

Playing with genes

About synthetic biology, iGEM competition and our project

Basic concepts in biology

- ▶ **Biology** - branch in science concerned with the study of life and living organisms.
- ▶ **Cell** - the functional basic unit of life.
Humans combined from billions of cells.
- ▶ **Bacteria** - one of the most ancient and common live organism on the plant.
One bacterium in as single cell and can not be seen with naked eye.



Bacteria under microscope

Basic concepts in biology

- ▶ **DNA** - long molecule containing all the genetic code and the instruction to build the cell components.
 - Consists of 4 basic bricks (bases) marked as A,G,C,T
 - Different organisms diverse from each other by the sequence of the basic bricks and their number.
- ▶ **Gene** - section of DNA contains information regarding specific attribute.
 - For example: gene encodes for information about hair color.

Yellow bar with left-pointing chevron < A

Green bar with right-pointing chevron > T

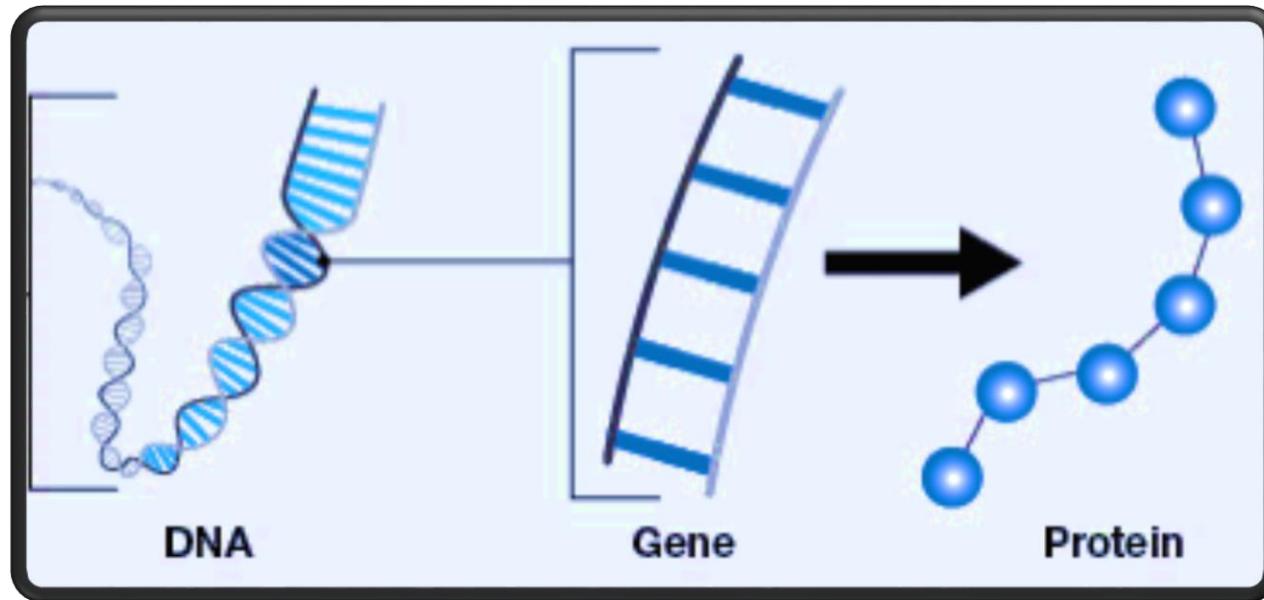
Blue bar with left-pointing chevron < C

Red bar with right-pointing chevron > G



Basic concepts in biology

- ▶ **Protein** - the “worker” of the cell. Molecule with different activity, according to the cell needs.
 - The cell translate gene (instruction) to specific protein (worker).



