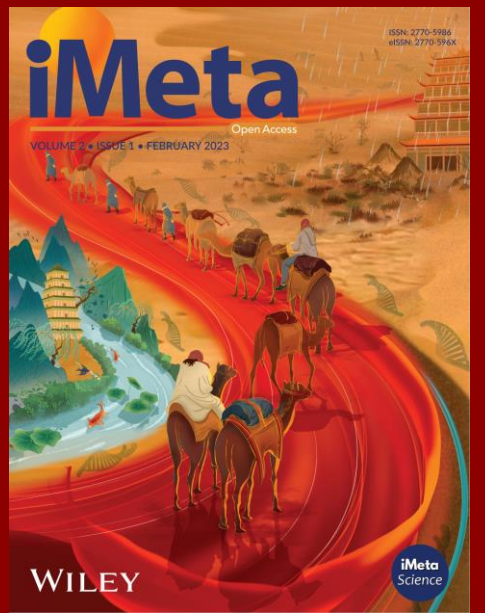
百岁人群微生物关键类群和代谢特征调控衰老过程中的肠道稳态

林维钏[1#]，张璀[1,2#]，雷和花[1,2#]，曹政[1,2]，高鑫[1]，于文凯[1,2]，李欣志[3]，向庆伟[4]，张志文[4]，庞世福[5]，罗卫飞[5*]，谢登辉[6*]，张利民[1,2*]，陈刚[4*]

[1]中国科学院精密测量科学与技术创新研究院
[2]中国科学院大学
[3]澳门科技大学医学院
[4]湖北中医药大学、湖北中医药大学附属湖北省中医院
[5]广西爱生生命科技有限公司
[6]南方医科大学附属第三医院



Weichuan Lin, Cui Zhang, Hehua Lei, Zheng Cao, Xin Gao, Wenkai Yu, Xinzhi Li, et al. 2026. Microbial keystone taxa and metabolic signatures in centenarians regulate intestinal homeostasis during aging. ***iMeta*** 5: e70134.
https://doi.org/10.1002/imt2.70134

简介

nature aging

Article

https://doi.org/10.1038/s43587-023-00389-y

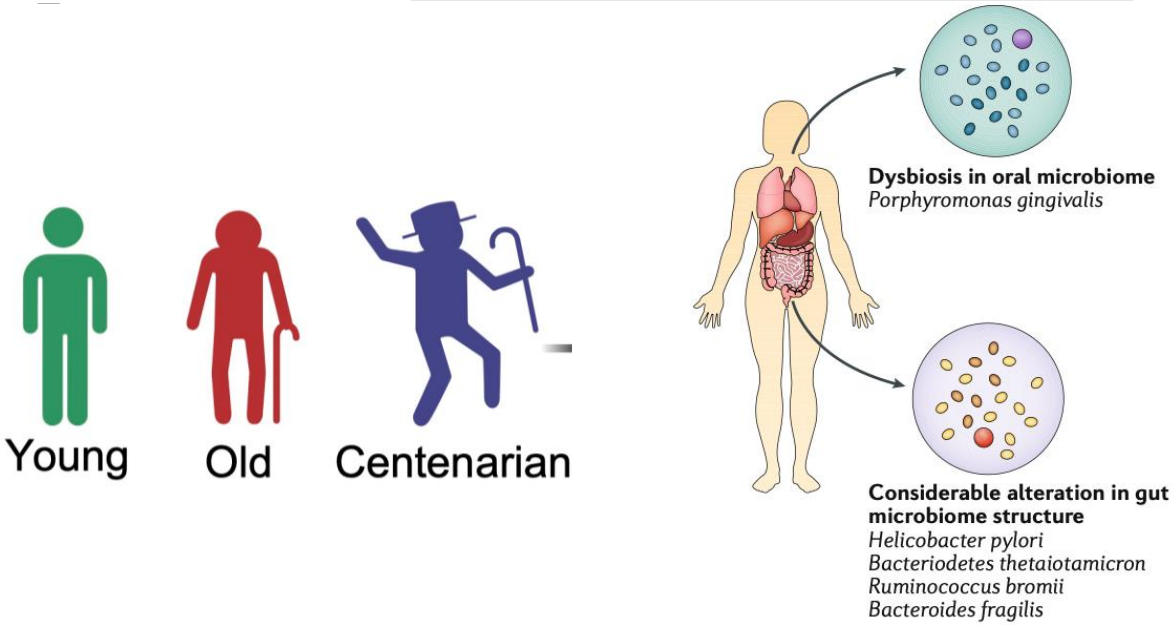
Longevity of centenarians is reflected by the gut microbiome with youth-associated signatures

Received: 25 May 2022

Accepted: 27 February 2023

Published online: 6 April 2023

Shifu Pang[1,7], Xiaodong Chen[1,2,7], Zhilong Lu[3], Lili Meng[1], Yu Huang[1], Xiuqi Yu[1], Lianfei Huang[1,4], Pengpeng Ye[1], Xiaochun Chen[1], Jian Liang[5], Tao Peng[6], Weifei Luo[1,2,3] ✉ & Shuai Wang[2,4] ✉



nature microbiology

Article

https://doi.org/10.1038/s41564-023-01370-6

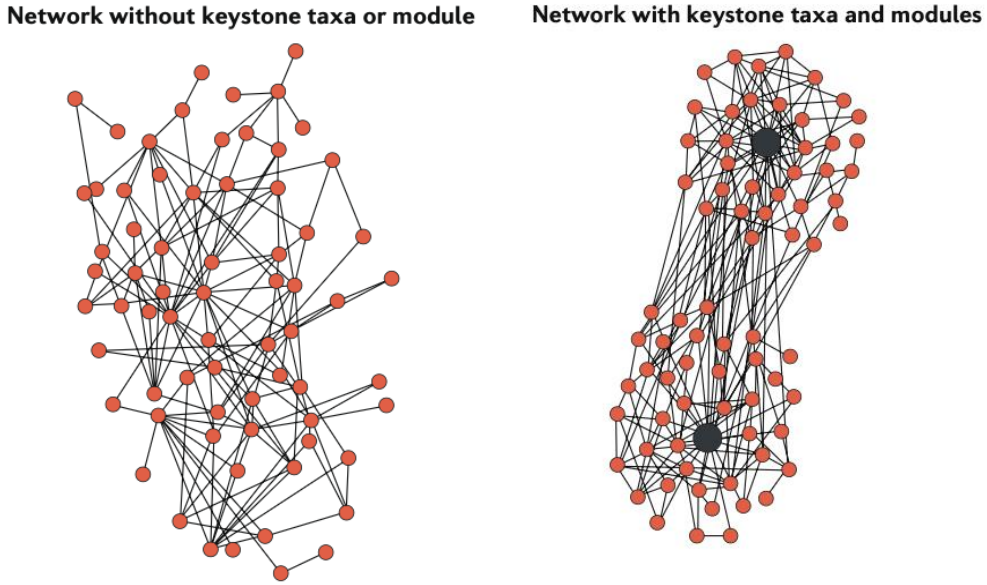
Centenarians have a diverse gut virome with the potential to modulate metabolism and promote healthy lifespan

