## Modeling Microbial Dynamics: Revealing the Components' Function of the coculture system consists of *E. coli* and *Synechococcus*.

## 微生物动力学建模：揭示由大肠杆菌和聚球藻组成的共培养系统的组分功能。

In conclusion, we developed three models. First, we constructed the formaldehyde degradation and formaldehyde indication pathway with ordinary differential equations to simulate the behavior of this part. Second, we turned to flux balance analysis (FBA) for a more convincing result. We achieved this with multiple steps: choosing and verifying GEMs, modification according to the pathway, and validation of the simulation result. The simulation result of formaldehyde is consistent with data from the wet lab, which verified the model. After that, we developed an optimized model to obtain an optimized cell number ratio between *Synechococcus* and *E. coli,* which can serve as a starting point when setting up the coculture system in reality*.* Third, we developed a physical model of alginate beads considering cell embedding based on diffusion and metabolite models. The finite element analysis results of different types of beads showed that the installation of a pump will increase the system’s efficiency, the increasing size of beads will decrease the photosynthesis efficiency due to light decay and the degradation efficiency will be limited due to the equilibrium between diffusion and metabolite. To sum up, our model verified the component’s function, served insights into the system’s function, and provided useful suggestions for future development on the system.

总的来说，我们开发了三个模型。首先，我们使用常微分方程构建了甲醛降解和甲醛指示途径，以模拟该部分的行为。其次，为了获得更有说服力的结果，我们转向了通量平衡分析（FBA）。我们通过多个步骤实现了这一目标：选择和验证基因组规模代谢网络模型（GEMs），根据我们的生化网络进行修改，并验证模拟结果。甲醛的模拟结果与实验数据一致，证实了该模型的准确性。随后，我们开发了一个优化模型，以获得聚球藻和大肠杆菌之间的最佳细胞比例，该比例可以作为在实际中建立共培养系统时的起点。第三，我们开发了一种基于扩散和代谢物模型考虑细胞嵌入的海藻酸钙凝胶小球的物理模型。不同类型小球的有限元分析结果显示，安装水泵将提高系统的效率，小球尺寸的增加将由于光衰减而降低光合效率，并且由于扩散和代谢之间的平衡，降解效率将受到限制。总的来说，我们的模型验证了组分的功能，为系统的功能给出了见解，并为今后系统的改进提供了有用的建议。