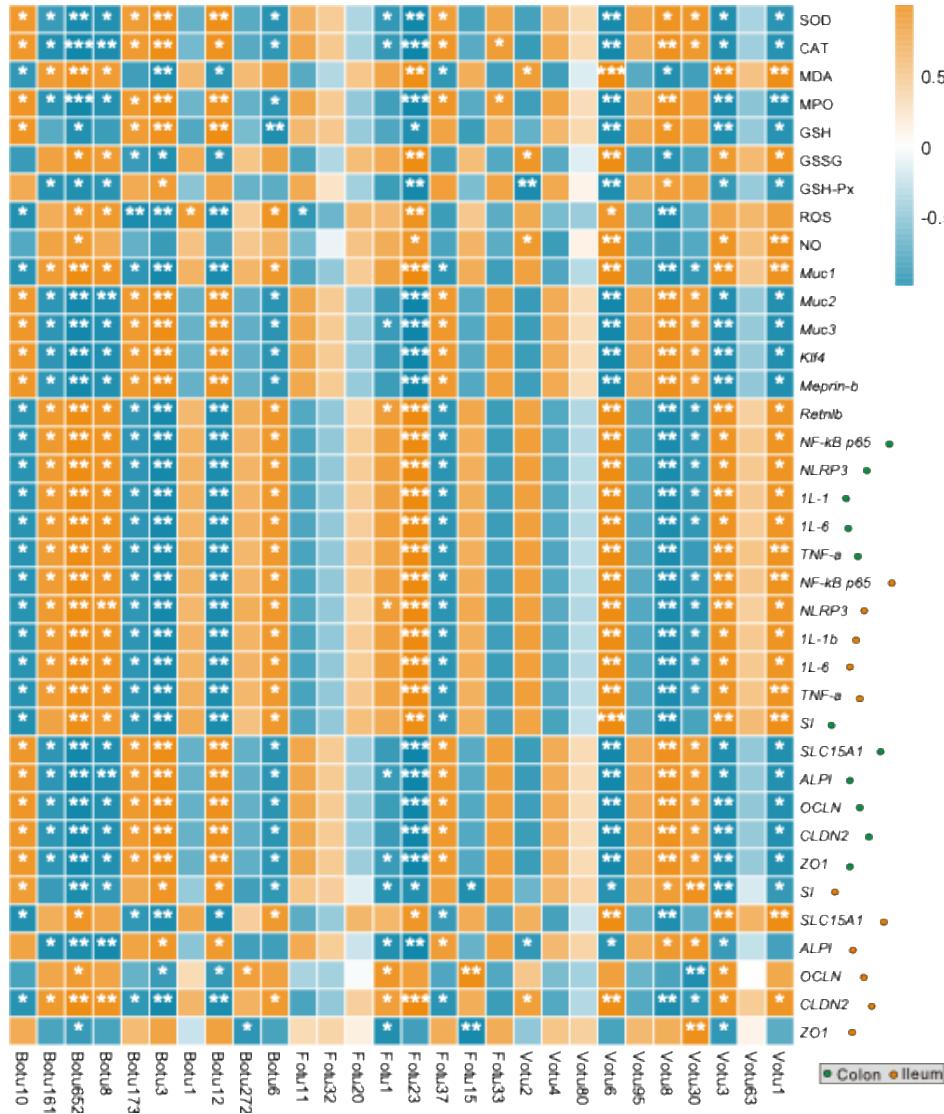
肠道菌群结构差异与功能作用



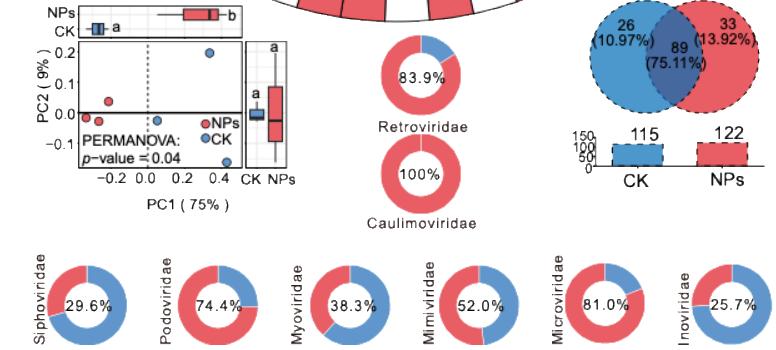
