程海荣课题组介绍

一、 教育与科研经历

2020.12-今　　上海交通大学生命科学技术学院，研究员，博士生导师

2013.1-2020.11　上海交通大学生命科学技术学院，副研究员，2017 年任博士生导师

2010.3-2012.12　上海交通大学生命科学技术学院，助理研究员

2008.1-2010.3　上海交通大学生命科学技术学院，博士后

2003.9-2006.8　中科院微生物研究所，博士生

2000.9-2003.8　广西大学生命科学技术学院，硕士生

1994.9-1998.7　华中农业大学园林学院（园艺系），本科生

2016/2017/2018/2019 年多次去波士顿、圣迭戈等地参加国际学术会议并做大会报告，介绍在功能糖醇领域的年度研究进展。

研究领域：

一直聚焦于减糖代糖产品的合成生物学的研究，开发高效的解脂耶氏酵母合成体系（单一途径与多酶途径合成体系），在解脂酵母中利用糖基转移酶体系合成人工的天然甜味增强剂。主要通过构建新型的微生物细胞工厂，以代谢工程手段来改良解脂耶氏酵母来高效且经济合成多种功能性糖醇或者低聚糖。以绿色多酶或全细胞催化替代化学全合成。先后研究开发了赤藓糖醇的绿色高效合成菌株、功能糖醇与功能性低聚糖的级联合成技术体系、功能糖醇母液的生物净化研究、一步发酵合成法合成甘露醇、木糖醇、赤藓醇、苏糖醇、庚七醇、阿洛酮糖等糖类甜味剂。研究成果已经得到应用并取得良好的应用效果，截止 2024 年 7 月，先后转让 18 项研究成果。申请或获得授权专利 20 余项。截止 2024 年 7 月，在国内外学术期刊发表科学论文 50 余篇。作为项目主持人，先后承担国家“863”“973”以及国家自然科学基金项目。作为第一完成人，“功能糖醇类产品高效生物催化和减排关键技术研发及产业化”项目荣获中国产学研促进会 2017 年度创新成果一等奖。

二、 发表的论文

1. Functional cloning and expression of an NAD-dependent D-Arabitol dehydrogenase gene from Gluconobacter oxydans in Escherichia coli. Cheng HR, Jiang N, Shen A and Feng YJ. ***FEMS Microbiol Lett***, 2005,252 (1),35-42. （第一作者）。

2. Extremely Rapid Extraction of DNA from Bacteria and Yeasts. Cheng HR and Jiang N. 2006. ***Biotechnol Lett***, 2006,28(1),35-39. (第一作者)。

3. Cloning, sequencing and characterization of the alpha-aminoadipate reductase gene (LYS2) from Saccharomycopsis fibuligera. Yan H, He P, Cheng HR, Shen A, Jiang N. ***Yeast***, 2007, 24(3):189-199.

4. Cloning, Purification and Characterization of an NAD-Dependent D-Arabitol Dehydrogenase from Acetic Acid Bacterium, Acetobacter suboxydans. Cheng HR*, Li ZL, Jiang N, Deng ZX. ***Protein J***, 2009,28(6):263-272. （通讯作者）。

5. An improved 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide (MTT) reduction assay for evaluating the viability of Escherichia coli cells. Wang HW, Cheng HR, Wang FQ, Wei DZ, Wang X. ***J Microbiol Methods***, 2010,82:330-333.

6. Microbiological production of L-arabitol from xylitol mother liquor. Jiang MG, Wang B, Yang L, Lin SJ, Cheng HR. ***J Microbiol Biotechnol***, 2011, 21(1):43-49. (通讯作者)

7. Comparison of methods for measuring viable E.coli cells during cultivation: Great differences in the early and late exponential growth phages. Wang HW, Cheng HR, Wei DZ, Wang FQ. ***J Microbiol Methods***, 2011,84(1):140-143.

