

Lecture-04, 05

# Parts and Design: BioBricks



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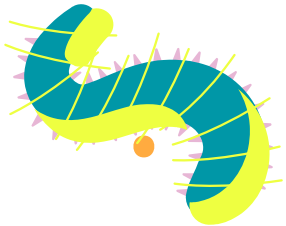
## BioBrick Intro

Introduction to the concept of BioBricks and “Parts”.

02

## Types

Overview on the various types of BioBricks



03

## Example

A case study of a biological system that is synthetically designed.



Modularising life

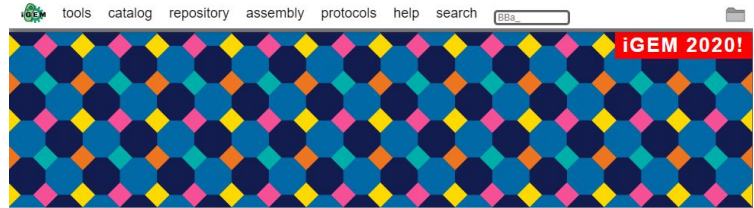
# 01: BioBricks

# What is Synthetic Biology ?

- Biology re-engineered to implement novel biological functions and systems.
- A growing collection and catalogue of DNA parts with specific functions – a Registry of BioBricks – emerged as an essential resource to reprogram living cells.
- Used to make programmable circuits.

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## Registry of Standard Biological Parts



### iGEM 2020: An exceptional year

This is not a normal year. Together, we are facing the biggest pandemic in the past 100 years. Based on your feedback, we are adapting the iGEM experience - we have examined each part of the competition to make it even better this year. This is iGEM in the time of a pandemic. It will be worth it.

[See the full announcement here](#)

Take a look at some of the changes on our [New for 2020](#) [hub](#).

### Add and Document Parts

Start adding and documenting your parts early! Throughout the season you can update your part documentation with new information, modelling data, and/or experimental characterization.

### Sample Submissions

iGEM teams do not need to send samples of their parts anymore. We encourage teams to focus on the design, modelling, characterization, and documentation of their parts!

### Update: Distribution Kit

As a result of the current pandemic, we will not be able to manufacture and ship our 2020 DNA Distribution Kits to teams and labs this year. We sincerely apologize for any inconvenience this may cause.

### Featured Part

#### Uppsala Chromoprotein Collection

Group: Team Uppsala

The 2011 Uppsala iGEM team centered their iGEM project around a library of reporter proteins with a focus on chromoproteins. The 2012 and 2013 teams, while having very different projects, continued the previous years' work alongside their projects.

This has resulted in a large collection of

















### DNA Synthesis Offer: IDT

IDT is once again generously offering 20 kb of DNA as gBlocks® Gene Fragments free of charge to each iGEM 2020 team! Click here to go to IDT's partner offers page for more info.

### Update: Composite Parts

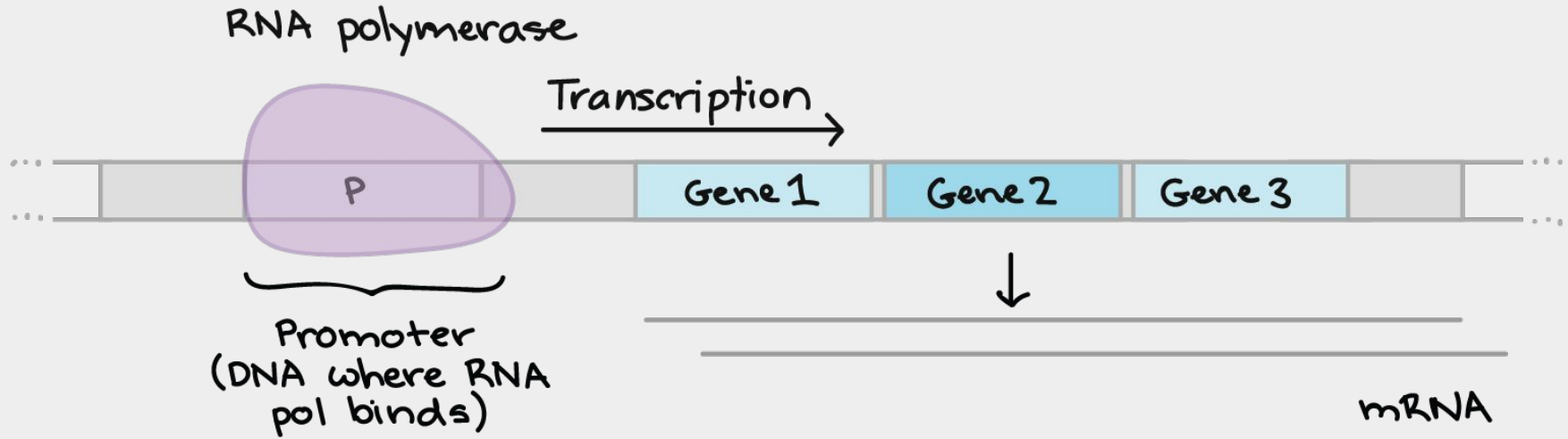
If you synthesized or used a different assembly system to create a composite part, you can now