Received: 12 September 2022

Accepted: 23 March 2023

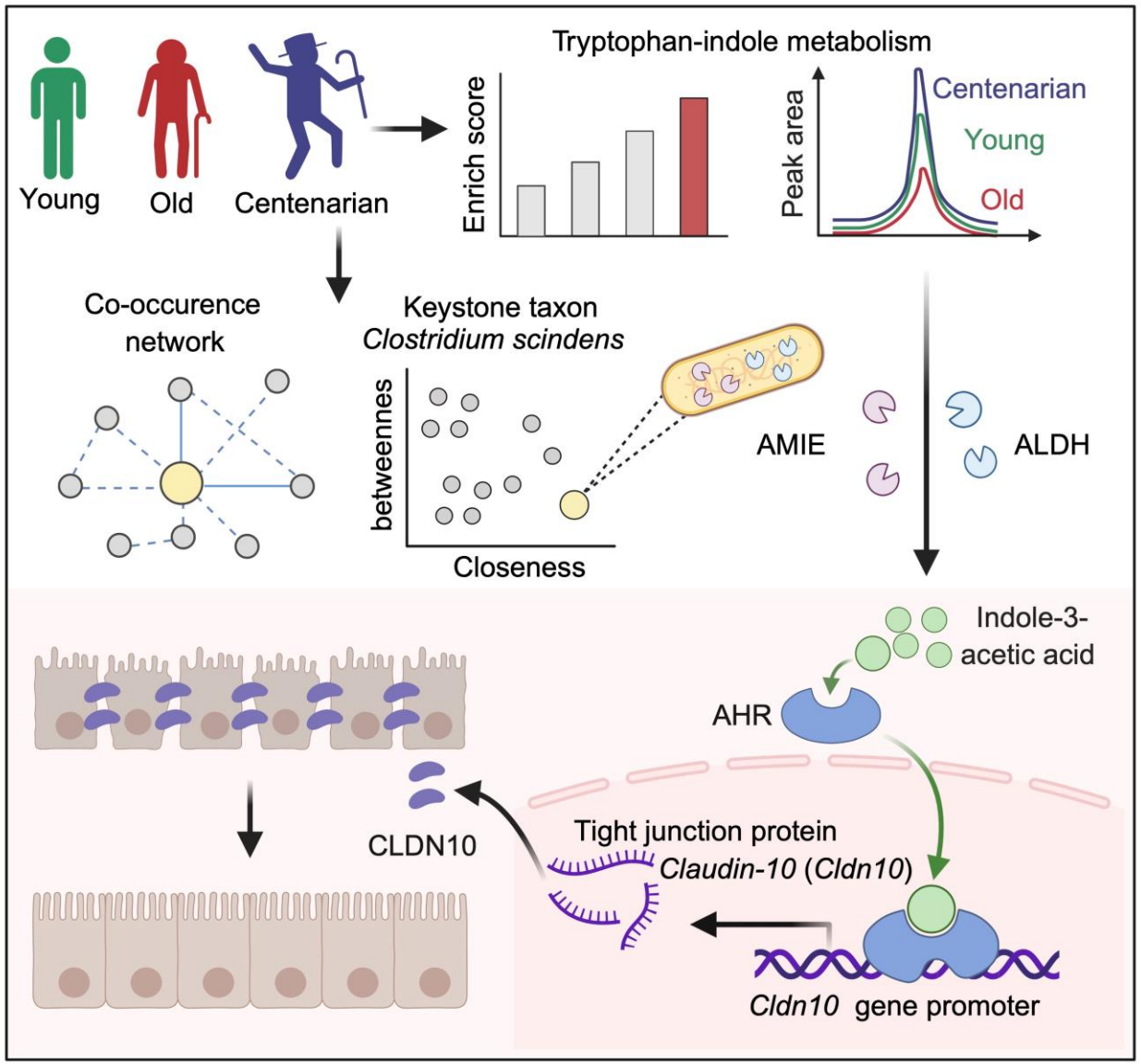
Published online: 15 May 2023

Joachim Johansen[1,2], Koji Atarashi[3], Yasumichi Arai[4], Nobuyoshi Hirose[4], Søren J. Sørensen[5], Tommi Vatanen[1,6], Mikael Knip[6,7,8], Kenya Honda[3], Ramnik J. Xavier[1] ✉, Simon Rasmussen[2,9] ✉ & Damian R. Plichta[1] ✉



Banerjee et al., Nature reviews microbiology, 2018; Pang et al., Nature aging, 2023; Johansen et al., Nature Microbiology, 2023.

亮点



- 共现网络分析鉴定出百岁人群中以*Clostridium*属细菌为主的关键类群;
- 梭状芽胞杆菌（*Clostridium scindens*）增强微生物网络稳定性，可能有助于长寿并降低年龄相关疾病易感性;
- 梭状芽胞杆菌通过自身酰胺酶AMIE和醛脱氢酶ALDH参与色氨酸代谢，产生吲哚-3-乙酸（IAA）；
- 梭状芽胞杆菌来源的IAA在小鼠中通过促进芳香烃受体AHR介导的紧密连接蛋白CLDN10信号维持肠道稳态。

实验设计

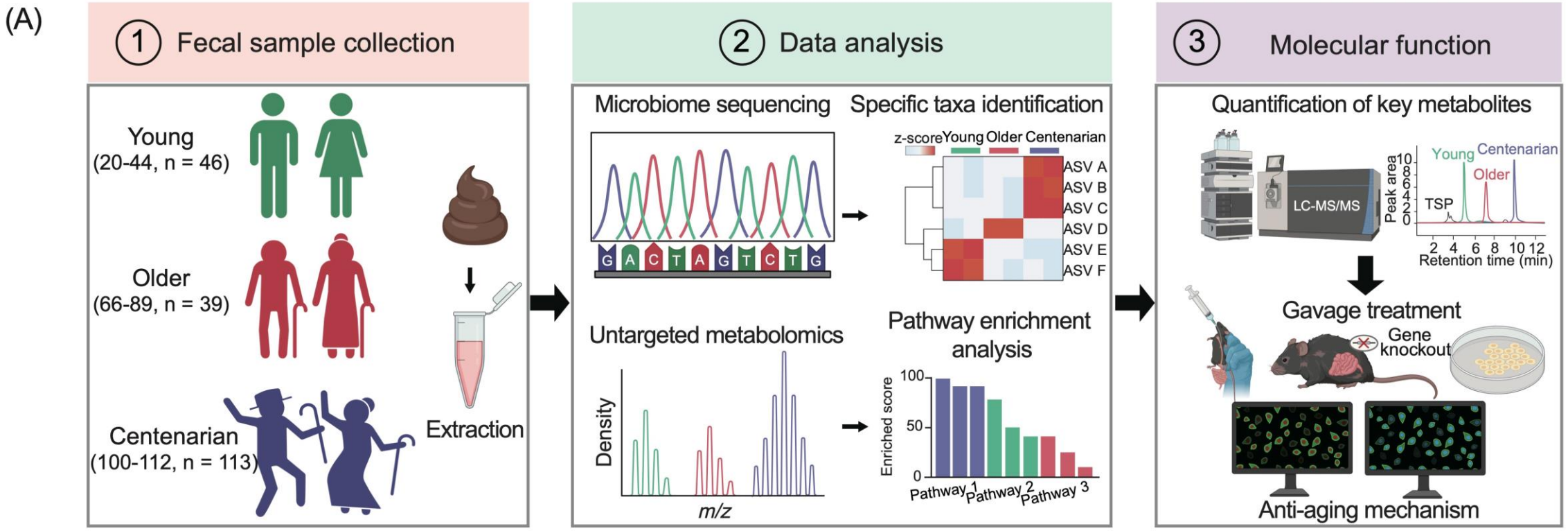


Figure 1A Fecal samples collection and study workflow.

百岁人群肠道微生物组变化和关键类群

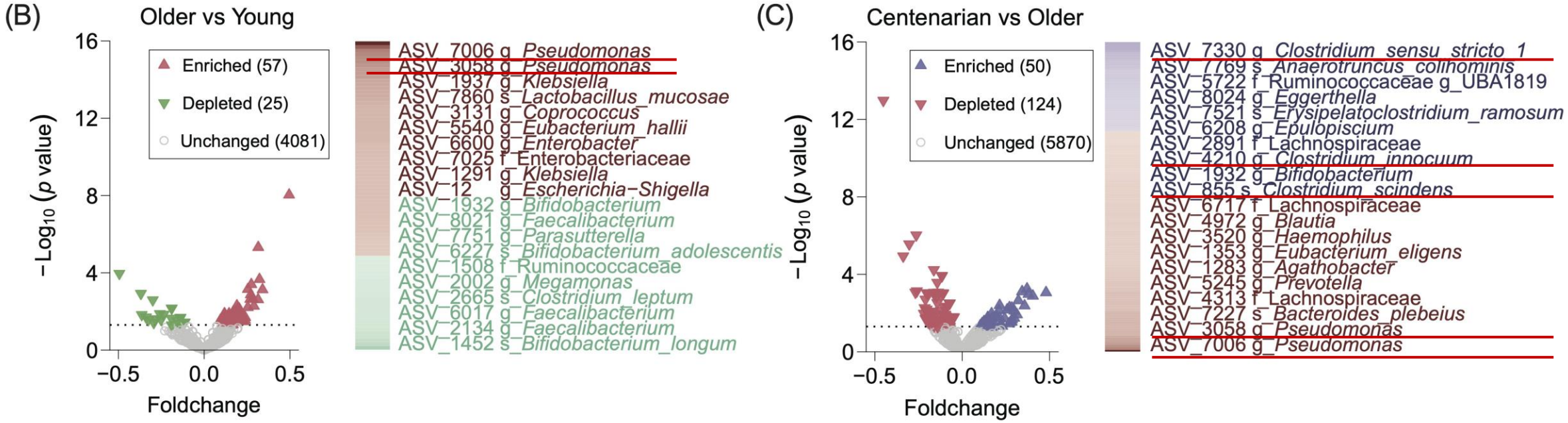


Figure 1B and C Differential amplicon sequence variants (ASVs) between centenarian or young and older group.

