Brief Report

Evo-Server: Platform for an open source microbial bioreactor designs targeting experimental evolution

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1. Summary

The current report is to introduce the platform "diyevoserver.com" for open source, DIY, microbial bioreactors targeting microbial adaptive laboratory evolution strategies.

2. Background

Evolutionary engineering, also known as adaptive laboratory evolution (ALE), is commonly used in biological research to acquire new and desirable traits in microbes and enzymes. The desired traits include improving microbial tolerance to unfavorable environmental conditions, better and efficient use of various substrates, improvement of product yield, and even better enzymes, all of which are critically important for development of efficient microbial cell factories. Although the rational-design-based synthetic biology and metabolic engineering are mutually complementary to each other, the evolutionary engineering is convenient to use as a useful tool to overcome the overwhelmingly complexity of biological systems and fast development of industrial strains.

Equipment for ALE has undergone a continuous enhancement for a more controllable experimental design and longer operation. Further, integration of automated evolutionary engineering to metabolic engineering and synthetic biology emerged as promising synthetic-evolution strategy.

On the other side, Do-It-Yourself (DIY) is the term which considered being the rising star of the automated evolutionary engineering. DIY, which has been strongly supported by the open source platforms, just like Single-Board Computers (SBC), showed usefulness

in offering affordable and customizable a high throughput technology to researchers. Positive impact from the DIY has been observed in the recent years on the experimental design and automation for adaptive laboratory evolution experiments (ALE) (Ekkers et al., 2020; Espeso et al., 2020; Pilizota & Yang, 2018; Wong et al., 2018). Usually commercial microbial bioreactors from companies are expensive and non-customizable, which limit the experimentation from going beyond the companies' bioreactor specifications. One of the most promising DIY's applications in biology are the chemostat and turbidostat systems for continuous culturing of microbes. In the current study we are presenting a new version of simple arduino-based microbial bioreactor, with application on ALE for bacterial methanol tolerance/utilization. The current version of the DIY microbial bioreactor is single, double, and multiple reactors with very flexible design regard costs, coding, and parts assembly. The platform is user-friendly, allows the researcher to design/monitor complex experiments in less time with ease. The whole equipment can be assembled and calibrated in just few hours. The goal of the current report is to bring attention to the online platform Evo-server, which could be considered as a seed for accelerated evolution of microorganisms under controlled laboratory conditions through DIY.

3. Scheme of the platform

The online platform involves full description for the assembly process, download section which is connected to Sketchfab for 3D models and Github for Arduino coding. All assembly procedures are introduced in PDF file format. Fig.1 shows the general scheme of the platform, that the reader can easily interact with.
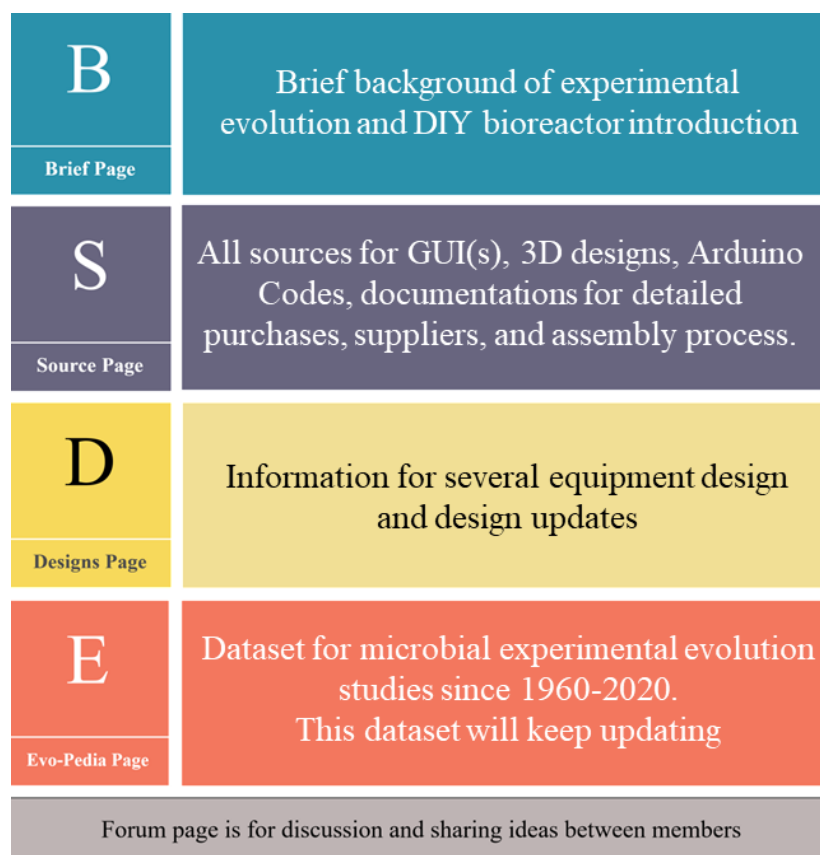
Fig.1 Scheme for the online platform diyevoserver.com.

References:

Ekkers, D. M., Branco dos Santos, F., Mallon, C. A., Bruggeman, F., & van Doorn, G. S. (2020). The omnistat: A flexible continuous-culture system for prolonged experimental evolution. *Methods in Ecology and Evolution*, *11*(8), 932–942. https://doi.org/10.1111/2041-210X.13403

Espeso, D. R., Dvořák, P., Aparicio, T., & de Lorenzo, V. (2020). An automated DIY framework for experimental evolution of Pseudomonas putida. *Microbial Biotechnology*. https://doi.org/10.1111/1751-7915.13678

Pilizota, T., & Yang, Y.-T. (2018). "Do It Yourself" Microbial Cultivation Techniques for Synthetic and Systems Biology: Cheap, Fun, and Flexible. *Frontiers in Microbiology*, *9*. https://doi.org/10.3389/fmicb.2018.01666

Wong, B. G., Mancuso, C. P., Kiriakov, S., Bashor, C. J., & Khalil, A. S. (2018). Precise, automated control of conditions for high-throughput growth of yeast and bacteria with eVOLVER. *Nature Biotechnology*, *36*(7), 614–623. https://doi.org/10.1038/nbt.4151