8. 用重组酶介导扩增技术快速扩增核酸。吕蓓，程海荣，严庆丰，黄震巨，沈桂芳，张志芳，李轶女，邓子新， 林敏，程奇。中国科学 C 辑，2010,40（10）：983-988。

9. Xylitol production from xylose mother liquor: a novel strategy that combines the use of recombinant Bacillus subtilis and Candida maltosa. Cheng HR, Wang B, Lv JY, Jiang MG, Lin SJ, Deng ZX. ***Microb Cell Fact***, 2011,10:5. (第一作者)

10. From shake flasks to bioreactors: survival of E. coli cells harboring pGST–hPTH through auto-induction by controlling initial content of yeast extract. Jia LH, Cheng HR, Wang HW, Luo H, Yan H. ***Appl Microbiol Biotechnol***, 2011,90(4):1419-1428.

11.A Novel Method to Prepare L-Arabinose from Xylose Mother Liquor by Yeast-mediated Biopurification. Cheng HR, Wang HW, Lv JY, Jiang MG, Lin SJ, Deng ZX. ***Microb Cell Fact***, 2011,10:43. (第一作者)

12. Ammonia-containing dimethyl sulfoxide (DMSO): An improved solvent for the dissolution of formazan crystals in the MTT assay. Wang HW, Wang FQ, Tao X, Cheng HR. ***Analytical Biochem***, 2012,421(1):324-326.（通讯作者）

13. Characterization of streptonigrin biosynthesis reveals a cryptic carboxyl methylation and an unusual oxidative cleavage of a N-C bond. Xu F, Kong DK, He XY, Zhang Z, Han M, Xie XQ, Wang P, Cheng HR, Tao MF, Zhang L, Deng ZX, Lin SJ. ***J Am Chem Soc***, 2013, 135(5):1739-48.

14. Functional role of β domain in the *Thermoanaerobacter tengcongensis* glucoamylase. Li ZL, Wei PY, Cheng HR, He P, Wang QH, Jiang N. ***Applied Microbiology and Biotechnology***, 2013, DOI: 10.1007/s00253-013-5051-2.

15. Genetically Engineered Pichia pastoris Yeast for Conversion of Glucose to Xylitol by a Single-fermentation Process. Cheng HR, Lv JY, Wang HW, Wang B, Li ZL, Deng ZX*. ***Applied Microbiology and Biotechnology***, 2014, 98:3539-3552. （通讯作者）

16. Improving the Expression of Recombinant Proteins in Escherichia coli BL21(DE3) Under Acetate Stress: An Alkaline pH Shift Approach. Hengwei Wang, Fengqing Wang, Wei Wang, Xueling Yao, Dongzhi Wei, Hairong Cheng, Zixin Deng. ***PloS ONE***, 2014,9(11):e112777.（通讯作者）

17. Zhang L, An J, Li L, Wang H, Liu D, Li N, Cheng HR, Deng Z. Highly efficient fructooligosaccharides production by an erythritol-producing yeast Yarrowia lipolytica displaying fructosyltransferase. ***J Agric Food Chem***. 2016,18,64(19):3828-37. doi: 10.1021/acs.jafc.6b00115. （通讯作者）。

18. An J, Zhang L, Li L, Liu D, Cheng H, Wang H, Nawaz MZ, Cheng HR*, Deng Z. An alternative approach to synthesizing galactooligosaccharides by cell-surface display of β-galactosidase on *Yarrowia lipolytica*. ***Journal of Agricultural and Food Chemistry***, 2016, 64(19):3819-27.

（通讯作者）

19. Wang H, Li L, Zhang L, An J, Cheng HR, Deng Z. Xylitol production from waste xylose mother liquor containing miscellaneous sugars and inhibitors: one-pot biotransformation by Candida tropicalis and recombinant Bacillus subtilis. ***Microbial Cell Factories*** 2016,16,15(1):82. doi: 10.1186/s12934-016-0480-0. （通讯作者）

20. Ning Li, Hengwei Wang, Huilin Cheng, Dawen Liu, Hairong Cheng, Zixin Deng. An integrated approach to producing high-purity trehalose from maltose by the yeast Yarrowia lipolytica displaying trehalose synthase (TreS) on the cell surface. ***J. Agric. Food Chem.***, 2016, 64 (31):6179–6187 （通讯作者）