## 02: Types of BioBricks

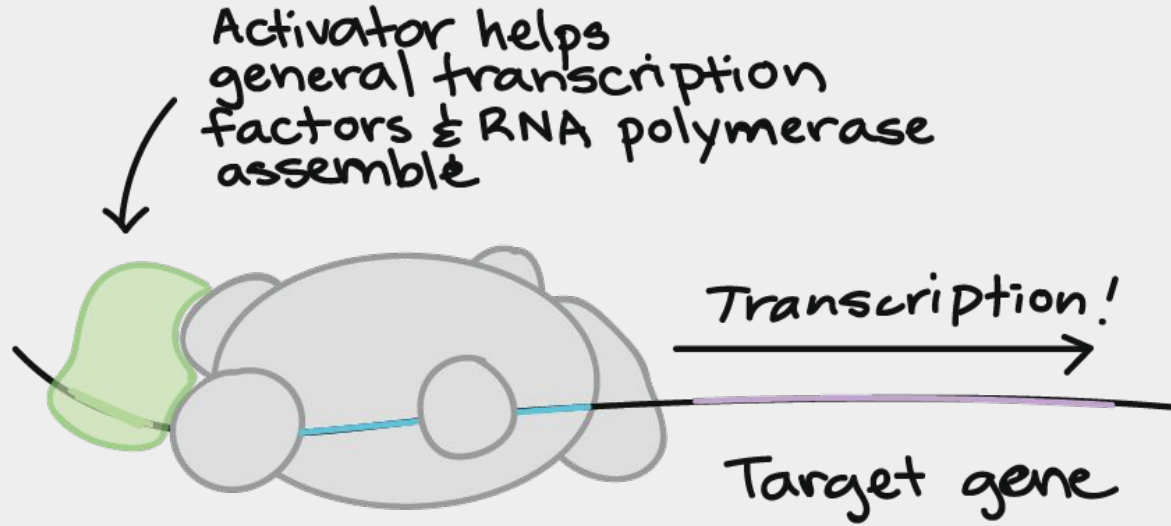
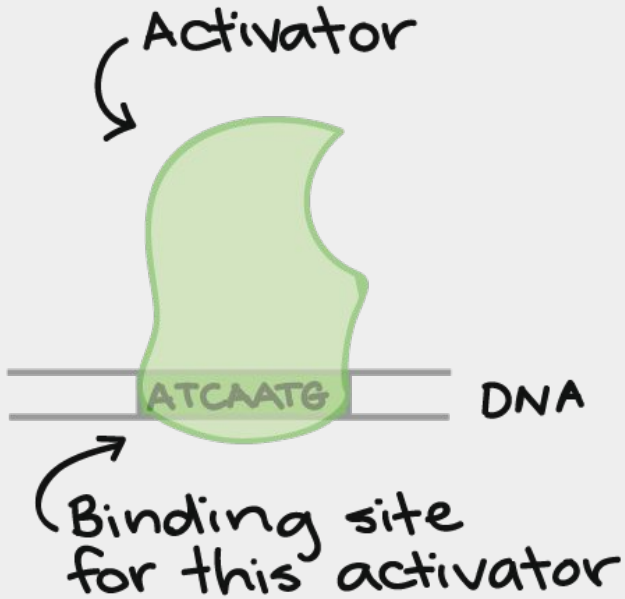
 promoter	 primer binding site
 cds	 restriction site
 ribosome entry site	 blunt restriction site
 terminator	 5' sticky restriction site
 operator	 3' sticky restriction site
 insulator	 5' overhang
 ribonuclease site	 3' overhang

Consist of sensors, actuators, input and output devices, and regulatory elements.

