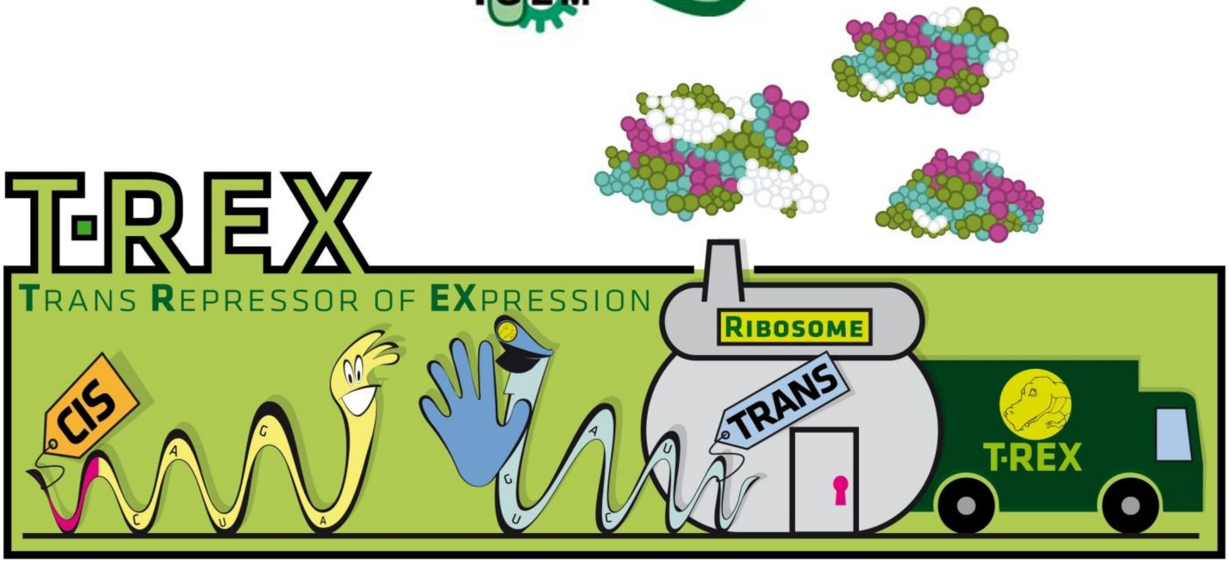
iGEM and Synthetic Biology

Brochure

By

UniBO iGEM Team 2009



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What is Synthetic Biology?

Synthetic Biology is a new engineering discipline studying principles and techniques for the design of devices made of biological materials (DNA, proteins, cells). Synthetic Biology uses whole cells and molecular constituents as blocks for the development of artificial (synthetic) biological system.

What does Synthetic Biology do?

Synthetic Biology uses **microorganisms** (bacteria, yeasts) as genetically "programmable **machines**" to be transformed with exogenous DNA molecules, containing the **"instructions"** to achieve a defined biological function. When the cell runs the program, it realizes a molecular circuit determining the desired behavior. The genetic program is assembled using **BioBricks**, which are DNA parts with specified biological functions. Currently, there are several thousand BioBricks, whose characteristics are described in the **Registry of Standard Biological Parts** (http://partsregistry.org).

Successes of Synthetic Biology

Synthetic Biology has already produced important results in many different fields:

- **biosensors** to detect the presence of molecules of interest;
- **bioenergy generators** (hydrogen, ethanol and biodiesel);
- **biopolymers generators** for industrial applications;
- **biopurifiers** to detect and metabolize toxic substances or pollutants;
- **diagnostic and therapeutic systems** for applications "in vivo" (i.e. cells able to release insulin in response to increased blood glucose or to counteract proliferation of tumor cells).

Implications of Synthetic Biology

Biology studies living matter to discover its functioning and behavior. Engineering, however, apply the knowledge gained with a new goal: using biological material to build new things helpful to mankind.

Considering the technical nature of Synthetic Biology, there are many possible questions about the implications arising from its products: Are organisms fabricated in a laboratory different from the ones existing in nature? Are collective benefits a "right aim" for genetically modified organisms? Is it right to assign an economic value

to products made with living materials? What are the principles to use for judging all this? How to be aware of the consequences of these applications? Is it right that the procedures to make synthetic biological systems and devices are open-source?
All these questions are part of a debate in the field of Synthetic Biology. The aim is to use Synthetic Biology techniques in a conscious and responsible way and to promote transparently-addressed objectives.