21. Li Lijuan，Wang Hengwei，Cheng Hairong，Deng Zixin. Isomaltulose production by yeast surface display of sucrose isomerase from Pantoea dispersa on Yarrowia lipolytica. ***Journal of Functional Foods***, 2017, 32：208~217.（通讯作者）

22. Siqi Wang, Hengwei Wang, Jiyang Lv, Zixin Deng, Hairong Cheng. Highly Efficient Erythritol Recovery from Waste Erythritol Mother Liquor by a Yeast-Mediated Biorefinery Process. ***J. Agric. Food Chem.***, 2017, 65:11020-11028, Nov. doi: 10.1021/acs.jafc.7b04112.（通讯作者）

23. Khan AZ, Shahid A, Cheng H, Mahboob S, Al-Ghanim KA, Bilal M, Nawaz MZ.Omics technologies for microalgae-based fuels and chemicals; challenges and opportunities. ***Protein Pept Lett***. 2018;25(2):99-107. doi: 10.2174/0929866525666180122100722.

23. Bilal M, Nawaz MZ, Iqbal HMN, Hou J, Mahboob S, Al-Ghanim KA, Cheng H. Engineering ligninolytic consortium for bioconversion of lignocelluloses to ethanol and chemicals. ***Protein Pept Lett***. 2018;25(2):108-119. doi: 10.2174/0929866525666180122105835.（共通讯作者）

25. Huiling Cheng, Siqi Wang, Muhammad Bilal, Xuemei Ge, Can Zhang, Patrick Fickers and Hairong Cheng. Identification, characterization of two NADPH-dependent erythrose reductases in the yeast Yarrowia lipolytica and improvement of erythritol productivity using metabolic engineering. ***Microbial Cell Factories***, 2018,17:133. (通讯作者)

26. 刘大文、程海荣*、邓子新。 解脂耶氏酵母表面展示β-淀粉酶与α-葡萄糖转苷酶及一步法由淀粉合成低聚异麦芽糖。生物工程学报， 2019 年 01 期 第 121-132 页。（通讯作者）

英文版：LIU Dawen, CHENG Hairong, DENG Zixin。One step production of isomalto-oligosaccharides by engineered *Yarrowia lipolytica* yeast co-displayed β-amylase and α-transglucosidase[J], Chinese Journal of Biotechnology, 2019 (01): 121-132. 通讯作者

27、王艺颖、程海荣*。2018. 解脂耶氏酵母细胞表面展示乳糖水解酶高效水解乳糖。中国生物工程杂志，2018，38(8):41-49.（通讯作者）

28、Bilal M, Asgher M, Cheng H*, Yan Y, Iqbal H.M.N.*. Multi-Point Enzyme Immobilization, Surface Chemistry, and Novel Platforms: A Paradigm Shift in Biocatalyst Design. ***Critical Reviews in Biotechnology***, 2019, 39(2), 202–219. 共通讯作者。

29、Ping Chi, Siqi Wang, Xuemei Ge, Muhammad Bilal, Patrick Fickers, Hairong Cheng*. Efficient D-threitol production by an engineered strain of Yarrowia lipolytica overexpressing xylitol dehydrogenase gene from Scheffersomyces stipitis. ***Biochemical Engineering Journal***.149 (2019) 107259. https://doi.org/10.1016/j.bej.2019.107259。通讯作者。

30、Yirong Xu，Ping Chi，Muhammad Bilal，Hairong Cheng*. Biosynthetic strategies to produce xylitol: an economical venture. ***Applied Microbiology and Biotechnology***, 2019, 103:5143-5160. https://doi.org/10.1007/s00253-019-09881-1。通讯作者。