百岁人群肠道微生物组变化和关键类群

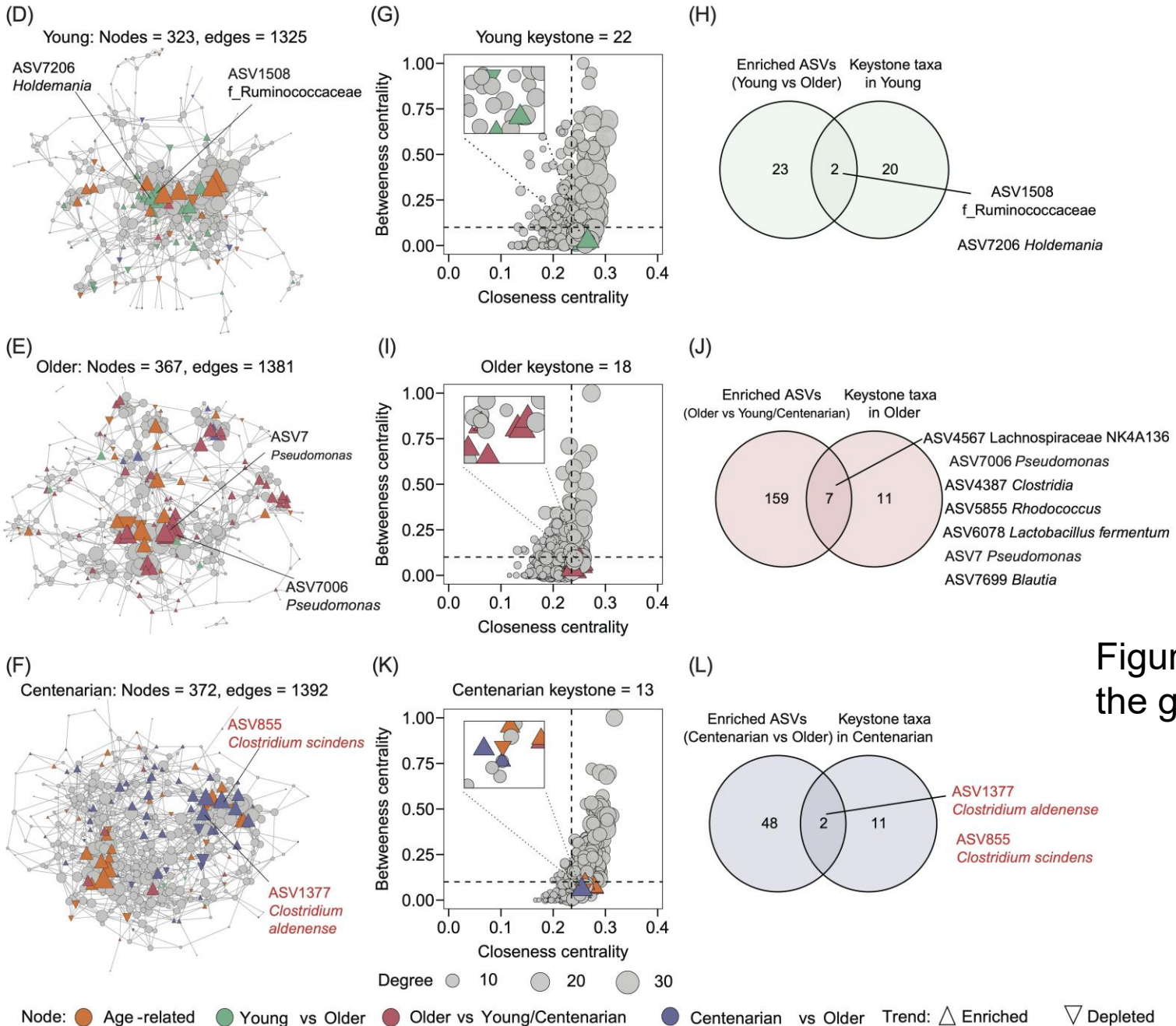


Figure 1D-L Identification of keystone taxa in the gut microbiome of centenarians.

解析百岁人群肠道代谢组特征

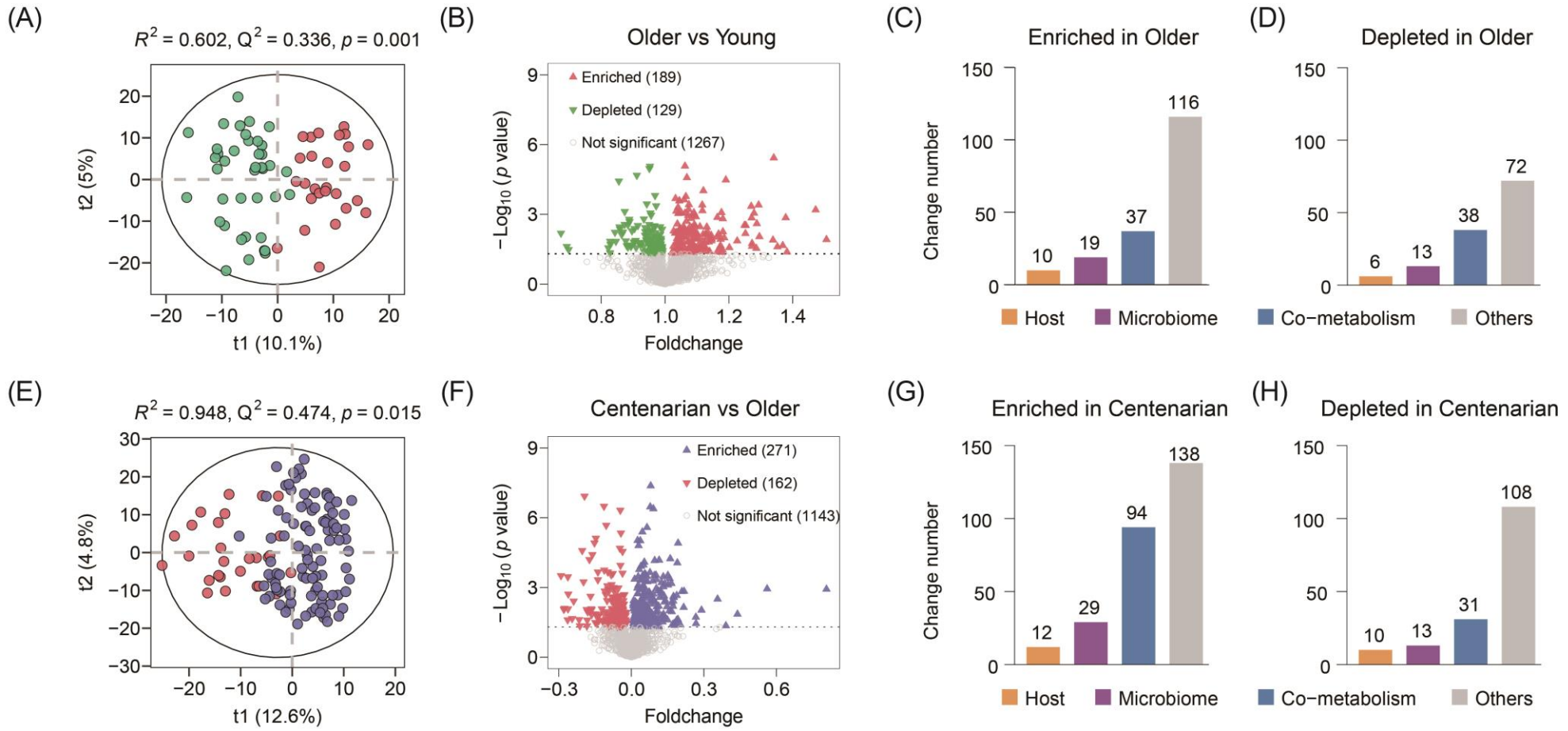


Figure 2 Metabolic signatures associated with the gut microbiota in centenarian.