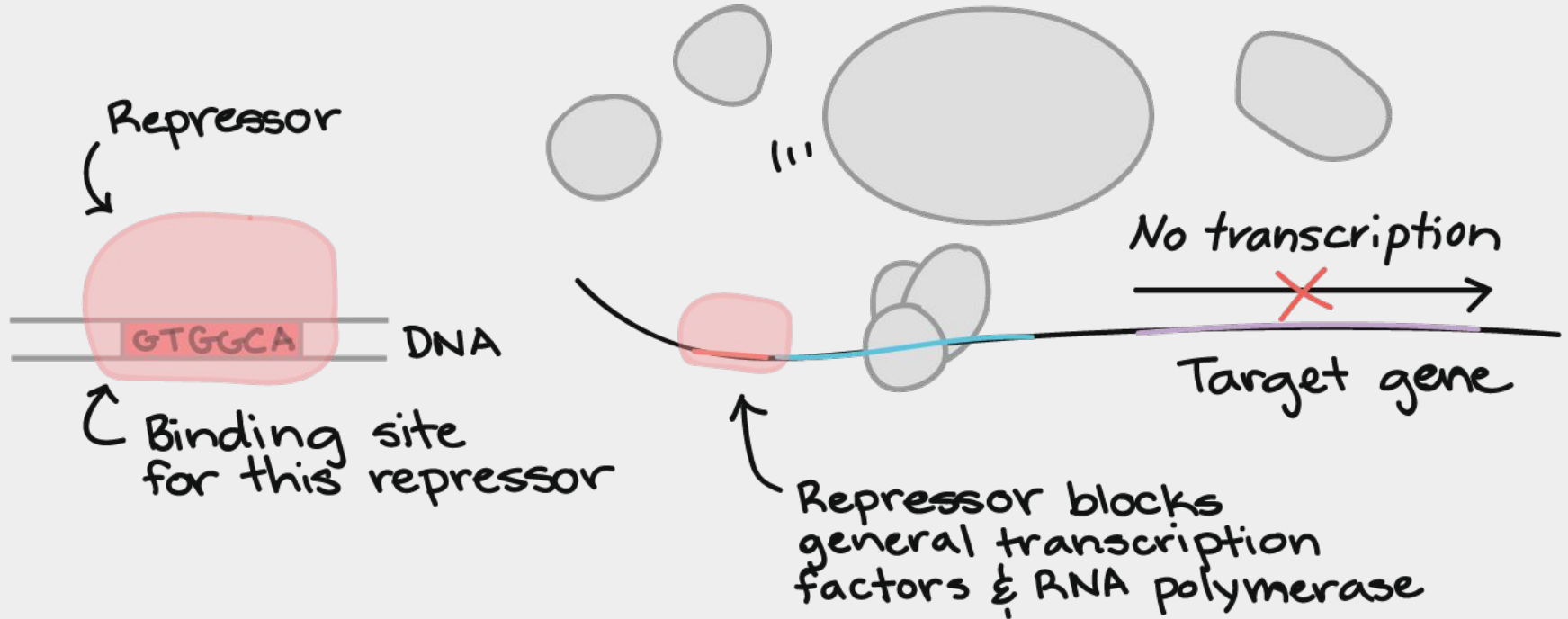
# Promoters



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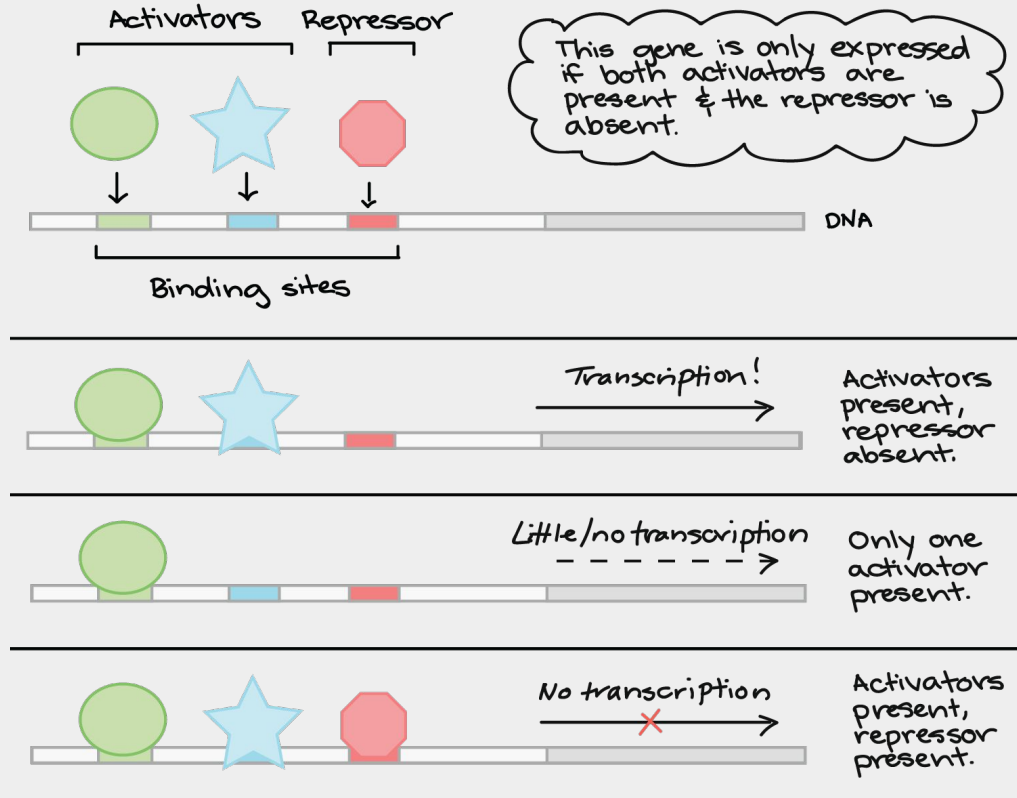


# Promoters





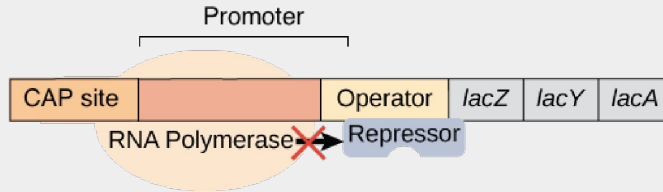
# Promoters



# Lac Operon - Repressor

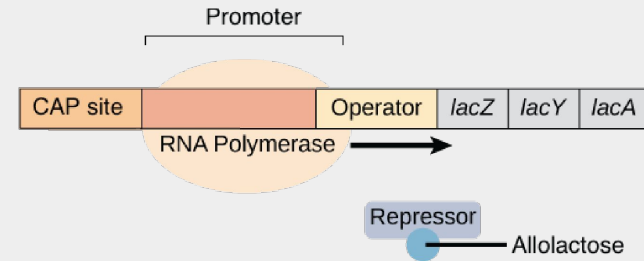
## No lactose:

When lactose is absent, the *lac* repressor binds tightly to the operator. It gets in RNA polymerase's way, preventing transcription.



## With lactose:

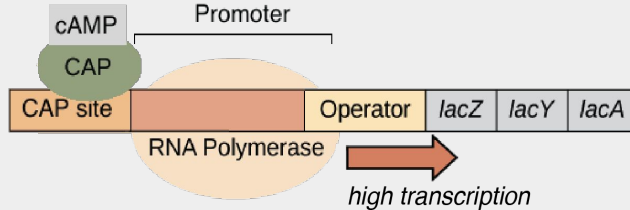
Allolactose (rearranged lactose) binds to the *lac* repressor and makes it let go of the operator. RNA polymerase can now transcribe the operon.



# Lac Operon - Activator

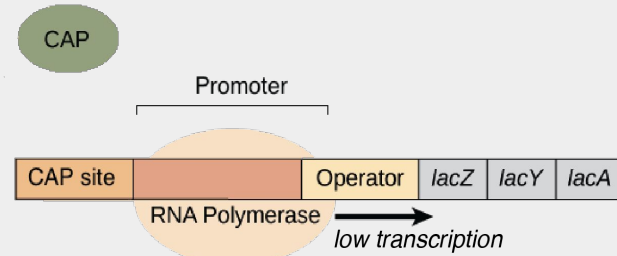
## Low glucose:

When glucose levels are low, cAMP is produced. The cAMP attaches to CAP, allowing it to bind DNA. CAP helps RNA polymerase bind to the promoter, resulting in high levels of transcription.