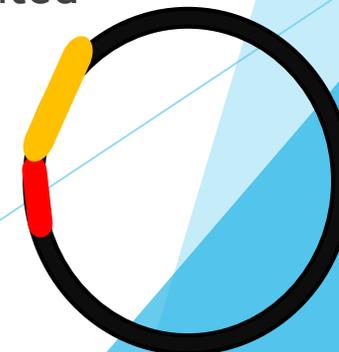
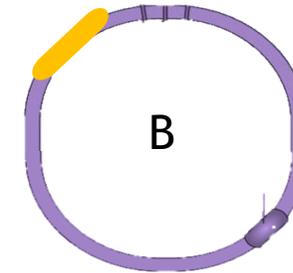
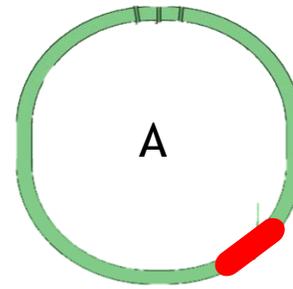
Synthetic Biology



- ▶ **Synthetic** = unification of two units into one new unit
- ▶ **Synthetic Biology** = unification of new biology systems
- ▶ Synthetic biology is in the cross between biology and engineering
- ▶ Researcher in synthetic biology engineering new biology system based on known part from other known biology systems.

Simple example

- ▶ Bacteria A has a gene that encodes for protein that make the bacteria color in red.
- ▶ Bacteria B has a gene that encodes for protein that make the bacteria smells like banana.
- ▶ **Goal:** get new bacteria with red color and smell like banana.
- ▶ **Process:**
 - Cut out the gene that encodes for color protein from bacteria A
 - Cut out the gene that encodes for smell protein from bacteria B
 - Take two cut genes and attach them together synthetically in the lab
 - Insert the new part into DNA of new bacteria
 - We got new bacteria with red color protein and smell protein as we wanted



Application of synthetic biology

- ▶ Fast and cheap production of medication and vaccines
- ▶ Medication for cancer
- ▶ Detecting different materials
- ▶ Data storage
- ▶ Creating biofuel
- ▶ Biodegradable packaging
- ▶ And more...



Funny facts

- ▶ Today you can write sequence of A,G,C,T in the computer and order DNA molecule over the internet.
- ▶ The DNA made synthetically with a machine, similar to a printer.
- ▶ Sugar is the starting material.
- ▶ With 25\$ you can buy enough amount of sugar to produce DNA of all humans on the planet!





iGEM

International Genetically Engineered Machine

- ▶ Worldwide synthetic biology competition.
- ▶ Participate groups of students and high school from all around the world.
- ▶ Each group build a project of biological system to solve a problem they encounter.
- ▶ Start in 2003 as MIT course with 5 groups.
- ▶ In 2016 will participate more then 300 groups from 5 continents.



iGEM in Israel

- ▶ Groups from Israel this year:
 - Technion
 - Ben Gurion University
 - Tel Hai academy
 - Danciger high school in Qiryat Shmona
- ▶ First Israeli group was from the Technion and participate in 2012
- ▶ All three iGEM Technion so far won gold medal!



S.Tar

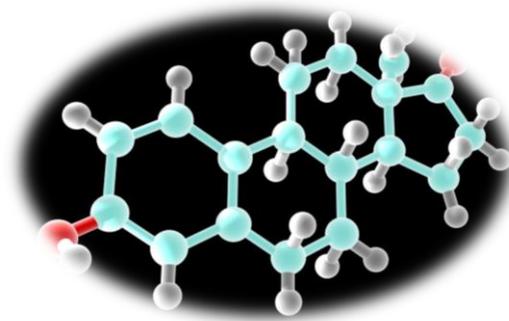
Platform for precise, fast, easy and cheap detection of specific materials