解析百岁人群肠道代谢组特征

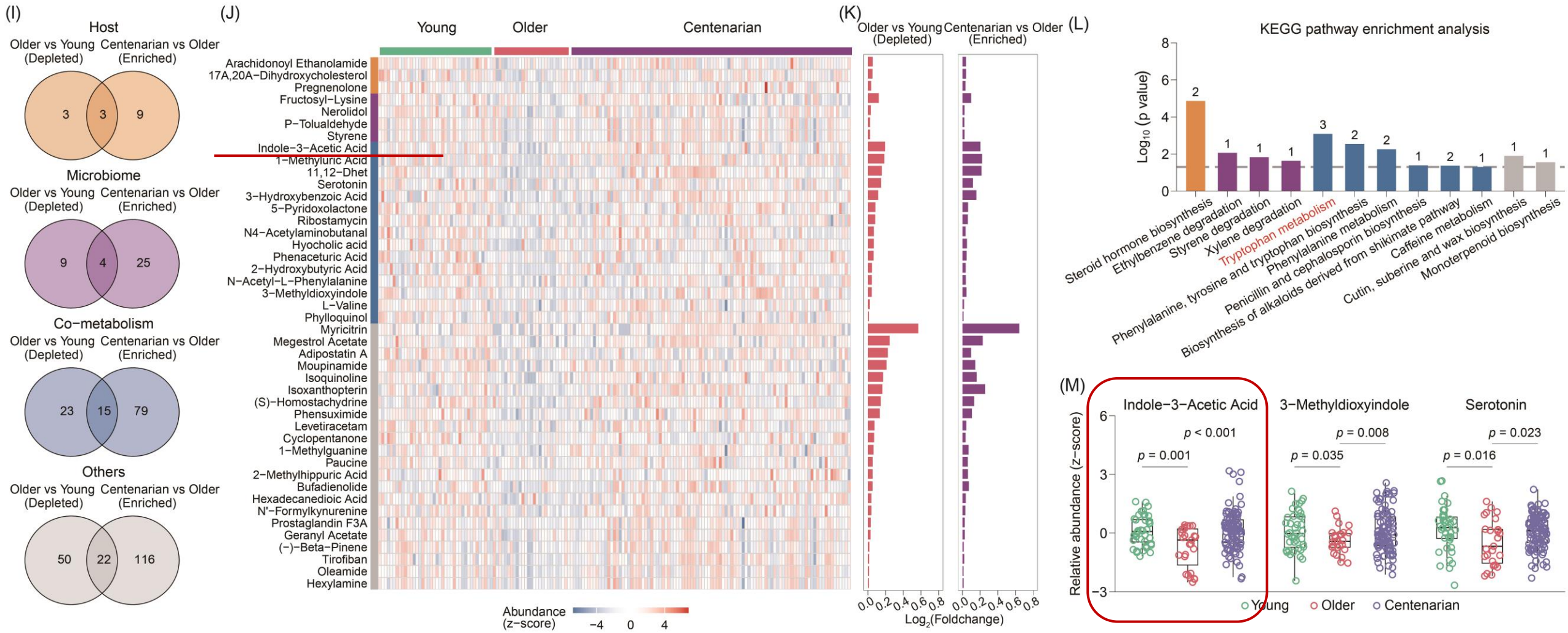
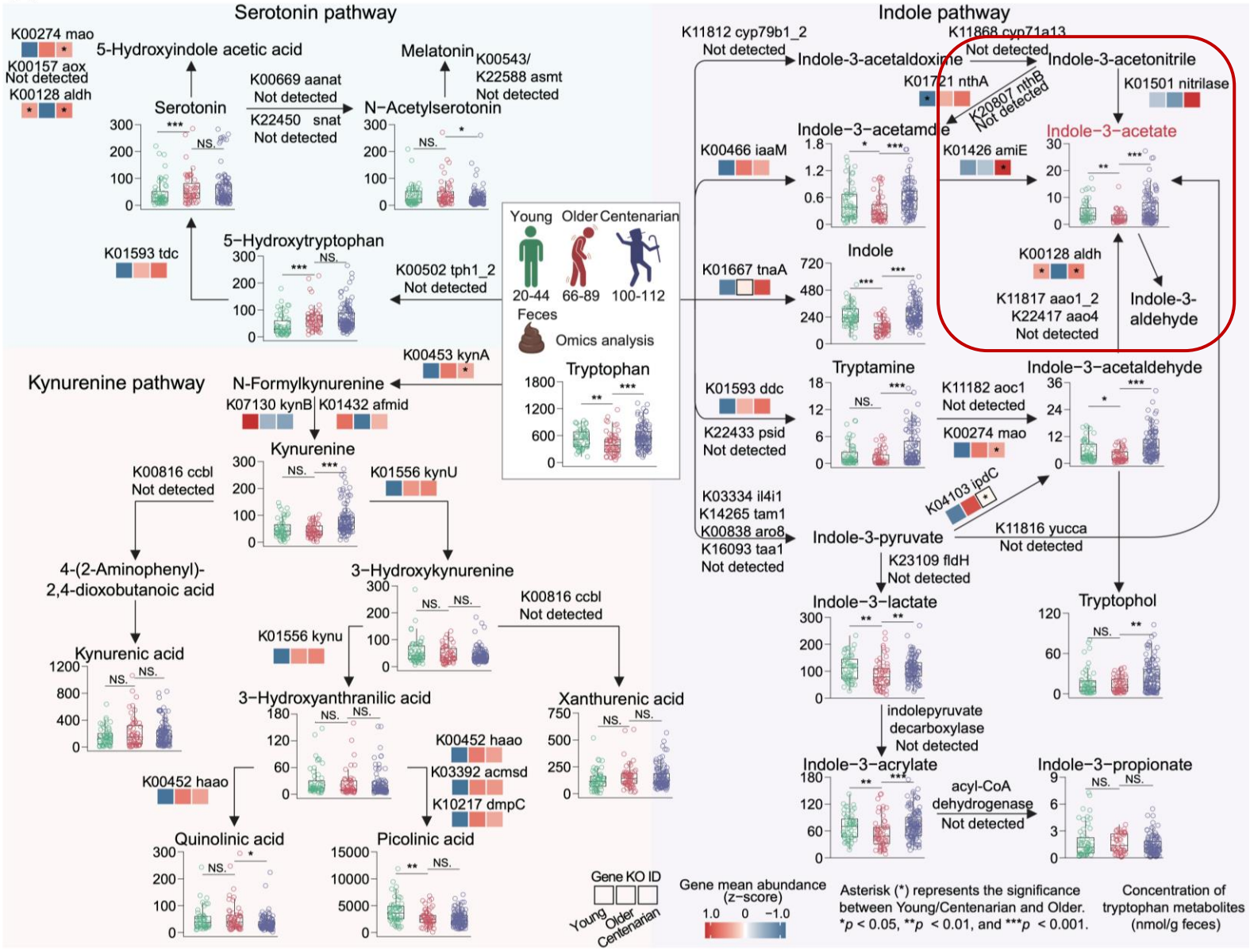


Figure 2 Metabolic signatures associated with the gut microbiota in centenarian.