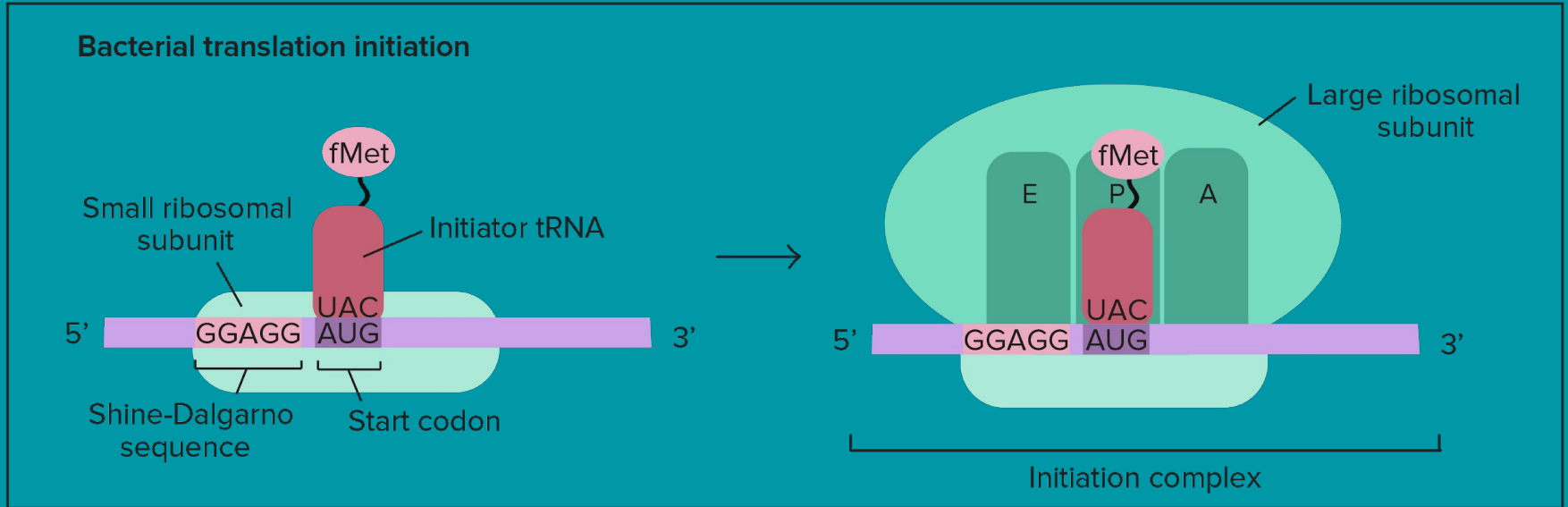


## High glucose:

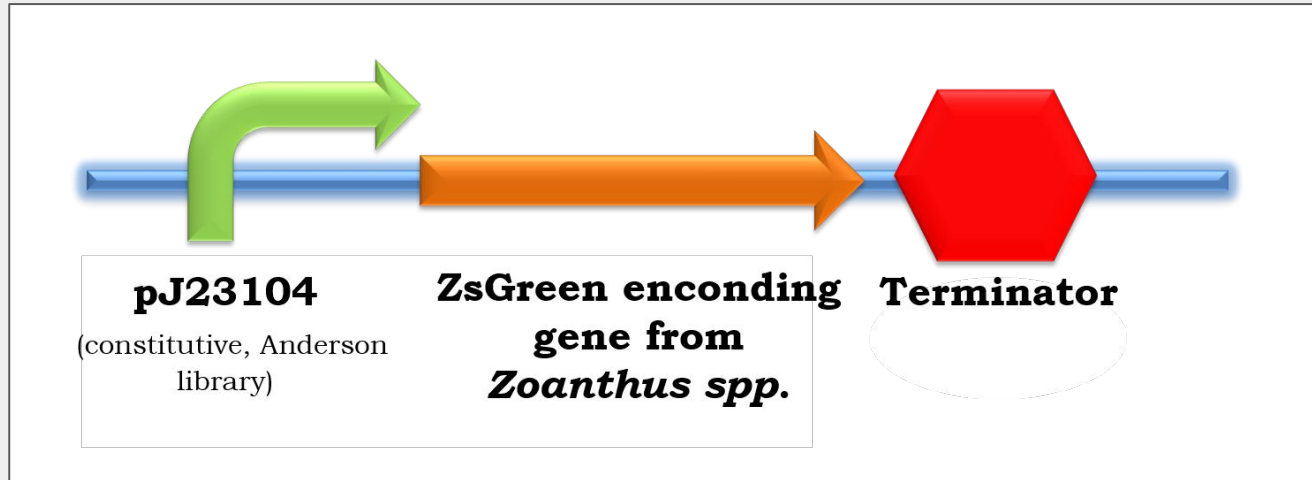
When glucose levels are high, no cAMP is made. CAP cannot bind DNA without cAMP, so transcription occurs only at a low level.