Water pollution



Forensics



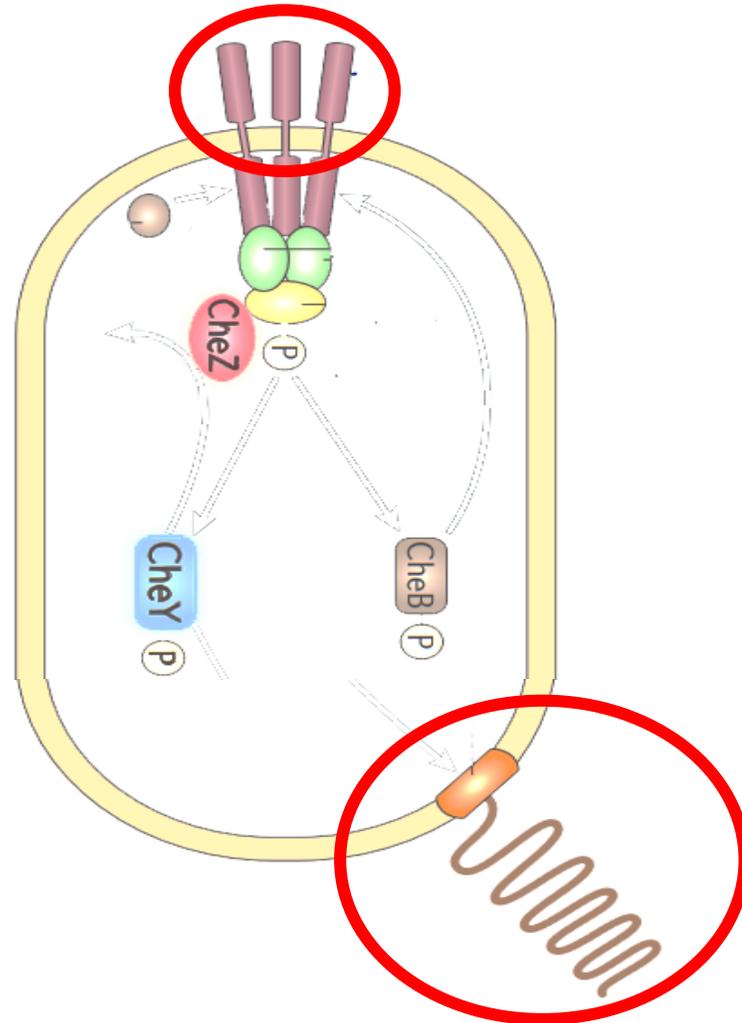
Hormones

chemotaxis

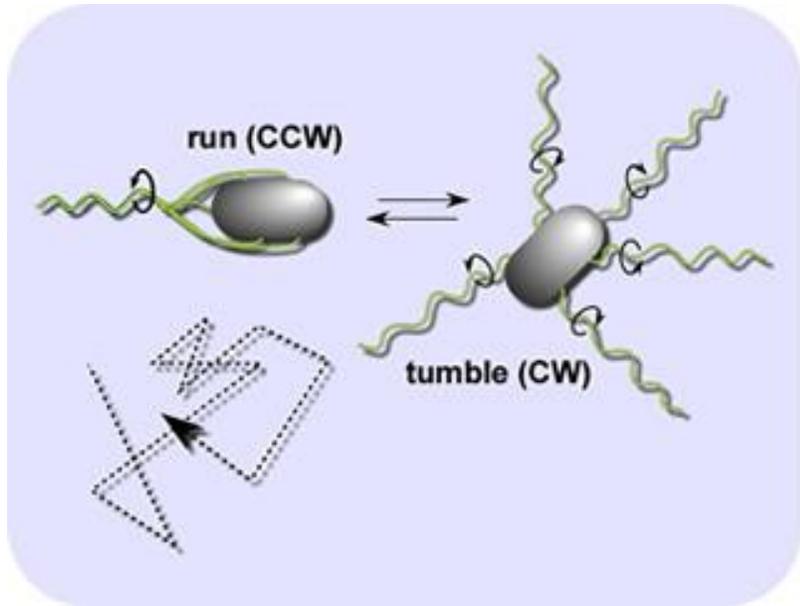
The ability of bacteria to **identify** and **move** towards attractants or away from repellents

