

# iGEM 2006 ETH Half Adder

## **Concepts**

Engineering Point

Biological Point

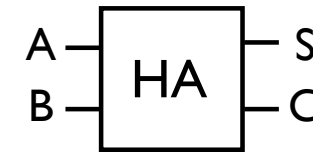
## **Implementation**

Implementation Details

Possible Experiments

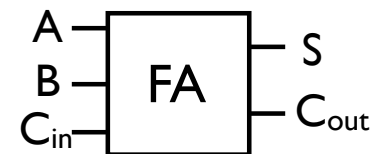
## **Evaluation**

### half adder (HA)



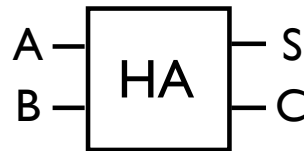
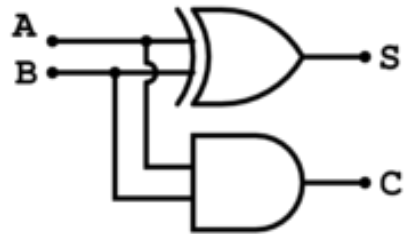
- *input*: 2 one-bit numbers A, B
- *output*: 1 two-bit number, arithmetic sum  $A+B$

### full adder (FA)



- *input*: 3 one-bit numbers A, B,  $C_{in}$
- *output*: 1 two-bit number, arith. sum  $A+B+C_{in}$
- ▶  $n$  FA's can be used to construct an  $n$ -bit adder
- ▶ can be constructed with 2 half adders

## half adder (HA)



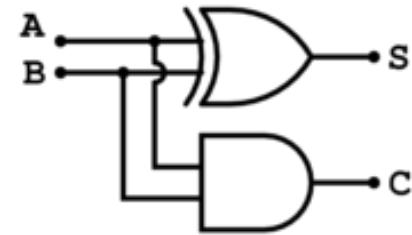
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$$S = A \mathbf{xor} B =$$
$$(A \text{ and not } B) \text{ or } (\text{not } A \text{ and } B) =$$
$$(A \text{ or } B) \text{ and } (\text{not } A \text{ or } \text{not } B)$$

$$C = A \mathbf{and} B$$

# iGEM 2006 ETH – Half Adder **Biological Point**

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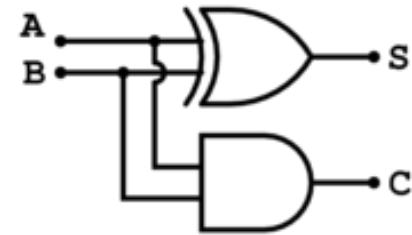
## inputs

- A promoter sensitive to *chemical* (to be defined)
- B *light sensitive* promoter (exists)

## outputs

- S **RFP**
- C **GFP**

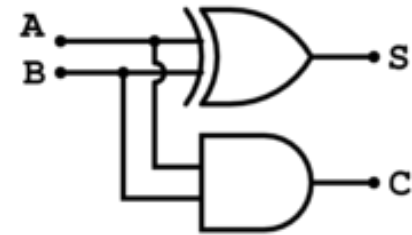
## logic (gates)



### and

- A induces prod. of inducer  $\alpha$
  - B induces production of an inducer  $\beta$
  - $\alpha\beta$  complex as inducer for GFP production
- 
- A induces prod. of inactive protein (GFP)
  - B induces production of an activation protein

## logic (gates)



### **xor**

- 2 simultaneous ways of RFP production
  - A inducer, B repressor
  - B inducer, A repressor

→  $A \text{ xor } B = (A \text{ and not } B) \text{ or } (B \text{ and not } A)$

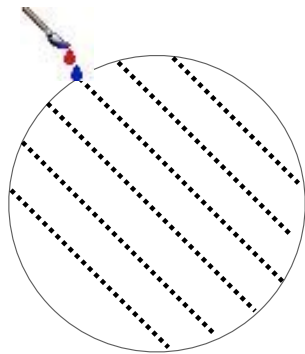
? *alternatives* ?

# iGEM 2006 ETH – Half Adder **Impl. Details**

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...

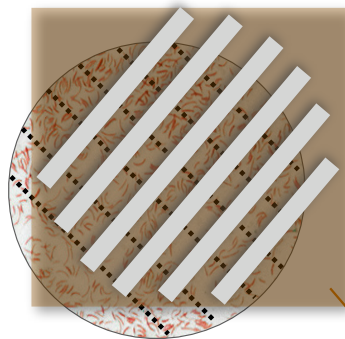
1. put chemical to plate



2. let bacteria grow uniformly

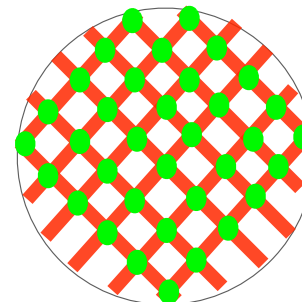


3. expose them to light



**cardboard with slits**

4. expected result





## pattern recognition experiment

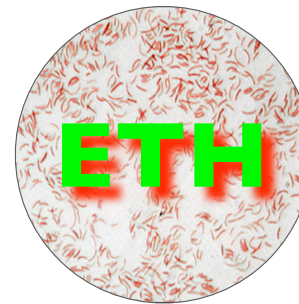
- expose bacteria to same pattern twice
  - once with *chemical*
  - once with *light*
- bacteria recognize whether it has been the same pattern
  - ✓ *no reaction:* ok, 2x no stimulus
  - ✓ *green:* ok, 2x stimulation
  - x *red:* not ok, 1x stimulation, 1x without



perfect match



less congruent



playing field

## challenges

- **xor**, and
- light sensitivity:
  - ➔ work in dark room?
  - ➔ additional signal to activate light sensitivity
  - ➔ sensitive to specific light spectrum

## pro's & con's

- + meaningful from engineering point
- + valuable parts for synthetic biology
- + experiments visually attractive
- + probably simple enough
- cheap copy of “bio-film” project (iGEM 2004)
- sensational experiments, have little in common with HA
- too simple?

**questions?**

**additions?**

**comments?**

**→ Wiki**