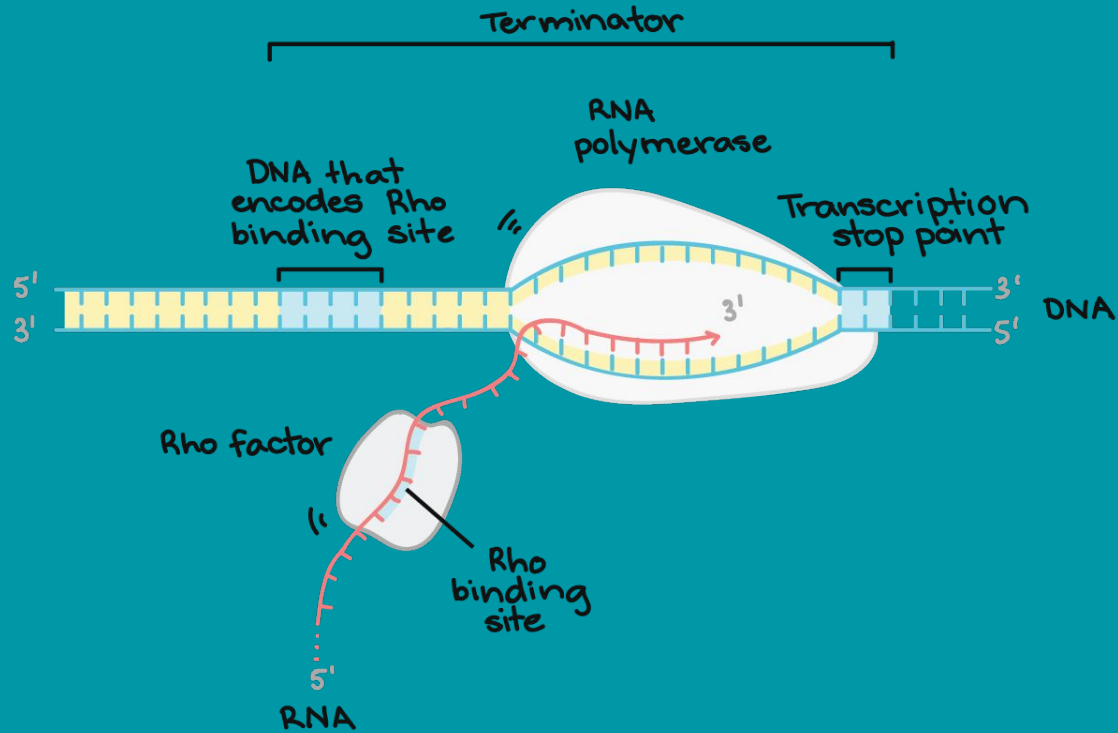
# Ribosome Binding Site (RBS)



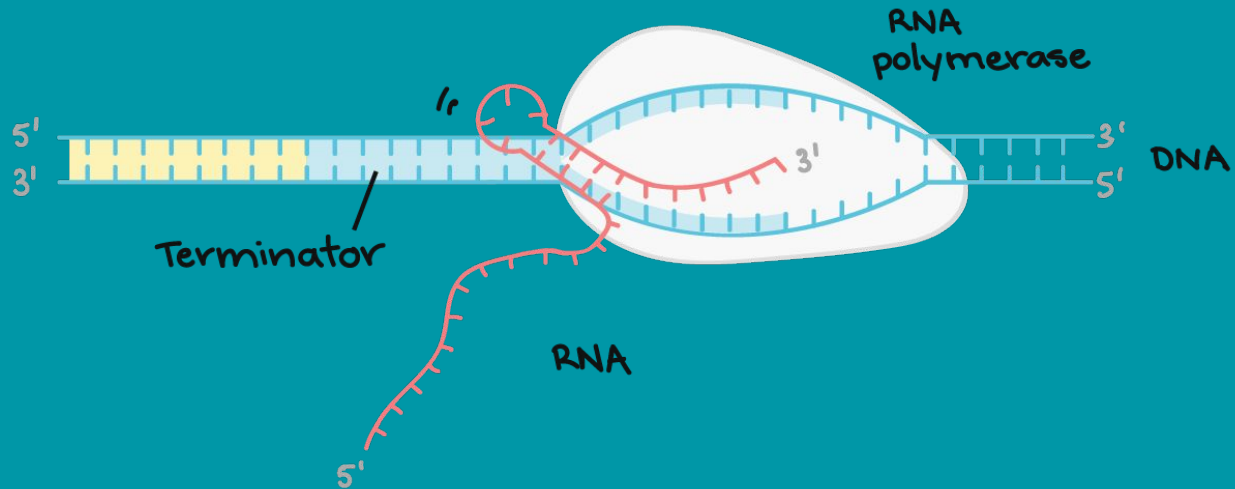
# Coding Sequences (CDS)