Identify

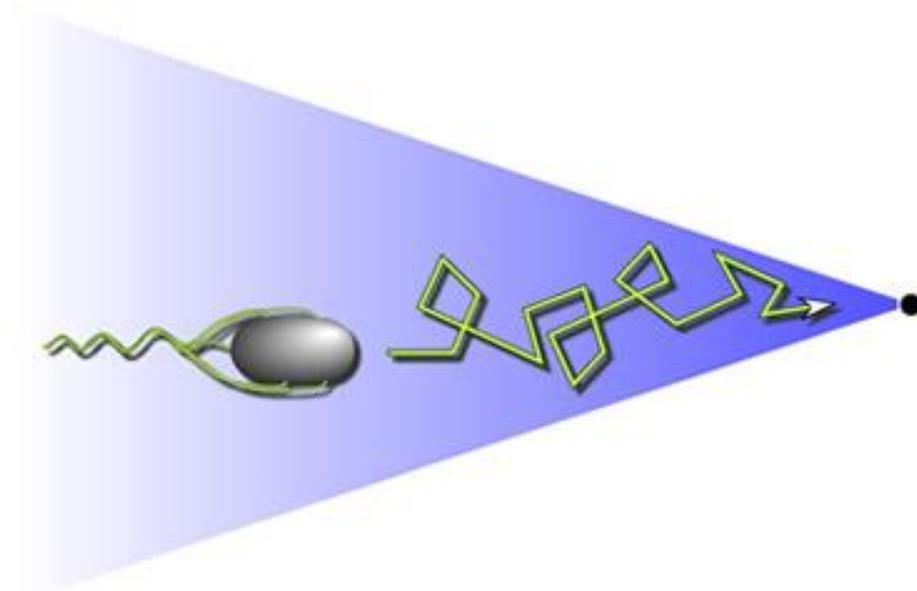
Identification through receptors



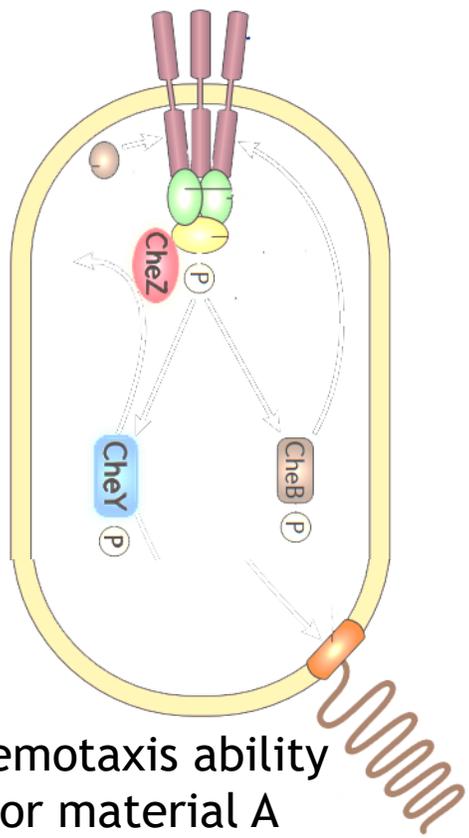