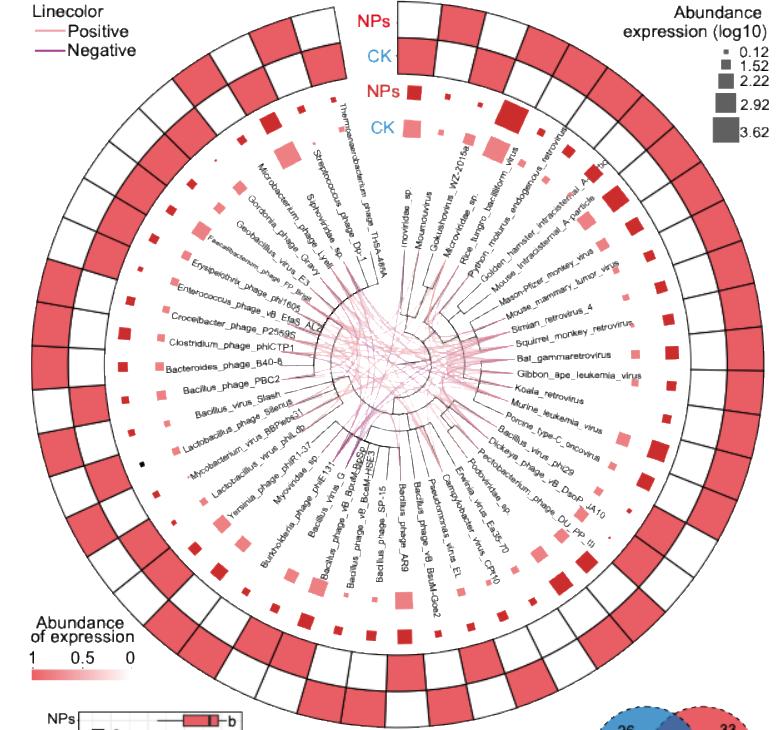
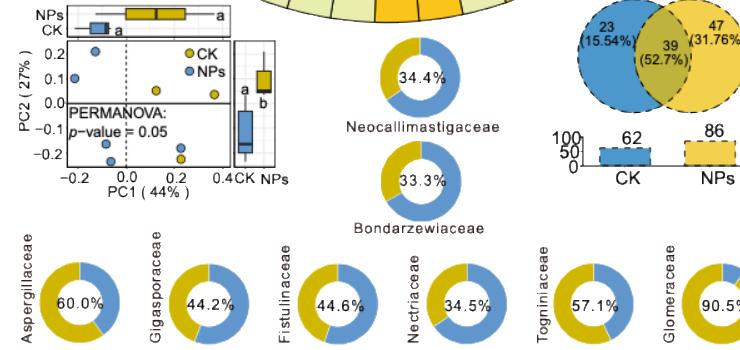
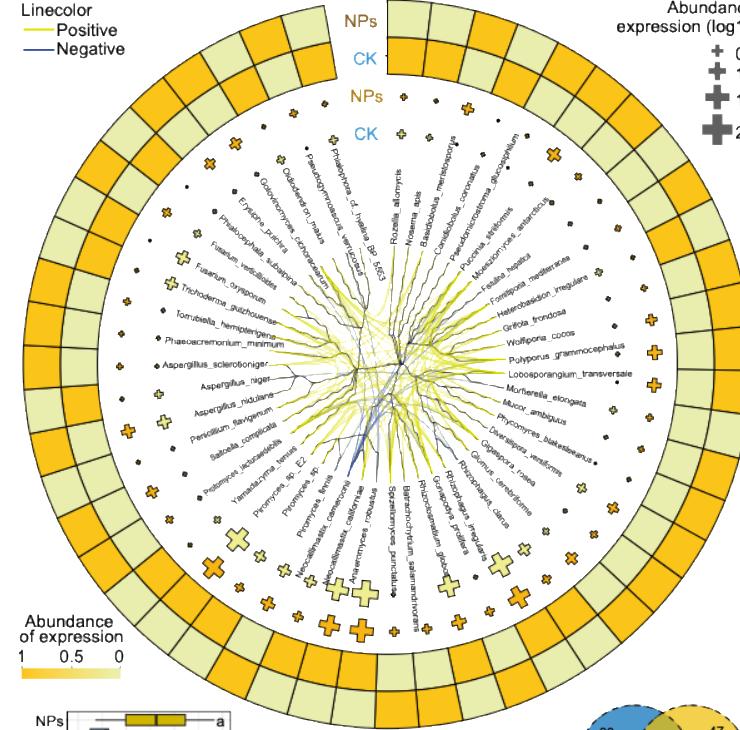