31. Muhammad Bilal*, Shuo Xu, Hafiz M.N. Iqbal, Hairong Cheng*. Yarrowia lipolytica as an emerging biotechnological chassis for functional sugars biosynthesis. ***Critical Reviews in Food Science and Nutrition***, 2021, 61(4): 535–552. DOI: 10.1080/10408398.2020.1739000. Published online: 17 Mar 2020，共通讯作者。本文围绕我课题组近五年来在解脂耶氏酵母功能糖（醇）领域的应用研究，并结合国内外其他学者的研究，进行了全方位的论述与展望。

32. Patrick Fickers*, Hairong Cheng, Carol Sze Ki Lin. Sugar alcohols and organic acids synthesis in *Yarrowia lipolytica*: where are we? *Microorganisms*, invited review by MDPI, 2020, 8:574.

33、Yirong Xu, Ping Chi, Jiyang Lv, Muhammad Bilal, Hairong Cheng*. L-Xylo-3-hexulose, a new rare sugar produced by the action of acetic acid bacteria on D-galactitol, an exception to Bertrand Hudson's rule. ***BBA-General Subjects***, Published online: Sep26, 2020. Volume 1865, Issue 1, January 2021, 129740，通讯作者。

34. Muhammad Zohaib Nawaz, Muhammad Bilal, Arslan Tariq, Hafiz M. N.Iqbal, Huda Ahmed Alghamdi & Hairong Cheng*. Bio-purification of sugar industry wastewater and production of high-value industrial products with a zero-waste concept. ***Critical Reviews in Food Science and Nutrition***,2021, 61(21):3537-3554. DOI: 10.1080/10408398.2020.1802696, Published online: 21 Aug 2020. 通讯作者。

35. Wang Nan, Ping Chi, Yawen Zou, Yirong Xu, Shuo Xu, M. Bilal, Patrick Fickers, Hairong Cheng*. Metabolic engineering of Yarrowia lipolytica for thermoresistance and enhanced erythritol productivity. ***Biotechnology for Biofuels***, 2020, 13:176. 通讯作者。

36. Hira Munir, Asima Mumtaz, Robina Rashid, Jawayria Najeeb,Muhammad Talha Zubair, Sahar Munir, Muhammad Bilal, Hairong Cheng*.*Eucalyptus camaldulensis* gum as a green matrix to fabrication of zinc and silver nanoparticles:Characterization and novel prospects as antimicrobial and dye-degrading agents. ***Journal of Materials Research and Technology***, 2020,9(6):15513-15524. （共通讯作者）

37. Muhammad Bilal, Hairong Cheng*, Reyna Berenice Gonzalez-Gonzalez, Roberto Parra-Saldı´var, Hafiz M.N. Iqbal*. Bio-applications and biotechnological applications of nanodiamonds. ***Journal of Materials Research and Technology***, 2021, 15 : 6175-6189. 通讯作者

38. Muhammad Bilal, Sarmad Ahmad Qamar, Vivek Yadav, Hairong Cheng*, Mujeeb Khan, Syed Farooq Adil, Mohammad J. Taherzadeh, Hafiz M.N. Iqbal*. Exploring the potential of ligninolytic armory for lignin valorization – A way forward for sustainable and cleaner production. ***Journal of Cleaner Production***, 2021, 326:129420. 通讯作者

39. Sarmad Ahmad Qamar, Mahpara Qamar, Aneela Basharat, Muhammad Bilal, Hairong Cheng*, Hafiz M.N. Iqbal*. Alginate-based nano-adsorbent materials – Bioinspired solution to mitigate

hazardous environmental pollutants. ***Chemosphere*** 2022,288:132618. 通讯作者

40. Muhammad Bilal, Liyun Ji, Yirong Xu, Shuo Xu, Yuping Lin, Hafiz M. N. Iqbal, Hairong Cheng*. Bioprospecting Kluyveromyces marxianus as a robust host for industrial biotechnology. ***Frontiers in Bioengineering and Biotechnology, section Synthetic Biology***, 2022;10:851768. doi: 10.3389/fbioe.2022.851768 通讯作者