色氨酸代谢与微生物关键类群有关



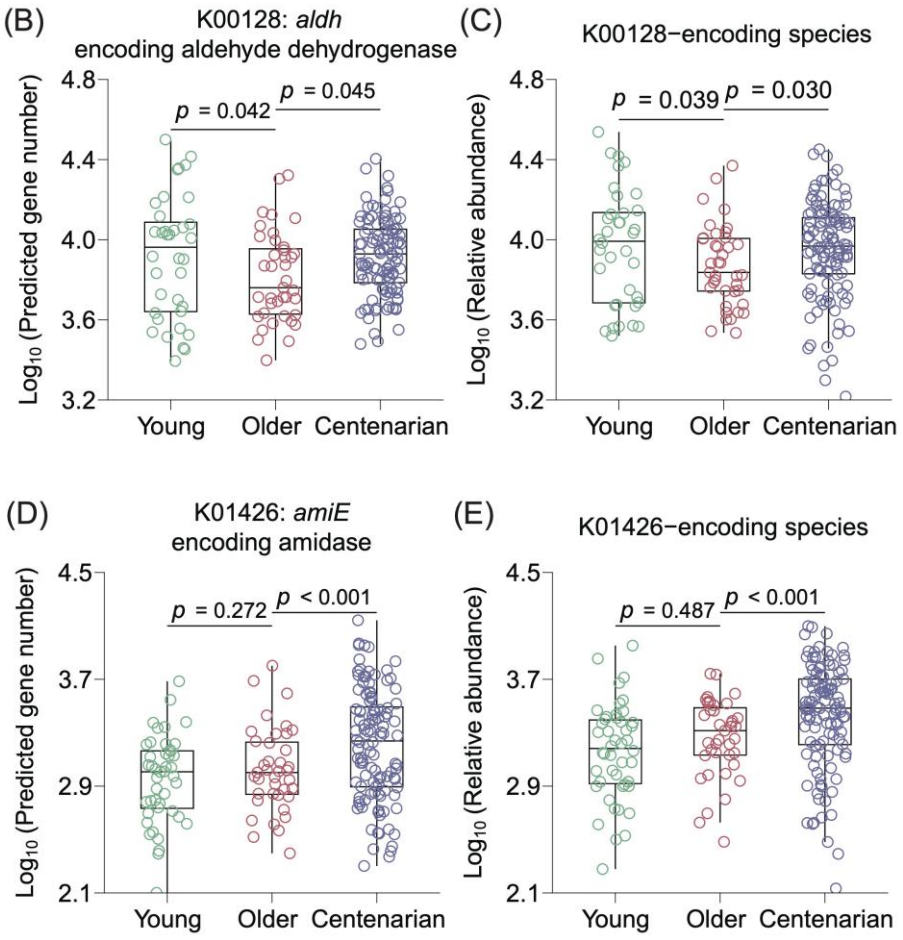


Figure 3 Correlation between the function potential of the gut microbiome and tryptophan metabolism.

色氨酸代谢与微生物关键类群有关

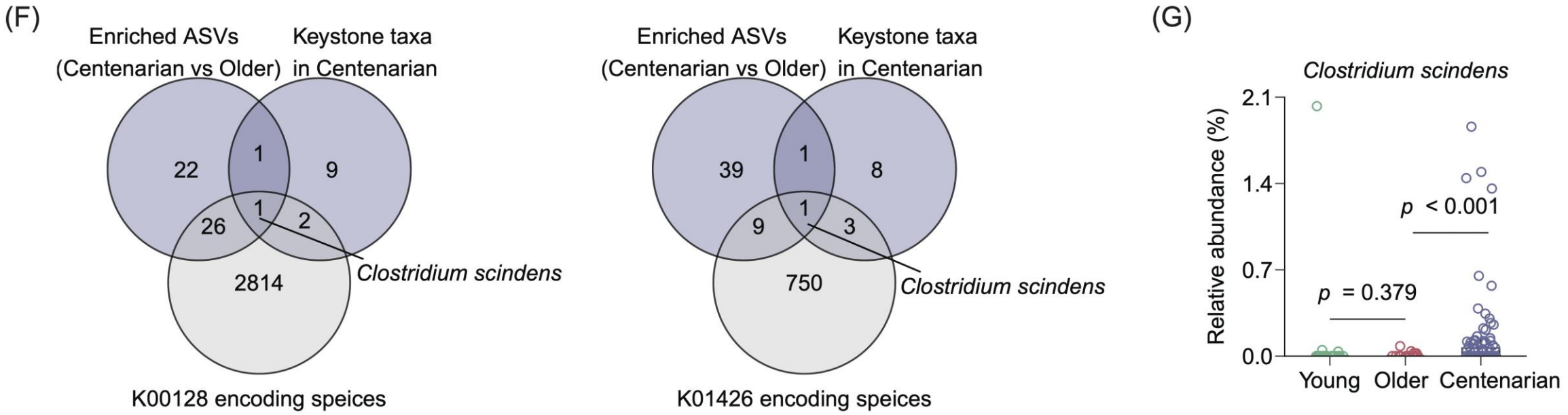


Figure 3 Correlation between the function potential of the gut microbiome and tryptophan metabolism.

梭状芽胞杆菌通过自身酶ALDH和AMIE产生IAA

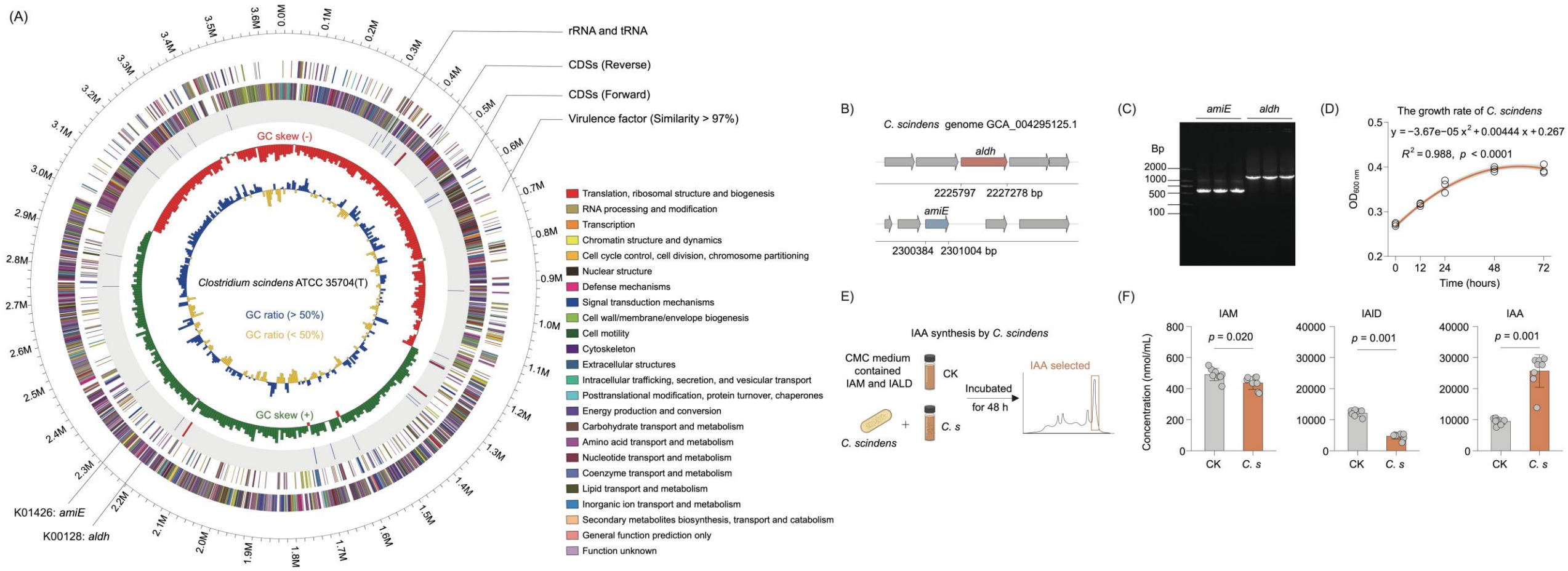


Figure 4 Genomic and functional characterization of *C. scindens* and *in vitro* validation of IAA production.