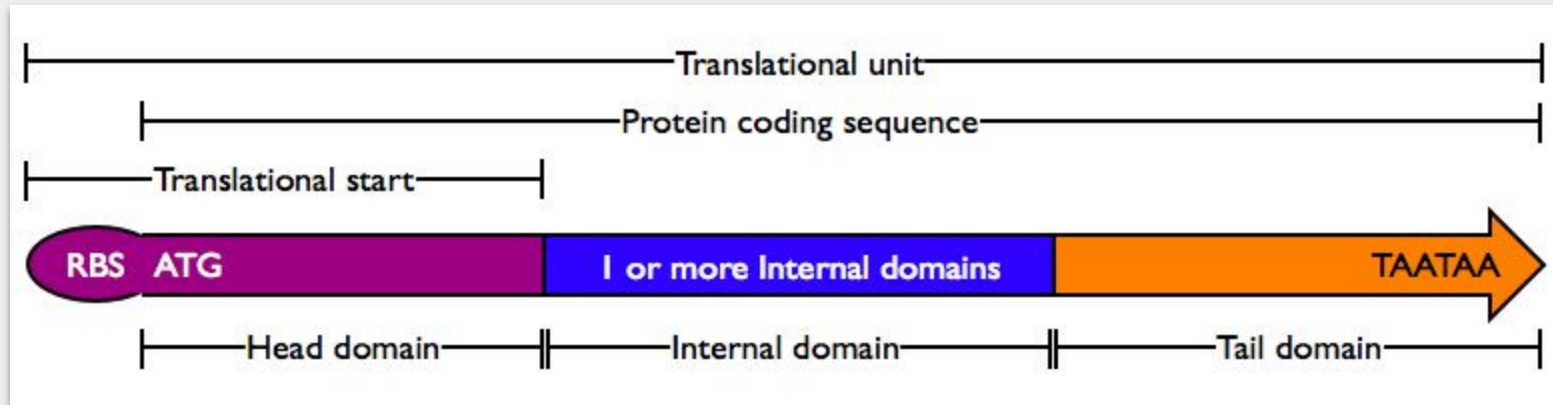
# Terminator



# Terminator

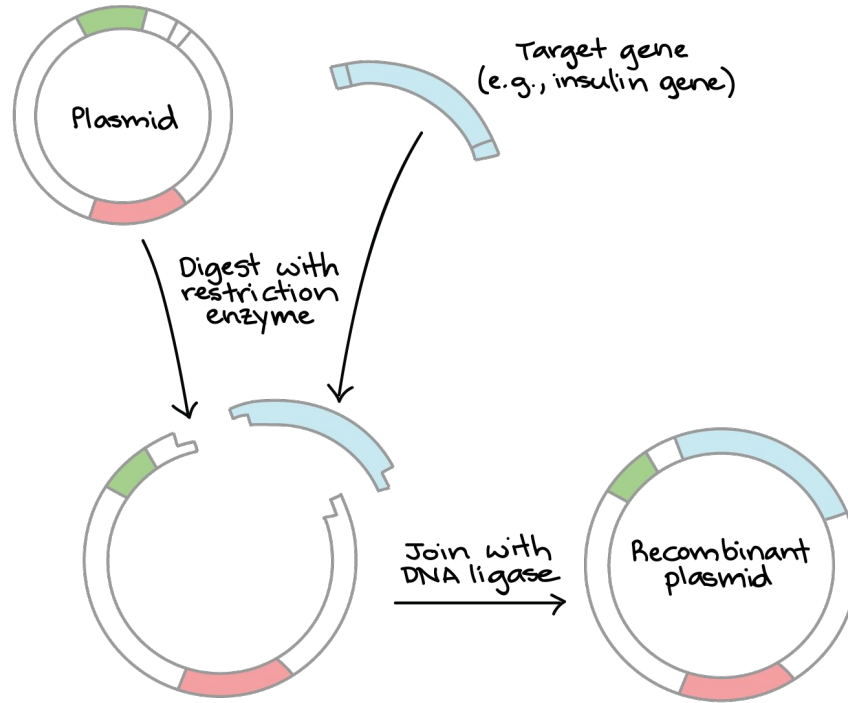


# Translational Units

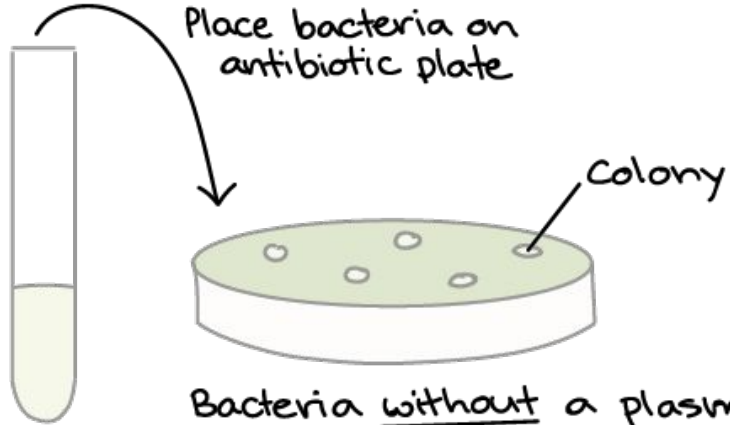
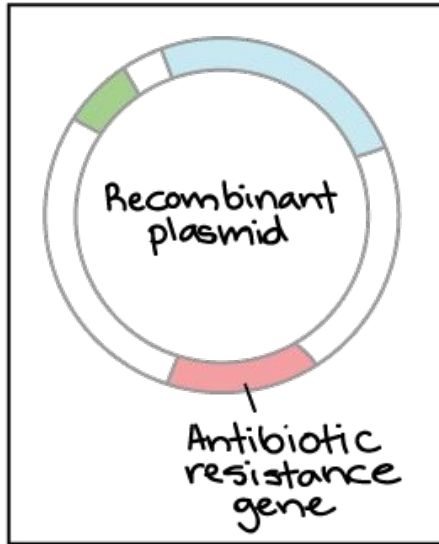