    Bilal M, Ji L, Xu Y, et al. Bioprospecting *Kluyveromyces marxianus* as a Robust Host for Industrial Biotechnology. *Front Bioeng Biotechnol*. 2022;10:851768. Published 2022 Apr 20. doi:10.3389/fbioe.2022.851768

41. Muhammad Bilal, Liyun Ji, Shuo Xu, Yue Zhang, Hafiz M. N. Iqbal, Hairong Cheng*. Bioprospecting and Biotechnological insights into Sweet-Tasting Proteins by Microbial hosts—A Review. 2022. ***Bioengineered***, 13(4), 9815-9828. 通讯作者

42. Yue Zhang, Xinyue Zhang, Yirong Xu, Shuo Xu, Muhammad Bilal, Hairong Cheng*. Engineering thermotolerant Yarrowia lipolytica for sustainable biosynthesis of mannitol and fructooligosaccharides. 2022. ***Biochemical Engineering Journal***, 187:108604. 通讯作者

43. Yirong Xu, Liyun Ji, Shuo Xu, Muhammad Bilal, Armin Ehrenreich, Zixin Deng, Hairong Cheng*. Membrane-bound Sorbitol Dehydrogenase is Responsible for the Unique Oxidation of D-Galactitol to L-Xylo-3-hexulose and D-Tagatose in Gluconobacter oxydans. ***BBA-General Subjects***, 1867:130289. Published online: Dec.10, 2022. 通讯作者.

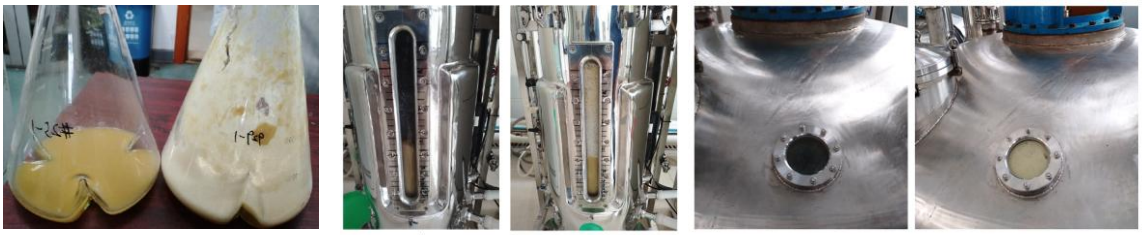
44. JianSong Gan, Muhammad Bilal, XiaoBing Li, Syed Zakir Hussain Shah, Badr A. Mohamed, Tony Hadibarata, Hairong Cheng*. Peroxidases-based enticing biotechnological platforms for biodegradation and biotransformation of emerging contaminants. 2022. ***Chemosphere*** 307:136035.

45. Zhongbiao Tan, Hairong Cheng, Gang Chen, Fang Ju, Jesús Fernandez-Lucas, Teofil Jesionowski, Muhammad Bilal. Designing Multifunctional Biocatalytic Cascade System by Multi-enzyme Co-Immobilization on Biopolymers and Nanostructured Materials. ***International Journal of Biological Macromolecules,*** Volume 227, 1 February 2023, Pages 535-550。

46. 张悦，徐硕，王楠，池萍，张馨月，程海荣*。发酵产泡性能降低的解脂耶氏酵母菌株的

获得及其性能（新资源微生物专刊），**微生物学报**， 2022 年第 11 期 4165-4175, 共 11 页

本研究通过基因组改组，获得一株产泡性能显著降低的解脂耶氏酵母，在合成功能糖醇的过程中无需添加消泡剂或显著减少消泡剂使用量，取得良好的效果。



A：不产泡的工程菌分别在 2 升摇瓶，50 升与 30 立方发酵罐中试验，无泡。

B：对比产泡菌分别在 2 升摇瓶，50 升与 30 立方发酵罐中试验，泡沫很多。

工程菌株自我消泡效果非常明显。

47. Muhammad Bilal, Ehsan Ullah Rashid, Jakub Zdarta, José C.S. dos Santosc, Pedro C.B. Fernandes, Hairong Cheng, Teofil Jesionowski. Designing magnetic nanobiocatalytic systems with multipurpose functionalities for biocatalysis, biotechnology and bioprocess applications. Sustainable Chemistry and Pharmacy, 2022, 100866. Volume 30, December 2022, 100866.