补充梭状芽胞杆菌可以延缓衰老

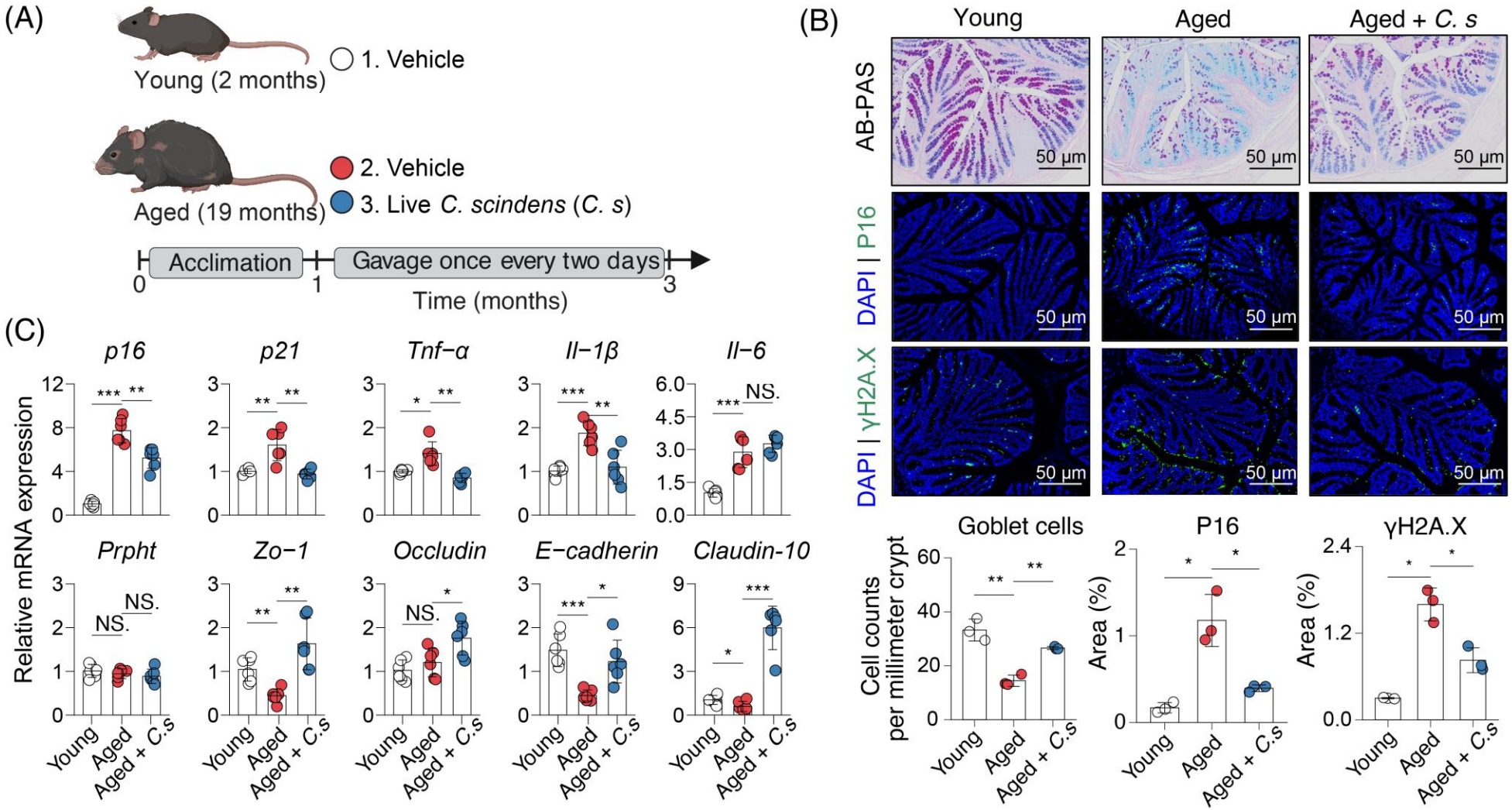


Figure 5 Supplementation with *C. scindens* mitigates intestinal aging.

补充梭状芽胞杆菌增强肠道细菌互作和IAA合成

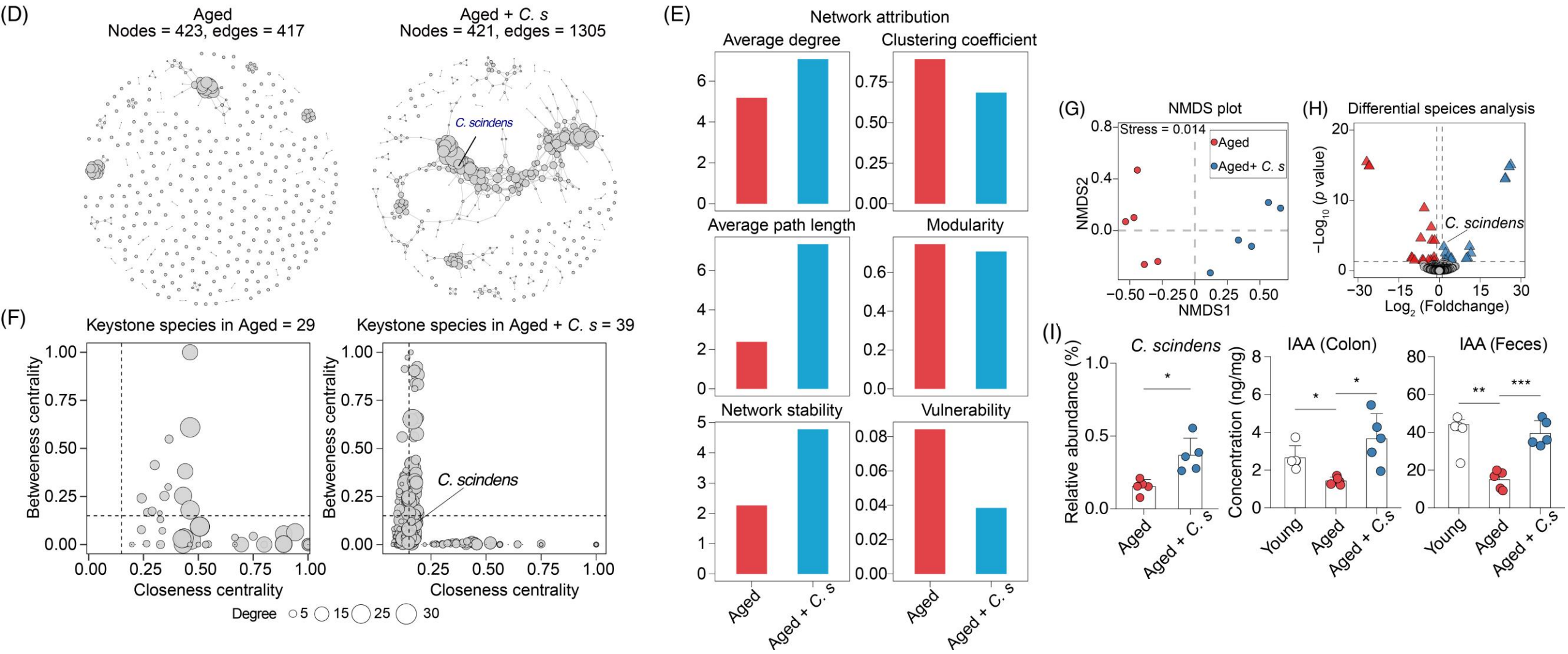


Figure 5 Supplementation with *C. scindens* mitigates intestinal aging.

