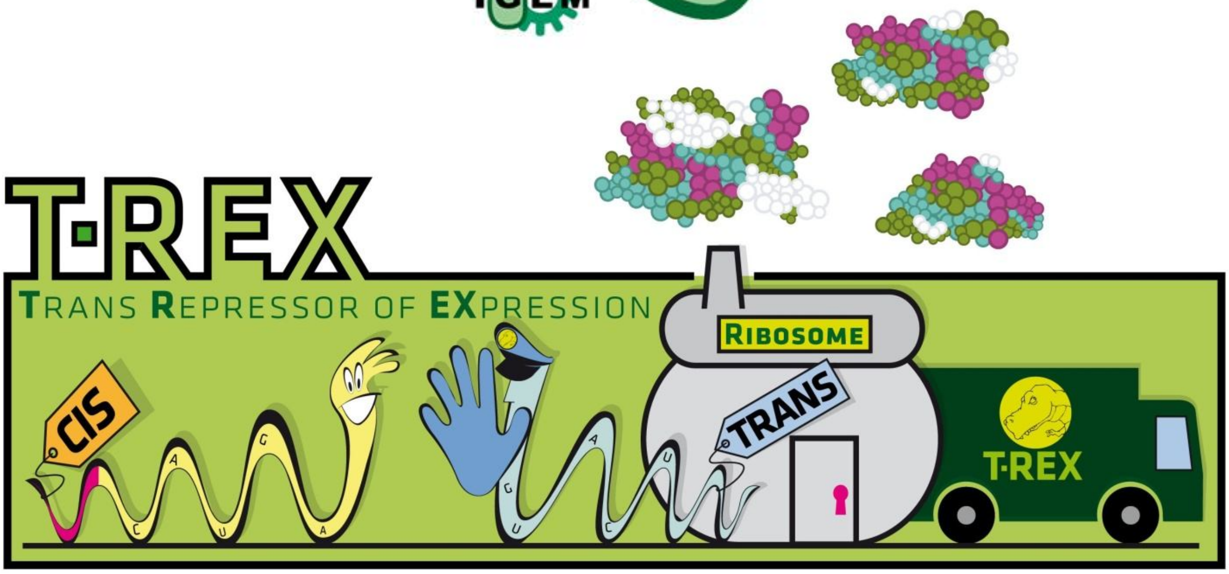
iGEM and Synthetic Biology
Brochure

By

UniBO iGEM Team 2009



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What is Synthetic Biology?

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

What does Synthetic Biology do?

Synthetic Biology uses **microorganisms** (bacteria, yeast) as genetically "programmable **machines**". **Programs** are performed by transforming the cells with exogenous DNA molecules, containing the **"instructions"** to achieve a predetermined biological function. When the cell runs the program, it realizes a molecular circuit that determines the desired behavior. The genetic program is assembled using **BioBricks**, which are DNA parts with specified biological functions. Currently, there are several thousand of 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 blood glucose increase or to counter proliferation of tumor cells).

Implications of Synthetic Biology

Biology uses living materials to discover its functioning and behavior. Engineering, however, apply the knowledge gained with a new goal: using the 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 applications: Are genetically modified organisms from the laboratories different from the ones existing in nature? Are collective benefits a "proper purpose" for genetically modifying organisms? Is right to assign an economic value to projects realized with living materials? What are

the principles to use for judging all this? How to be aware of the consequences of applications? Is right that the procedures to realize biological systems and devices are open source?
All these questions are considered by Synthetic Biology which tries to use in a conscious and responsible way its techniques and promotes the objective of its studies transparently.