48. Liu, M.; Cheng, H. Discovery and Functional Evaluation of Heat Tolerance Genes in the Nonconventional Yeast *Yarrowia lipolytica*. Fermentation 2023, 9, 509. https://doi.org/10.3390/fermentation9060509.

49. Shuo Xu, Xinyi Zhang, Yue Zhang, Qian Li, Liyun Ji, Hairong Cheng. Concomitant Production of Erythritol and Carotene by Engineered *Yarrowia lipolytica.* J. Agric. Food Chem. 2023, 71, 30, 11567–11578, accepted on June 30, 2023. DOI: 10.1021/acs.jafc.3c03033

50. Liyun Ji, Shuo Xu, Yue Zhang, Hairong Cheng. Screening of broad-host expression promoters for shuttle expression vectors in non-conventional yeasts and bacteria. Microbial Cell Factories, (2024) 23:230. https://doi.org/10.1186/s12934-024-02506-x

51. Shuo Xu, Yawen Zou, Liyun Ji, Muhammad Bilal, Hairong Cheng*. Producing Trehalose from Maltodextrin by the Erythritol-Producing Yeast Yarrowia lipolytica Co-displaying maltooligosyltrehalose synthase and maltooligosyltrehalose trehalohydrolase. ACS Sustainable Chemistry & Engineering, accepted on Feb 9, 2024. https://doi.org/10.1021/acssuschemeng.3c07191

52. Shuo Xu, Qian Li, Yue Zhang, Xinyi Zhang, Liyun Ji, Hairong Cheng*. Screening of Foamless Yarrowia lipolytica Strain by NHEJ-mediated Mutation and Metabolic Engineering for Erythritol Production from Sucrose-Based Feedstocks. ACS Food Science & Technology, 2024. 4,657-667. https://doi.org/10.1021/acsfoodscitech.3c00580

53. Shuo Xu, Xinyi Zhang, Qian Li, Yue Zhang, Liyun Ji, Patrick Fickers, Hairong Cheng*. Synergistic effect of transporter and pathway engineering on erythritol synthesis performance by Yarrowia lipolytica, *Applied Environmental Microbiology*, 2025, 91(4): e00061-25. https://doi.org/10.1128/aem.00061-25

54. Liyun Ji, Qing Li, Ye Li, Shuo Xu, Hairong Cheng*. Volemitol Production from Yarrowia lipolytica via Transaldolase Gene (TAL) Disruption and Erythrose-4-Phosphate (E4P) Flux Regulation. *Biochemical Engineering Journal*, 2025, 213:109535. https://doi.org/10.1016/j.bej.2024.109535

55. Qing Li, Shuo Xu, Tong Li, Liyun Ji and Hairong Cheng. Threitol, a Novel Functional Sugar Alcohol Biosynthesized by Engineered *Yarrowia lipolytica*, Has the Potential as a Low-Calorie Sugar-Reducing Sweetener. ***Foods***, 2025, 14, 2539. https://doi.org/10.3390/ foods14142539.

主持的国家级项目：

1、2021YFA0910503，国家重点研发计划/合成生物学，**智能定向组合生物合成新骨架人工产物，** 2021-11-30 至 2026-11-30

2、21Z990103334，2021-03-01 至 2024-02-29，国家合成生物技术创新中心(中国科学院天津工业生物技术研究所)，**马克斯克鲁维酵母菌种创制及菌体蛋白的合成与应用。**

3、2018YFA0900702，国家重点研发计划/合成生物学，**解脂耶氏酵母合成多烯类**

化合物的催化元器件创制与表征，2019-07-01 至 2024-06-30。

4、21877078，**氧化葡糖杆菌 GOX1857 脱氢酶区域选择性催化半乳糖醇第 3 位羟基的分子机制及酶分子改造，**国家自然科学基金委员会，2019-01-01 至 2022-12-31。