# Plasmid Backbone

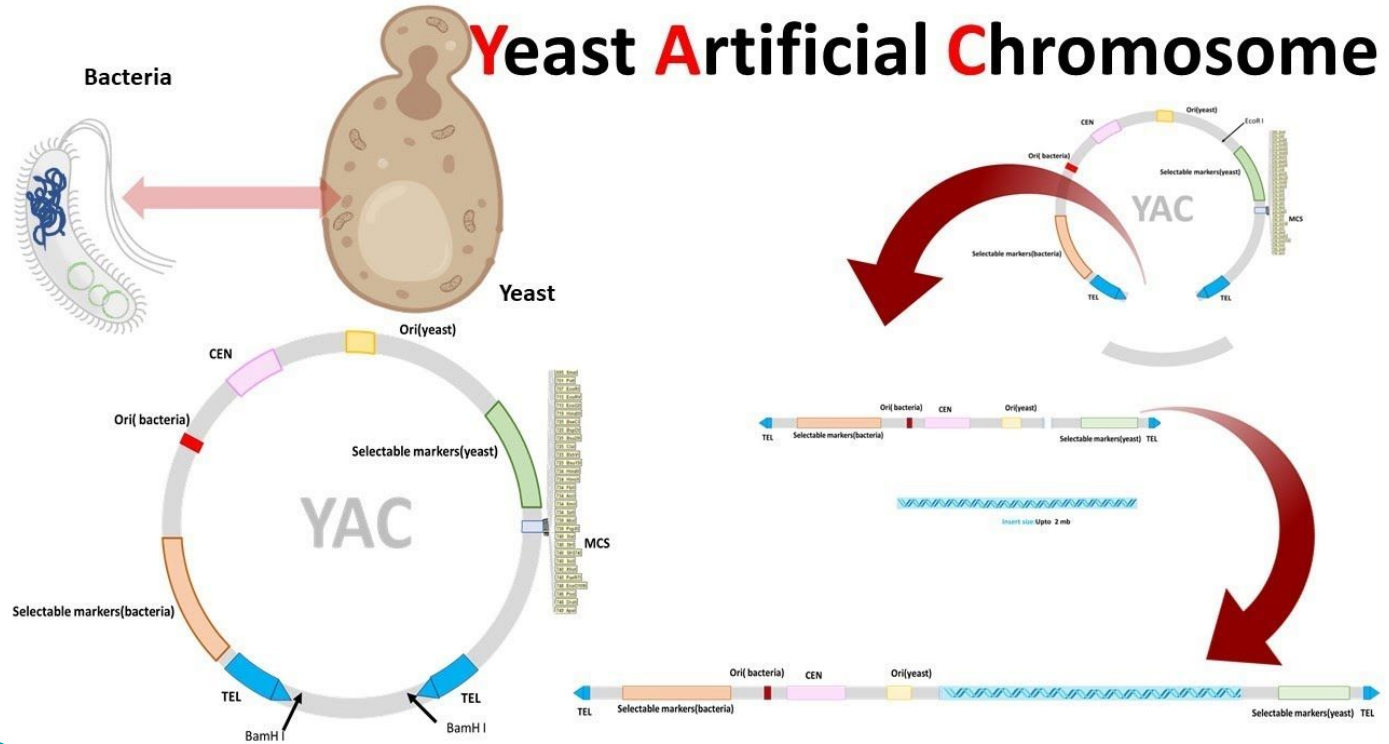


# Plasmid Backbone



Bacteria without a plasmid die.  
Each bacterium with a plasmid makes a colony.

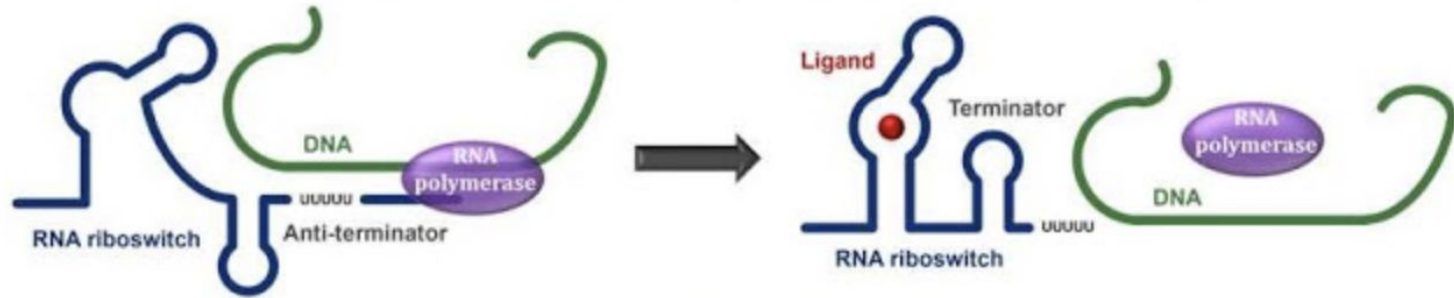
# Plasmid Backbone



# RiboSwitches

1. RNA elements Binding to small metabolite/ligand- bringing conformational changes.
2. Located in the 5' untranslated region.
3. Regulate gene expression
4. Very sensitive and ligand specific.
5. The PreQ1 riboswitch is the smallest known naturally occurring riboswitch with just 34 nucleotides required for substrate binding.

