We hereby present iGEM’s first self-sufficient biolamp powered by solar light. We have tamed an artificial consortium between two microorganisms: *Synechococcus elongatus*, a photosynthetic cyanobacterium and *Alivibrio fischeri*, a bioluminescence marine heterotrophic bacterium. The cyanobacterium produces AHL, the signaling molecule that induces bioluminescence in *A. fischeri*. As our biolamp only requires to be “lighted” at night, we have used a photosensitive promoter (PpBAI) to control its gene (luxI). Furthermore, our cyanobacteria is able to export sucrose to fed *A. fischeri*, rendering our biolamp self-sustainable, as the energy used for our biolamp comes directly from the Sun.

**How we make light:**

We have designed a construct in order to regulate the day/night switch of *Alivibrio fischeri* bioluminescence. This consists on a device controlled by a light-regulated promoter from *S. elongatus* (PpBAI), which is mainly active during the day. When pBAI is active, the expression of a cl inverter device takes place. This inverter avoids the LuxI gene transcription. During the night the pBAI promoter is inactive, cl inverter is not present, allowing the expression of LuxI gene and AHL synthesis.

We synthesized the pBAI promoter and retrieved the other parts from the Registry of Standard Parts. We assembled PpBAI with the standard BioBrick pSB1C3 plasmid. In order to characterize the pBAI promoter we transformed a cscB *S. elongatus* strain with a pBAI::luxCDABE fusion vector provided by Goldén and we obtained resistant antibiotic colonies. Luminiscence measures are currently being made.

**SYSTEM ENGINEERING**

Our furthest engineering goal was the design of a co-culture bioreactor to keep the system working in continuous and to separate the photosynthetic module from the biolamp module to render it useful. The structure basically consists of two vessels: the *S. elongatus* culture and the *A. fischeri* culture, in a common broth connected by tubing but isolated by 0.45 micron pore membranes, where molecules but not cells can flow through. The common medium contains all substances required by both organisms to grow; salt and high pH for both organisms, micronutrients for cyanobacteria and peptone for *A. fischeri* (carbon source provided by sucrose export). We did some experiments to assay these requirements to design the common broth composition.

In order to mix the soluble content between vessels, there is a pump system with time-switching sense reversal (to avoid clogging one side of the membranes). To keep the system in continuous growth, we have an attached filtering system which recycles the fluid, activated by optical detectors of population. Above it, an automatic evaporation water retifer to keep osmotic balance.

**HUMAN PRACTICES**

Our goal was to approach Synthetic Biology to the general population with several broad activities. The most important one is a Bilingual Spanish/English Blog, called Synth(eth)ic Biology, where several issues about Synthetic Biology have been discussed as well as all the activities we have been organizing during the summer, and we have also had conversations with people about the implications of Synthetic Biology in Bioethics and interviews with iGEM teams from other participants.

The organized activities include:

- **Fig. 8. Do a poll about synthetic biology and our project**
- **Fig. 9. Lectures about DNA and Synthetic Biology**
- **Fig. 10. Seminar and Discussion at CSIC**

**MODELLING**

We have done a theoretical approximation of the behaviour of the whole bioreactor, based on previous models of both organisms. We were looking for the optimal bioreactor designed parameters, volume cultures and cell densities, in order to have enough light emission, a stable day/night switch and a sucrose energy balance to keep the system autonomous.

First model: We used a Synechococcus metabolic network with 898 reactions, to which we add the sucrose and AHL export functions. We performed a flux balance analysis to obtain maximum sucrose and AHL production, at exponential and stationary growth rates, besides biological constraints and inputs of light and CO\(_2\). We took the maximum experimental value that the cscB strain is able to export in exponential growth to obtain a concrete AHL value as input for the next model.

Second model: We used an *A. fischeri* quorum sensing model, based on 9 differential rate equations to predict the operation of the lux operon. We modified this model in order to adapt the equations to the most efficient bioreactor volume adding the AHL input obtained from the *S. elongatus* model.

Combining the models: By combining the results of both models we want to adapt the volume of the cultures for the most efficient light production for our biolamp.

**ACHIEVEMENTS**

- **Submitted a well characterized part to the Registry of Standard Biological Parts.**
- **Designed a self-sufficient photosynthetically-powered biolamp.**
- **Built an effective model for the different biolamp processes.**
- **Transformed *Synechococcus elongatus* PCC7942 to characterize the pBAI promoter.**

**ACKNOWLEDGMENTS**

- Opened a bilingual webpage about synthetic biology, focusing on divulgation.
- Established collaborations with other iGEM teams: UC London, Copenhagen, Chile.
- Tested and characterized new and better culture medium for growing cyanobacteria in our lab conditions.
- Fulfill all Bronze, Silver and Gold Medal requirements.