梭状芽胞杆菌来源的IAA通过AHR-CLDN10信号延缓衰老

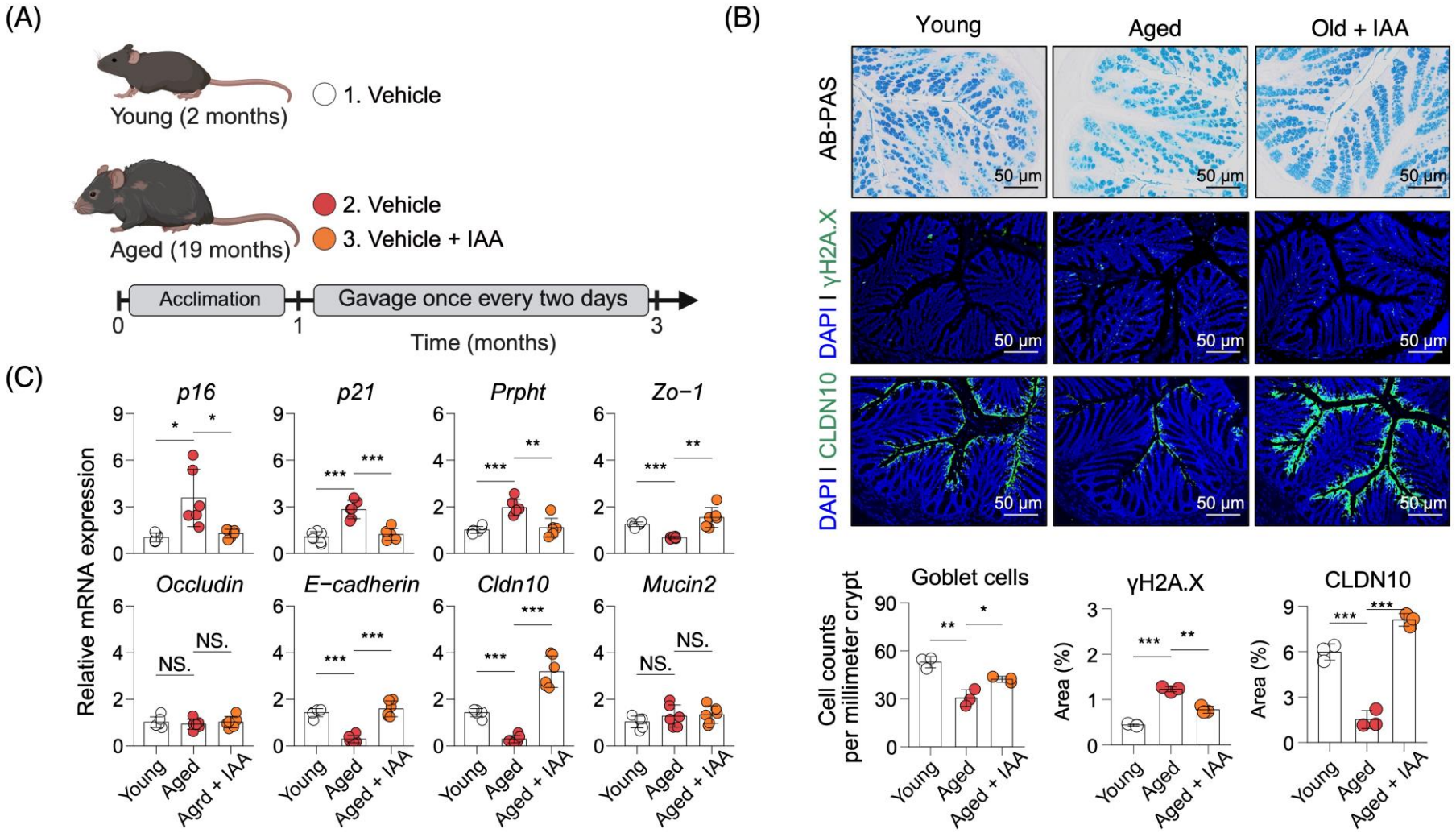


Figure 6 IAA supplementation mitigates intestinal aging and promotes CLDN10 expression in vivo via intestinal aryl hydrocarbon receptor (AHR) signaling.

梭状芽胞杆菌来源的IAA通过AHR-CLDN10信号延缓衰老

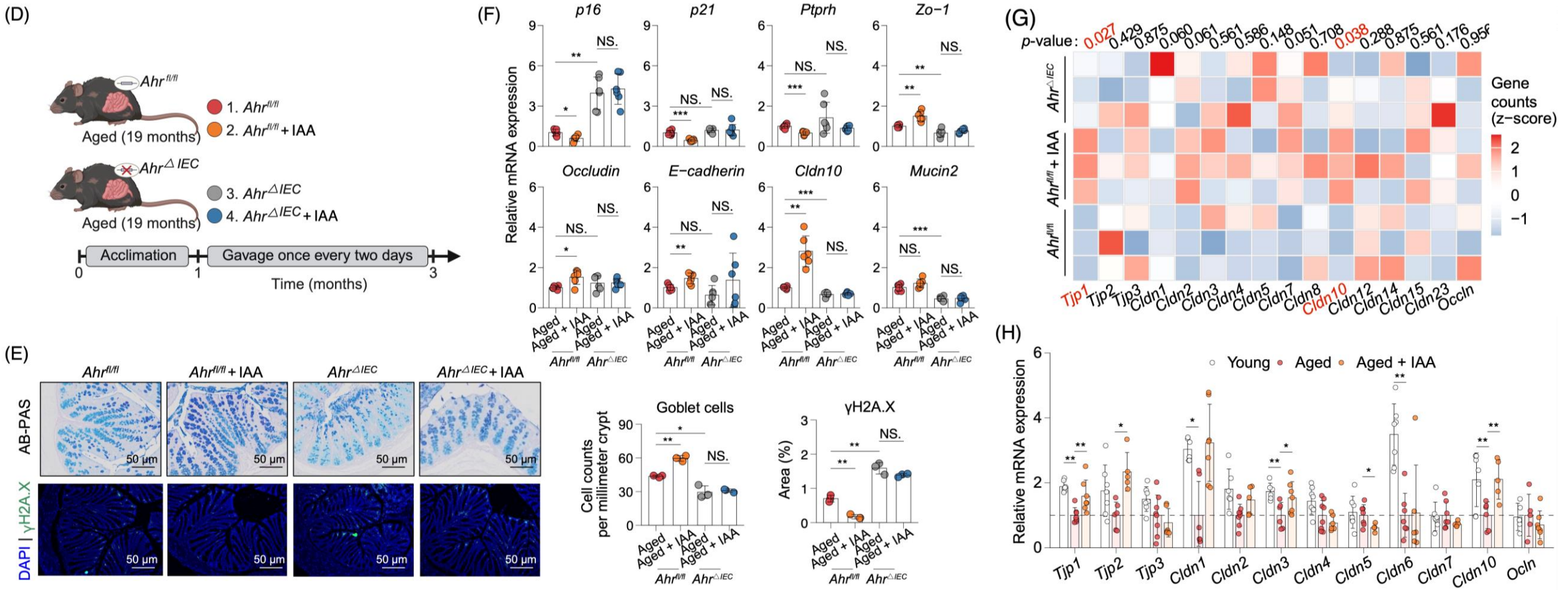


Figure 6 IAA supplementation mitigates intestinal aging and promotes CLDN10 expression in vivo via intestinal aryl hydrocarbon receptor (AHR) signaling.