6、23Z150100162，**基于生物发酵合成的减糖与代糖类产品的研究与开发**，2022-12-01 至 2024-12-31，内蒙古自治区科技厅。

三、 专利

围绕解脂耶氏酵母在功能糖醇领域的应用，申请了多项专利：

1、程海荣，吕霁烊，王犇，邓子新。从赤藓糖醇母液中提取赤藓糖醇的方法及其专用酵母菌种。专利号：ZL201310283189。授权

2、程海荣，吕霁烊，王犇，李德春，邓子新。合成赤藓糖醇的 *Yarrowia lipolytica* 酵母菌株及其用于生产赤藓糖醇的方法。ZL201310382059. 授权

4. 程海荣;张乐彬;安瑾;李莉娟;王犇;李云枫。合成低聚果糖的专用菌株及其用于合成低聚果糖的方法。申请号 201510599954.3。 实审，申请公布日：2016.1.6

5. 程海荣;安瑾;张乐彬;李莉娟;王犇;李云枫。合成低聚半乳糖的专用菌株及用于合成低聚半乳糖的方法。ZL201510600511.1. 授权公告日：2019.1.11

6.程海荣;刘大文;王思绮。合成低聚异麦芽糖的解脂亚罗威酵母菌株及其合成方法。申请号 201810455434.9。实审，申请公布日：2018.12.28

7、程海荣。合成木糖醇的重组解脂耶氏酵母的构建方法及其菌株。申请号：2019111111632.实审，申请公布日：2020.3.13。申请公布号：CN110878261A，申请日：2019.11.14. 国际第一份合成生物学合成木糖醇的专利，已获授权，并已申请美国专利。

8、程海荣，王楠，池萍。合成赤藓糖醇的重组解脂耶氏酵母菌的构建方法及其菌株。申请号：202010069250.实审，申请公布日：2020.7.3。申请日：2020.01.21. 2022.12.5 已授权。

9. 程海荣，李莉娟，安瑾，张乐彬，王犇，李云枫。合成海藻糖的专用菌株及其用于合成海藻糖的方法。专利号：ZL2015105999257。授权公告日：2018.10.23，授权公告号：CN 105219663 B

10.程海荣，邹亚文。合成海藻糖的重组解脂耶氏酵母菌的构建方法。申请号：202010252783.8，申请日 2020.4.1，申请公布日：2020.8.7。申请公布号：CN111500617A

11. 程海荣，黄艺园。发酵产泡沫能力降低的解脂耶氏酵母菌的构建方法和应用。申请号：CN202111182315.9，申请日 2021 年 10 月 11 日

12. 程海荣,黄艺园,张馨月,邹亚文,张悦,徐硕,徐一榕。提高解脂耶氏酵母耐热性的方法及用于发酵合成甘露醇。申请日：2022.2.21，申请号：202210157542.4。

13. Hairong Cheng. Construction method and recombinant yeast strain Yarrowia lipolytica for xylitol synthesis. 2022. US Patent Application Number 17/737012, Pub. No.: US 2022/0259622 A1, Pub. Date: Aug.18, 2022.（美国专利）

14. 程海荣，徐硕。一种高效快速合成赤藓糖醇的酵母菌及其构建方法，CN2024100874358，申请日期

2024.1.22.

15. Hairong Cheng, Shuo Xu. A highly efficient and rapid yeast for synthesizing erythritol and its construction method. 2024. US Patent Application Number 17/737012, Pub. No.: US 2024/0259622 A1, Pub. Date: May.28, 2024. (美国专利)

16. 程海荣, 纪丽云。一种能高效合成庚七醇的重组解脂耶氏酵母菌株及其构建方法和应用。申请号：2024110334093。

17. 程海荣。一种低产泡能力的解脂耶氏酵母菌株及其应用。申请号：2024109514396。

18. 程海荣。一种耐高温耐酸的解脂耶氏酵母菌株及其应用。申请号：202410951431X。