The iGEM Competition

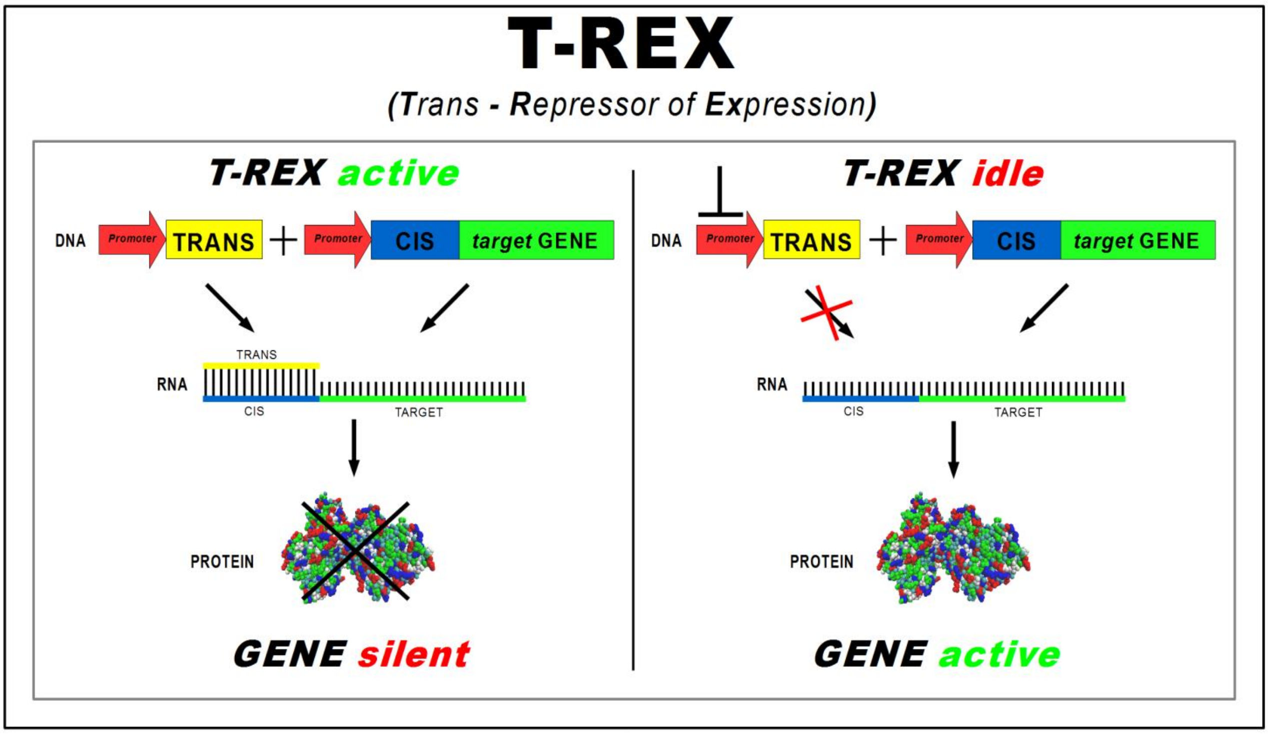
iGEM (**I**nternational **G**enetically **E**ngineered **M**achine) is an international **Synthetic Biology competition**, organized by **MIT** in Boston, which involves team of both students and professors. In 2009 there will be 112 teams from all the world, including two from Italy (University of Bologna 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, teams build a new **genetic circuit** to be implemented in a microorganism, to make it able to do a **new biological function**.
iGEM aims to:

- Promoting academic study of Synthetic Biology;
- Actuating application of of engineering principles to biology;
- Building a society able to use biological techologies in a productive way.

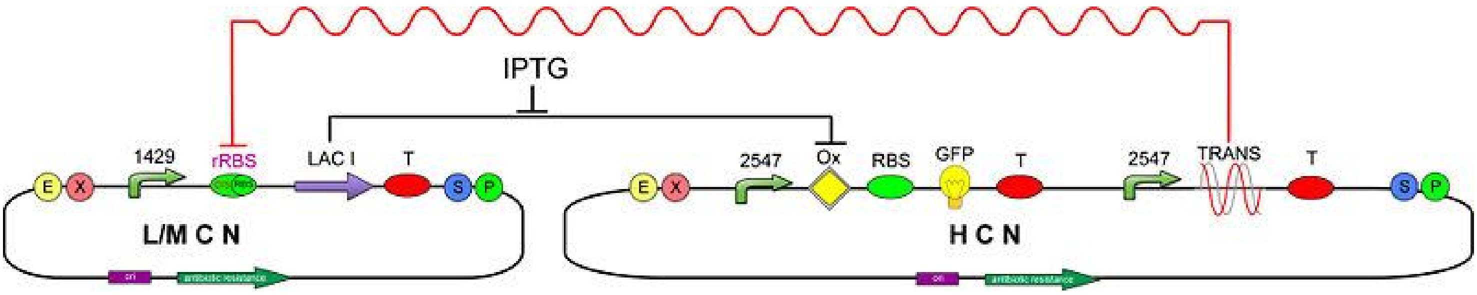
Il progetto dell'UniBO iGEM Team 2009

The project aims to implement a protein synthesis regulation system in *Escherichia coli* that acts at translational level, regardless of the target gene. This "**general-purpose**" device allows a faster control of protein expression.
The 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, under the control of an inducible promoter, is complementary to the Cis one and contains also a RBS cover.
Transcription of the target gene produces a mRNA strand, starting with the Cis element, which is translated into proteins by ribosomes. Trans' promoter induction

produces a transcript that binds with the Cis part. The RNA duplex prevents ribosome from binding to RBS, repressing protein synthesis.



We developed a circuit in order to test and characterize our T-Rex device:



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

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