# RIBOSWITCH?

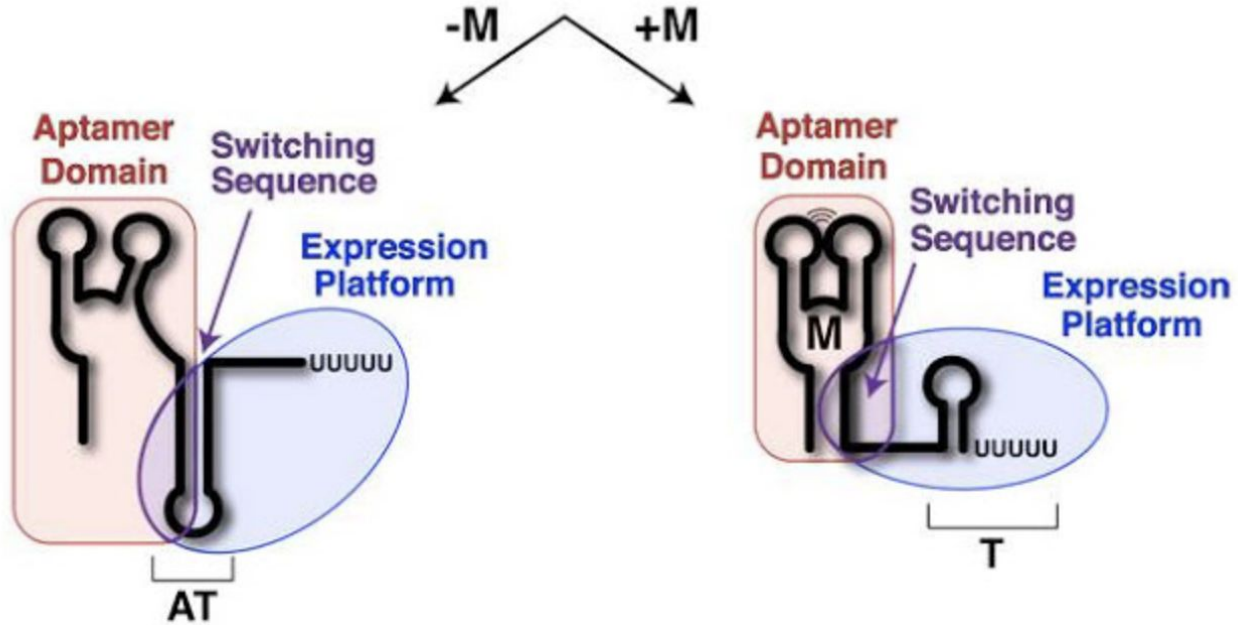


# Examples

1. TPP riboswitch
2. Glycine riboswitch
3. FMN riboswitch
4. Purine riboswitch
5. Cobalamin riboswitch



# Structure

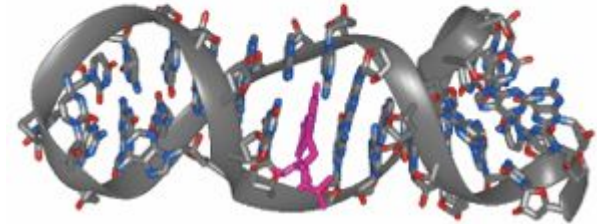


# Aptamers

RNA aptamers are structures that bind specifically to target ligands

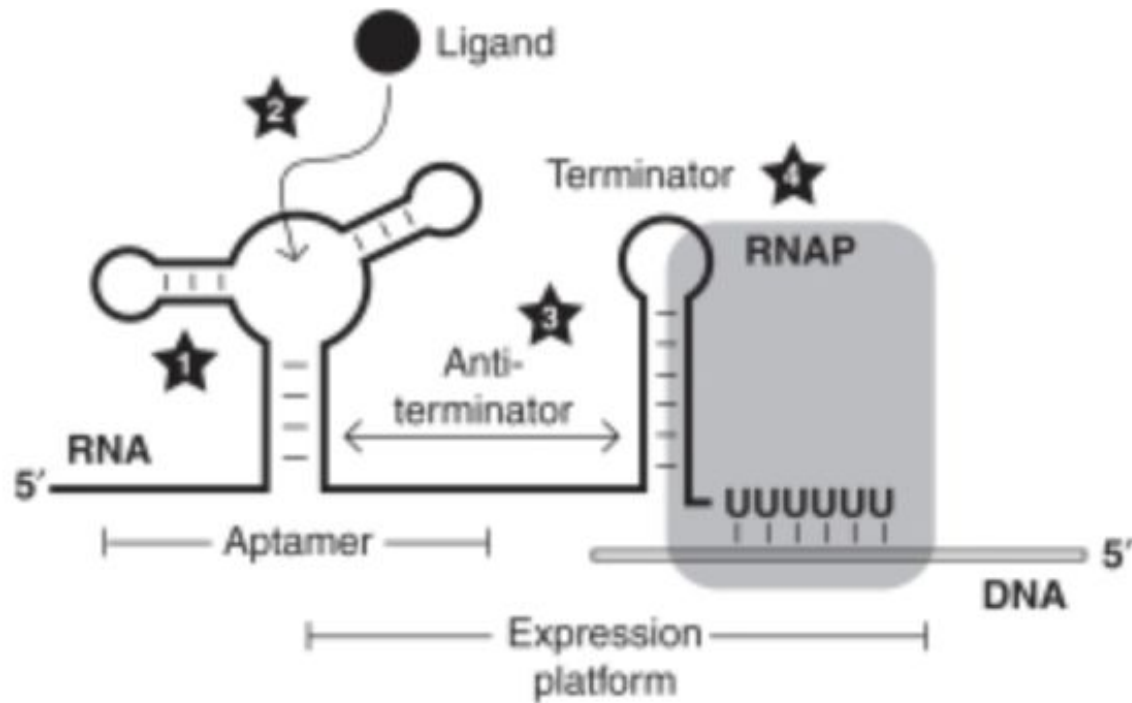
Most aptamers exhibit conformational changes upon binding to ligand (induced fit binding)

Many aptamers have been generated in the laboratory for a wide range of target molecules (e.g. theophylline aptamer)

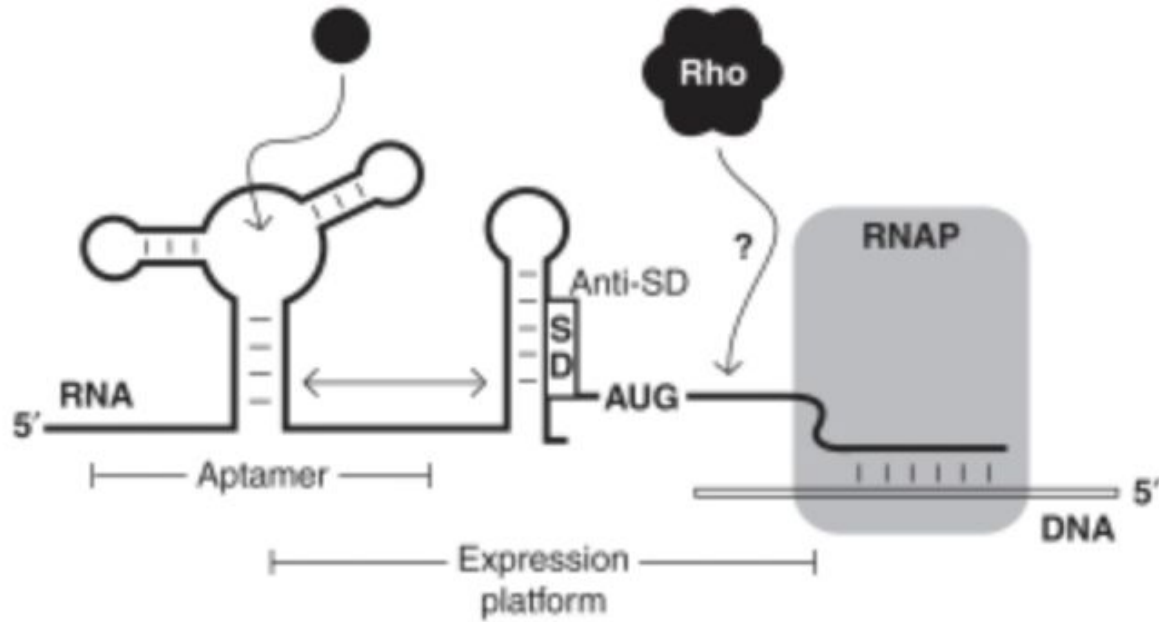




# Mechanism



# Mechanism



# Categories

1. Organised into classes based on type of ligand they bind to and their secondary structure
2. A family of riboswitches typically recognise the same ligand
3. Example SAM riboswitch family



# Applications