梭状芽胞杆菌来源的IAA通过AHR-CLDN10信号延缓衰老

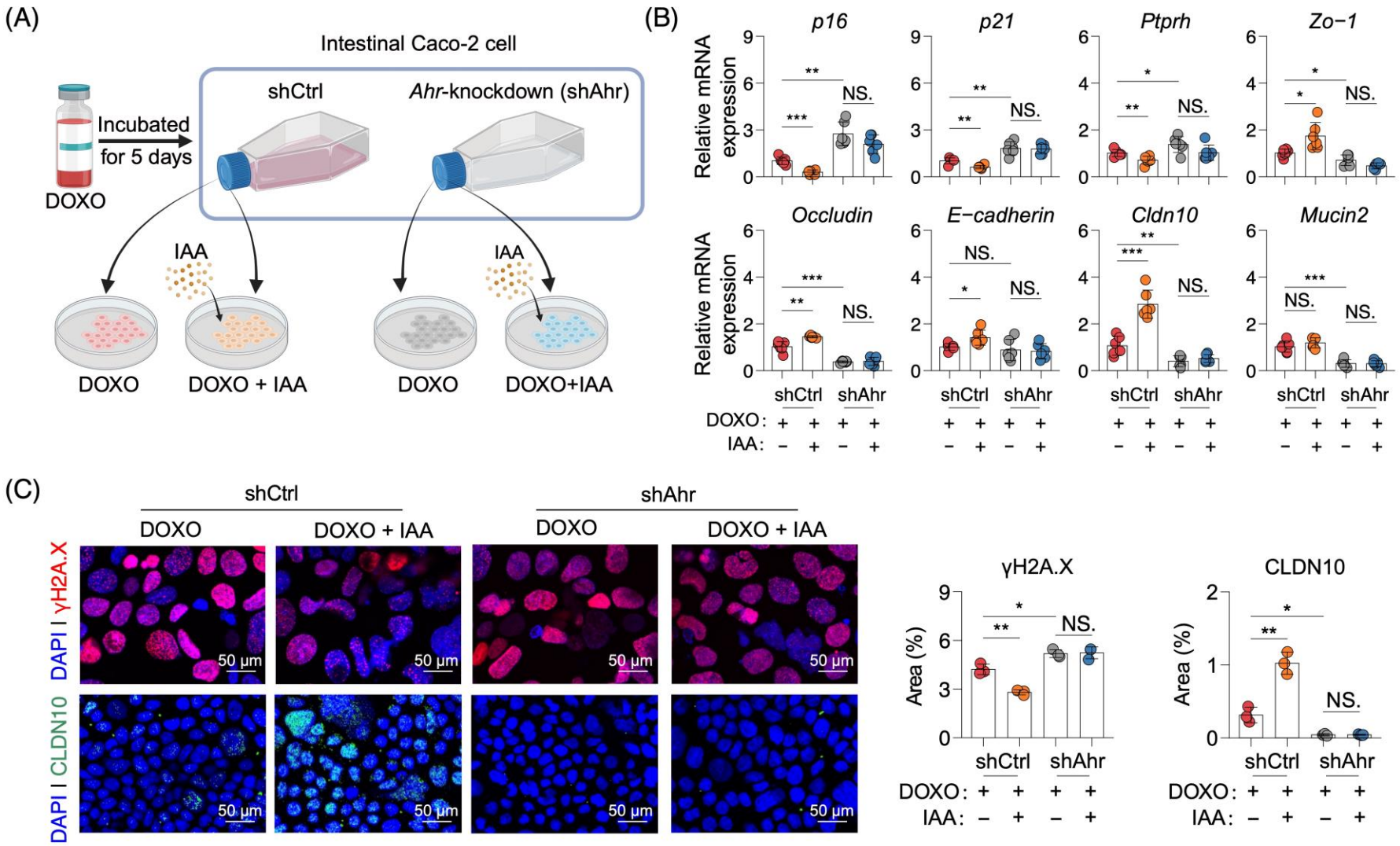


Figure 7 IAA supplementation attenuates cellular senescence in vitro via intestinal AHR-CLDN10 signaling.

IAA激活AHR-CLDN10信号改善肠道屏障功能障碍

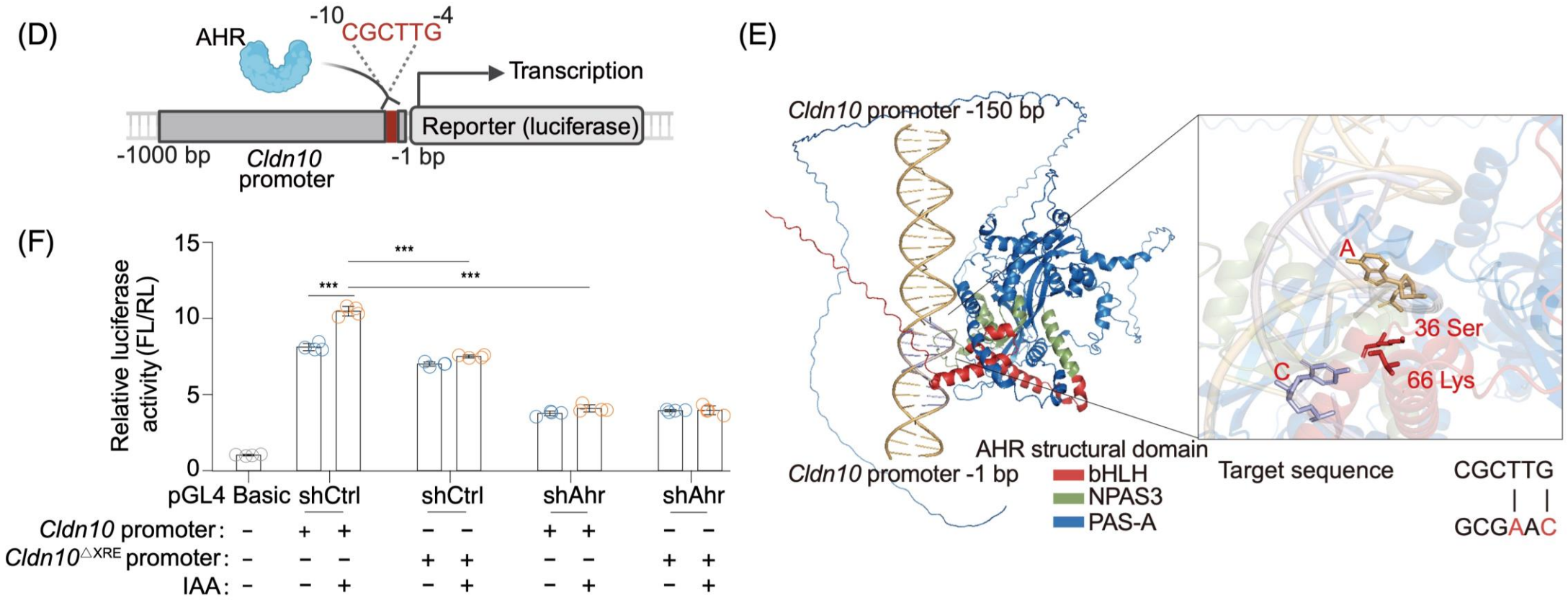


Figure 7 IAA supplementation attenuates cellular senescence in vitro via intestinal AHR-CLDN10 signaling.

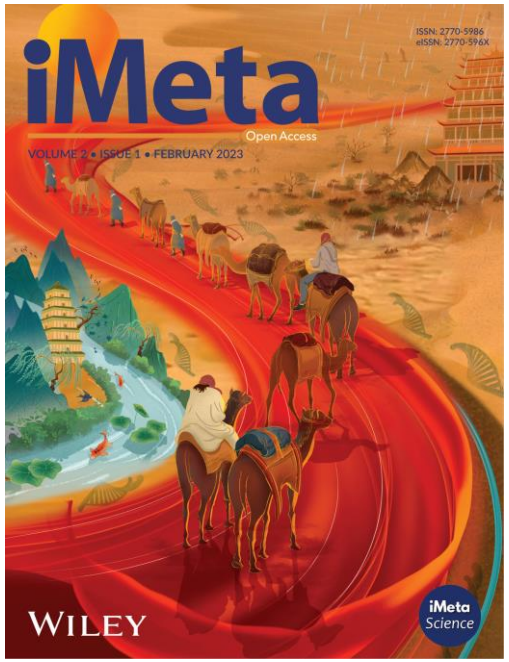
总结

- 本研究为靶向关键类群和微生物-宿主相互作用以缓解衰老及年龄相关疾病提供了机制基础。
- 本研究采用共现微生物网络分析，在百岁人群中识别出微生物关键类群梭状芽胞杆菌及其代谢物IAA这一代谢特征。
- 梭状芽胞杆菌通过自身酰胺酶AMIE和醛脱氢酶ALDH调控IAA合成。
- 本研究揭示了梭状芽胞杆菌和IAA在通过微生物-微生物和微生物-宿主相互作用促进肠道微生态稳定和宿主稳态方面发挥关键作用。

Weichuan Lin, Cui Zhang, Hehua Lei, Zheng Cao, Xin Gao, Wenkai Yu, Xinzhi Li, et al. 2026. Microbial keystone taxa and metabolic signatures in centenarians regulate intestinal homeostasis during aging. ***iMeta*** 5: e70134. https://doi.org/10.1002/imt2.70134

iMeta(宏): 生物和医学顶级成果发表平台

iMeta WILEY



iMeta (宏)期刊是由宏科学和威立共同出版，对标***Cell***的生物/医学期刊，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。已被**SCIE**、**PubMed**等收录，最新影响因子(IF)33.2，位列全球第65，中国第5，分区表生物学1区Top，CNS级成果发表平台，外审平均21天，投稿至发表中位数87天。

iMetaOmics (宏组学)，定位IF>15对标***NC/SA***的生物/医学综合期刊，已被**ESCI**、**PubMed**等收录。

iMetaMed (宏医学)定位IF>15的医学综合期刊，欢迎投稿!

主页: http://www.imeta.science

出版社: https://wileyonlinelibrary.com/journal/imeta

投稿: iMeta: https://wiley.atyponrex.com/journal/IMT2
iMetaOmics: https://wiley.atyponrex.com/journal/IMO2
iMetaMed: https://wiley.atyponrex.com/journal/IMM3

office@imeta.science
imetaomics@imeta.science

宣传片

iMeta

更新日期
2026/3/30