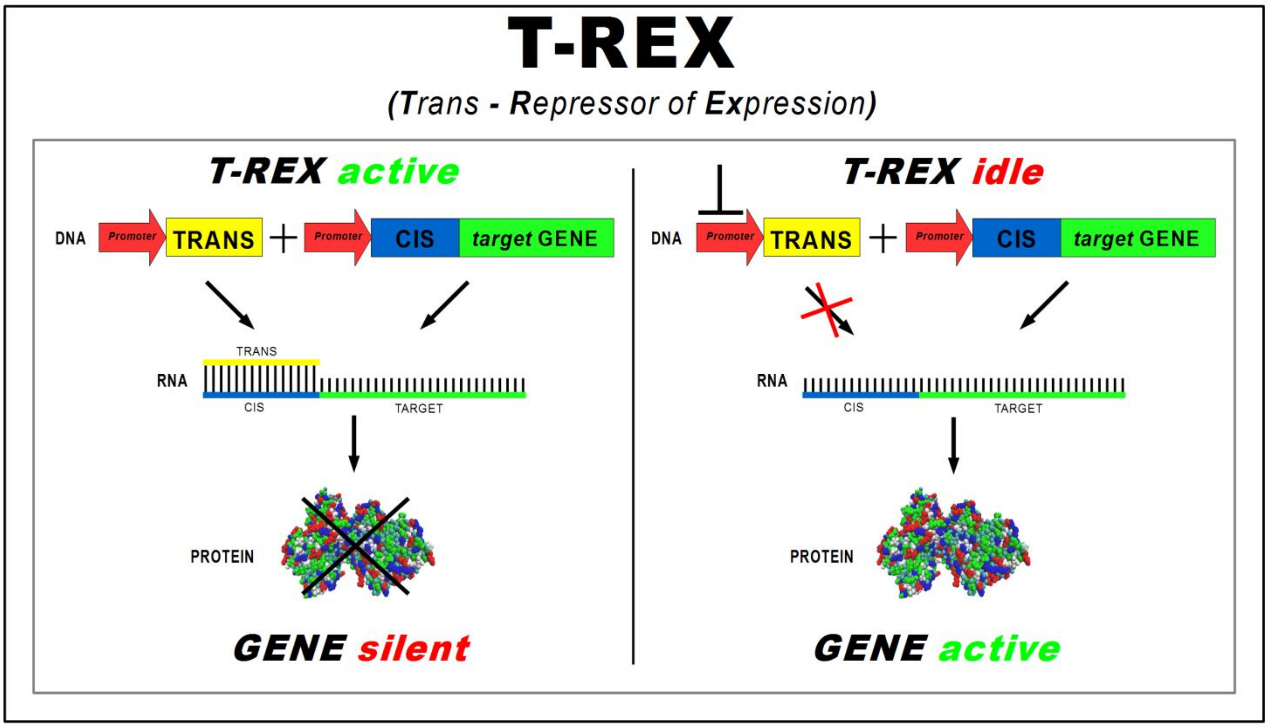
iGEM Competition

iGEM (**i**nternational **G**enetically **E**ngineered **M**achine) is an international **competition** in **Synthetic Biology,** organized by the **MIT** (Boston, MA, USA) and involving teams of both students and mentors. In 2009 112 teams from all over the world will participate, including two from Italy (University of Bologna and University of Pavia).
Every team received a set of genetic components (BioBricks) from the **Registry of Standard Biological Parts**. Using these BioBricks and others of their own design, the teams build a new **genetic circuit** to be implemented in a microorganism, to make it able to perform a **new biological function**.
iGEM aims to:

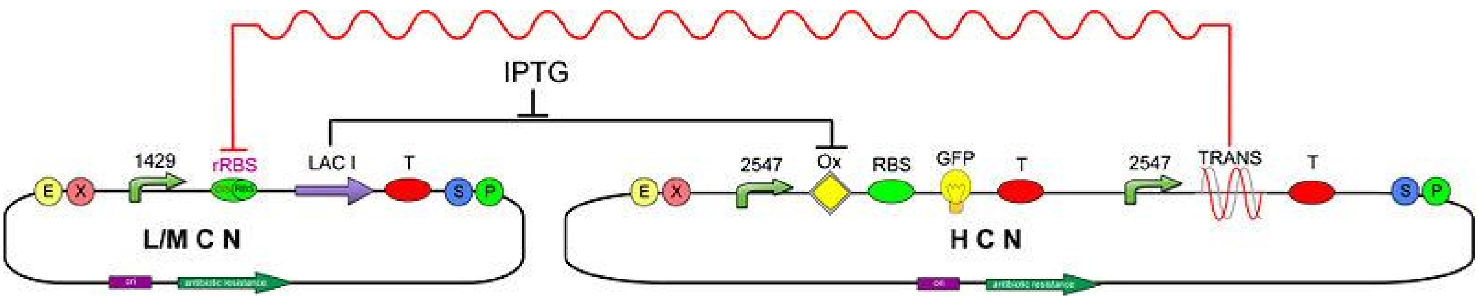
- Promoting academic study of Synthetic Biology;
- Actuating applications of engineering principles to biology;
- Stimulate the conscious use of Synthetic Biology.

UniBO iGEM Team 2009's Project

The project developed this year by the **UniBO iGEM Team** aims to implement in *Escherichia coli* a protein synthesis regulation device that acts at the translational level with any target gene of interest. This "**general-purpose**" device should allow a faster control of protein expression.This device was named **T-Rex** (**T**rans **R**epressor of **Ex**pression). It consists of two new BioBricks: the **Trans-repressor** and the **Cis-repressing**. The Cis-repressing element ends with the ribosomal binding site (RBS) and is assembled upstream of the target protein coding sequence. The Trans-repressor element, controlled by an inducible promoter, is complementary to the Cis-repressing element and contains also a RBS cover. Transcription of the target gene produces a mRNA strand, containing a 5' UTR Cis element, which is translated into proteins by ribosome. Induction of Trans promoter produces a transcript that binds with the Cis part. The RNA duplex prevents ribosome from binding to RBS, thus repressing protein synthesis.



To test and characterize our T-Rex device the following circuit was developed:



Project and team's details can be found at:
http://2009.igem.org/Team:Bologna

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