Movement



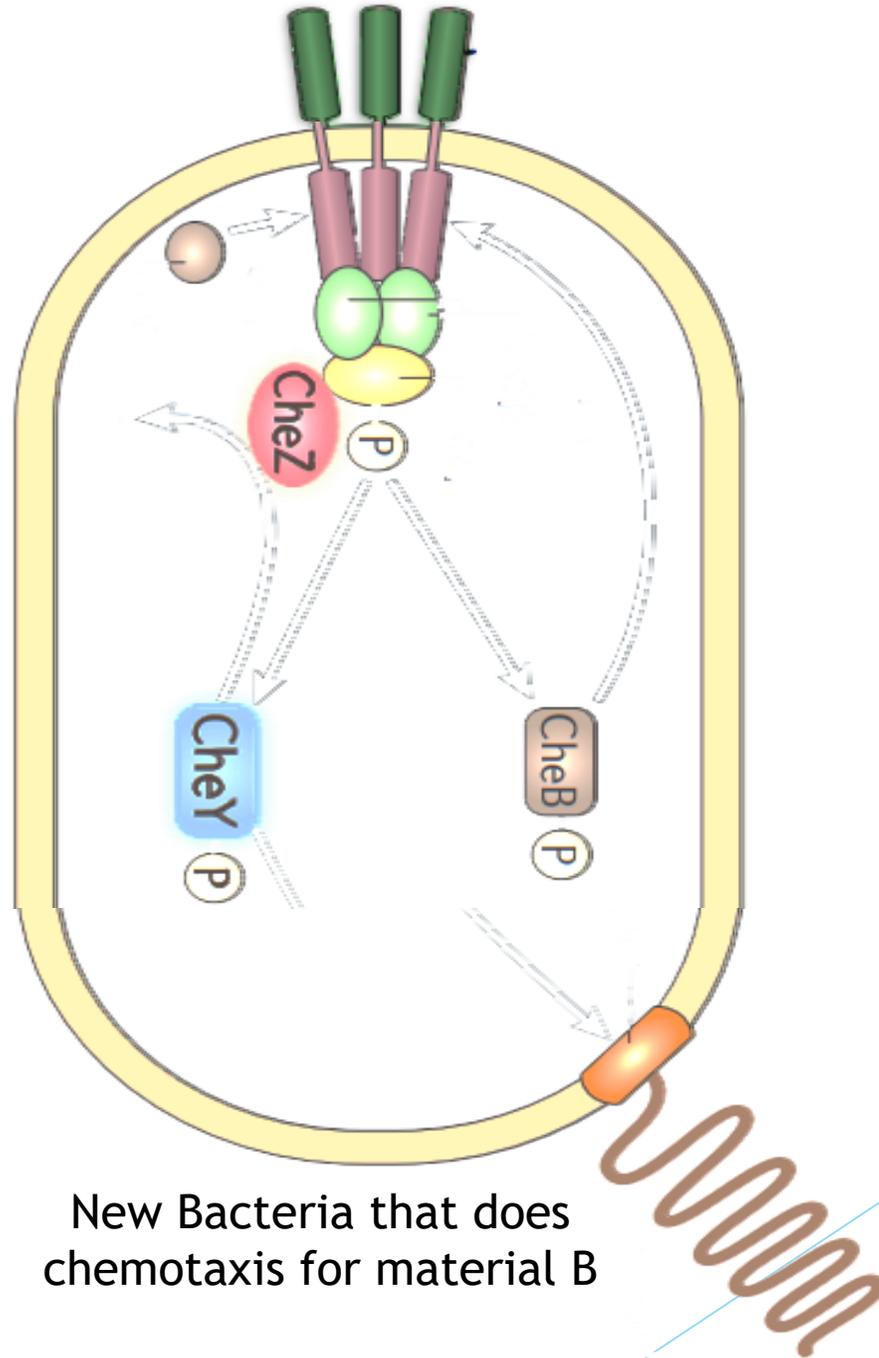
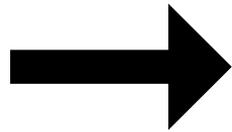
Random movement