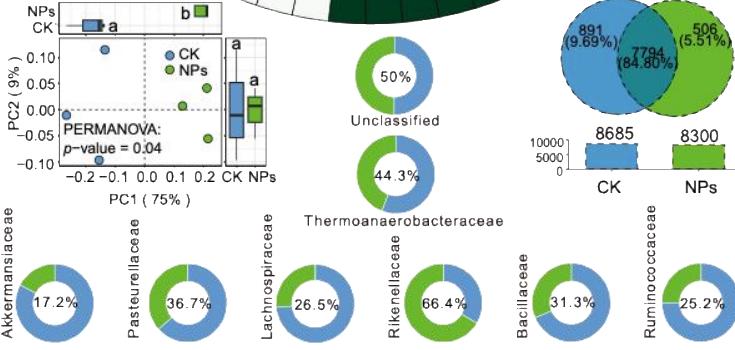
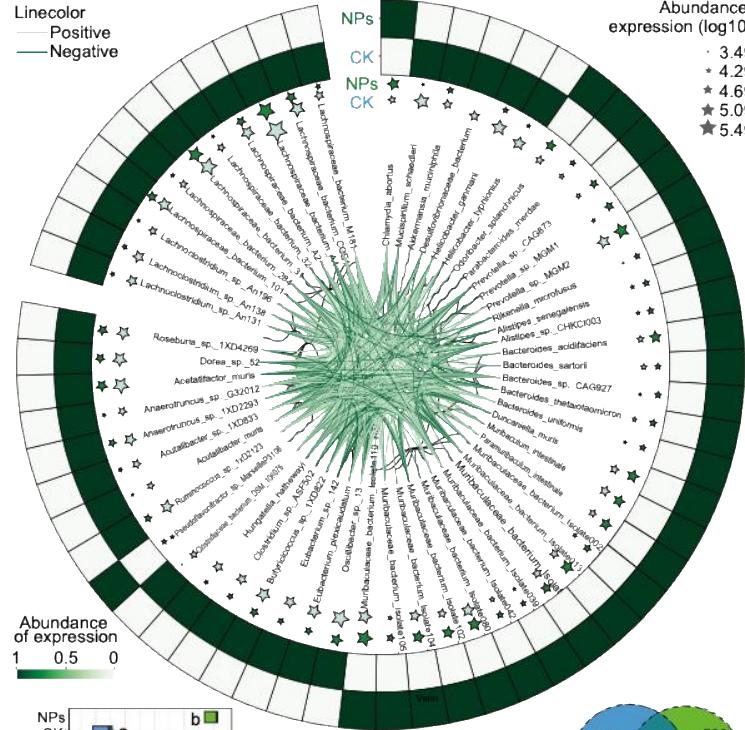
热树可视化显示CK和NPs暴露组之间细菌、真菌和病毒群落的不同分类丰度