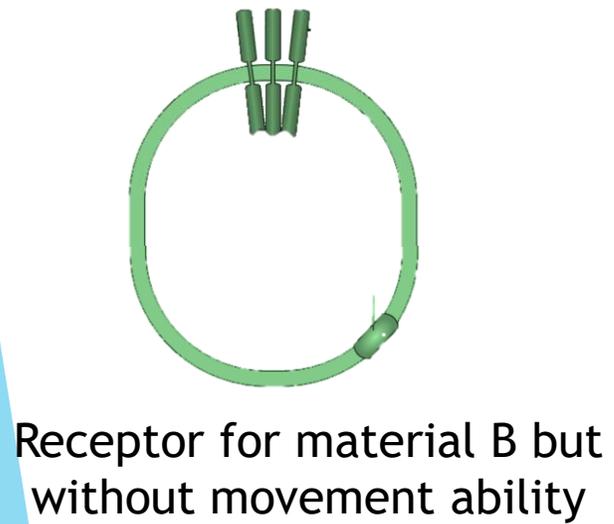
Movement towards attractant



Chemotaxis ability
for material A

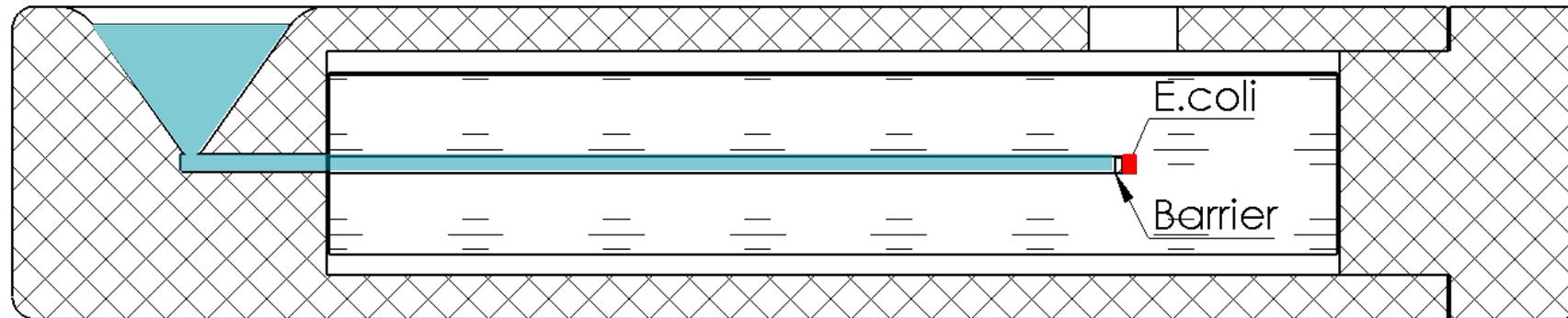
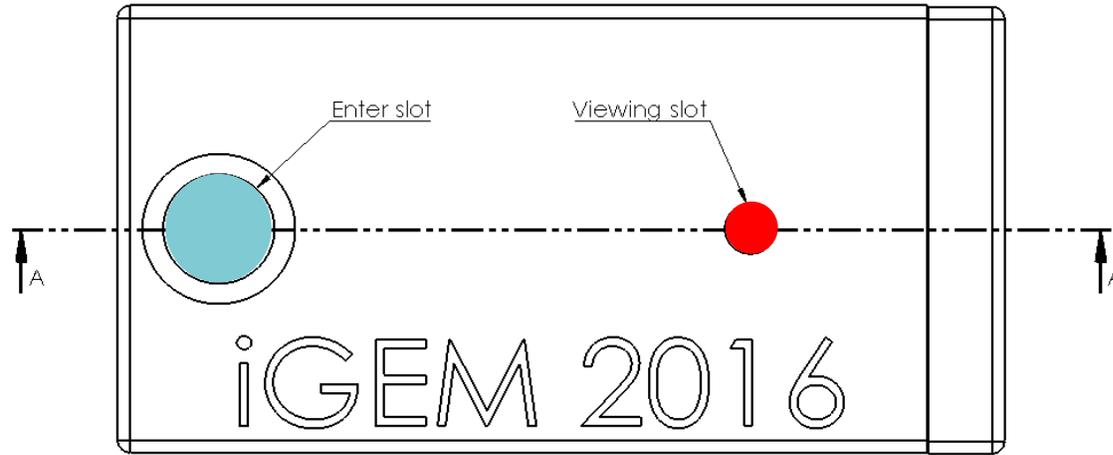


New Bacteria that does
chemotaxis for material B



Receptor for material B but
without movement ability

Prototype of our chip



SECTION A-A

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