线性判别分析效应大小 (LEfSe)
识别NPs暴露后的差异富集类群。

热图显示肠道物理化学指数与细菌、真菌和病毒群落特征微生物类群丰度之间的Spearman相关系数。

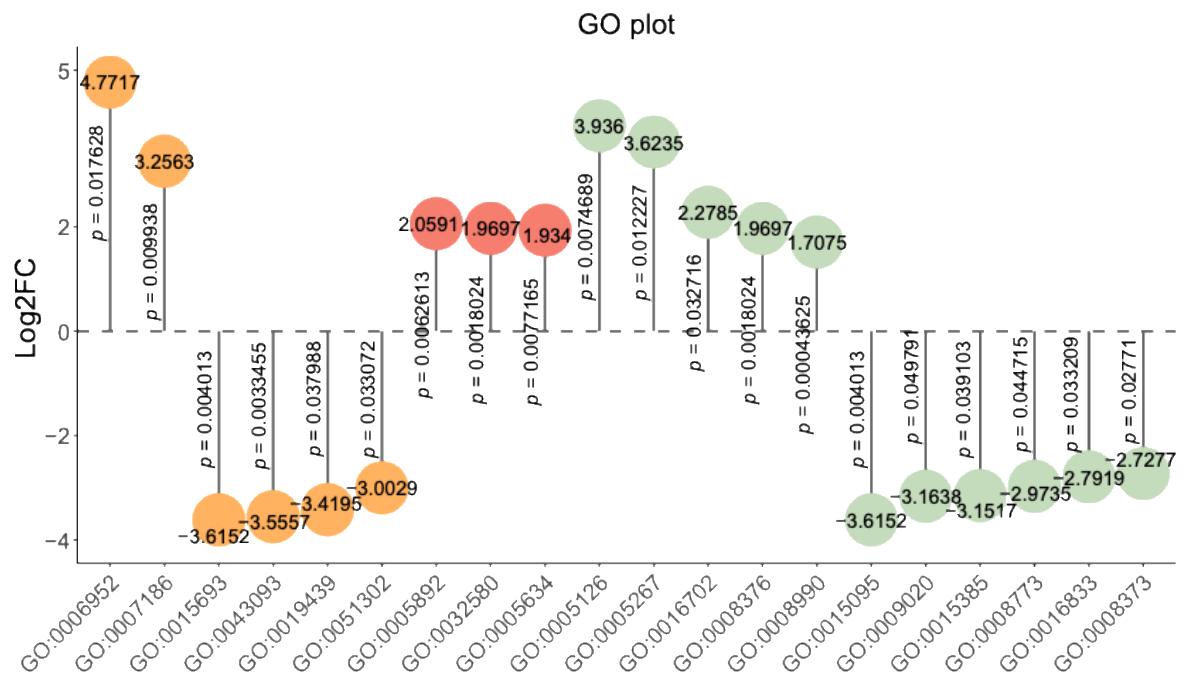


肠道菌群结构差异与功能作用



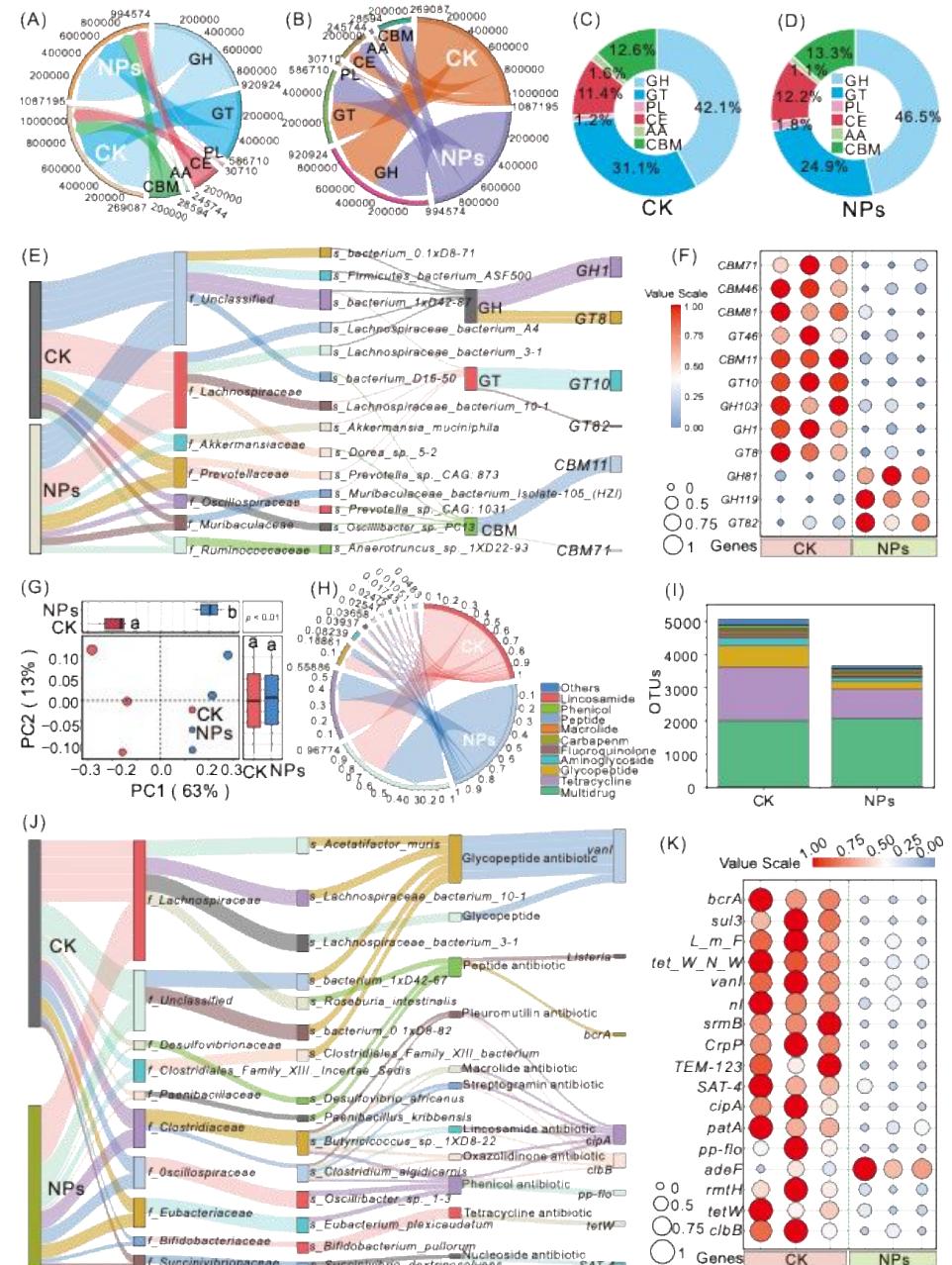
NPs暴露改变小鼠肠道细菌、真菌和病毒群落结构

肠道菌群CAZymes和ARGs的变化

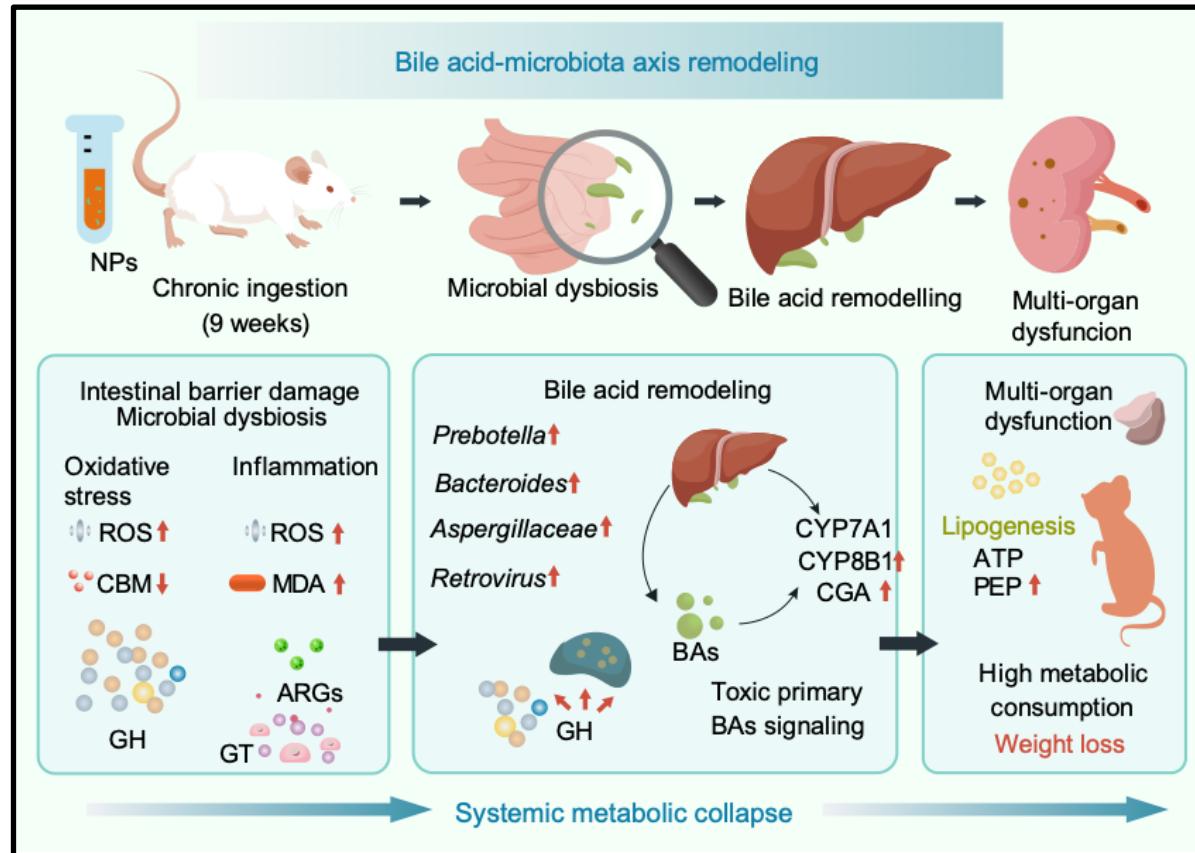


NPs暴露后小鼠肠道微生物群GO功能富集

NPs暴露对肠道碳水化合物活性酶 (CAZymes) 和抗生素抗性基因 (ARGs) 的影响

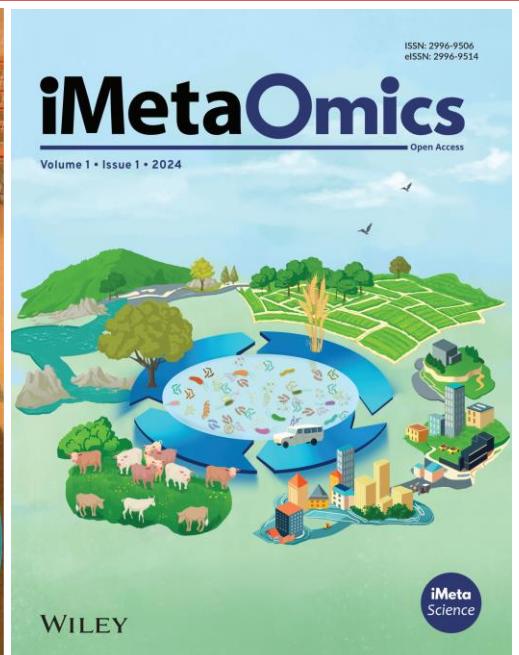
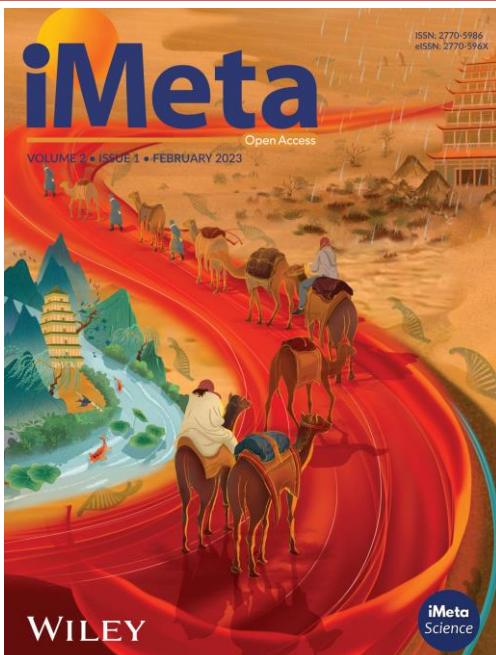


总结与展望



本研究通过构建“微塑料—肠道—微生物群—代谢”轴，证明了长期环境剂量的纳米塑料暴露绝非无害。它通过胆汁酸这一关键信使，将肠道微生态的紊乱（功能基因重编程、多界失调）与远端器官（肝、肾）的代谢崩溃紧密耦联。这一发现不仅解释了NPs毒性的系统性机制，也为干预策略提供了新思路：靶向恢复胆汁酸代谢平衡或重建具有 7α -脱羟基功能的肠道菌群，可能是缓解微塑料肠道健康风险的有效途径。

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iMeta(宏)期刊是由宏科学、千名华人科学家和威立共同出版，对标**Cell**的生物/医学类综合期刊，主编刘双江和傅静远教授，欢迎高影响力的研究、方法和综述投稿，重点关注生物技术、大数据和组学等前沿交叉学科。已被[SCIE](#)、[PubMed](#)等收录，最新IF 33.2，位列全球SCI期刊第65位(前千分之三)，中国第5位，微生物学研究类全球第一，中科院生物学双1区Top。外审平均21天，投稿至发表中位数87天。

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