# Team sheet

TEAM NAME _____ START TIME _____

## 1 Which organism did you choose?

Write its name and the number on the card.

## 2 What is the anti-stress module called?

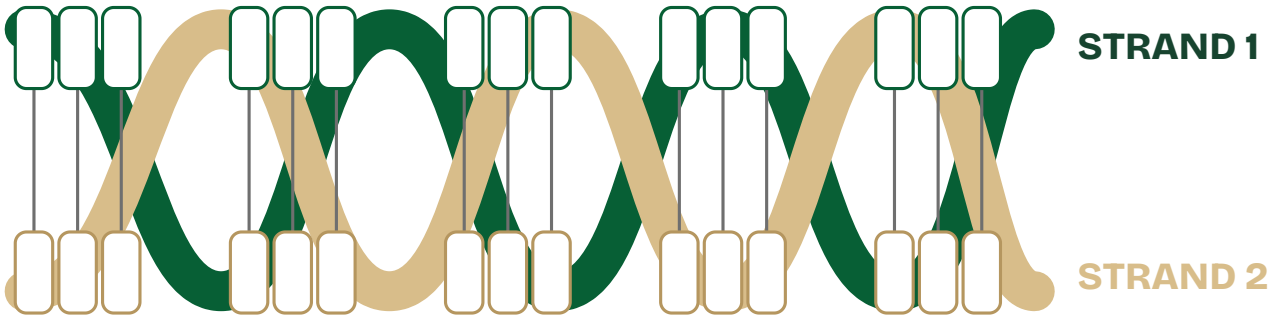
Write it exactly as it appears on the correct card, and its number underneath.

## 3 The molecule that holds water

Copy the five amino acids of the candidate you chose.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | | | | |

STRAND 1 · REPLACE EACH AMINO ACID WITH ITS CODON, IN ORDER, USING YOUR ORGANISM'S CODE




STRAND 2 · THE COMPLEMENTARY ONE. A - U | C - G

How many G's are there in total on both strands? If more than nine, add the digits together.

## The lock

| ACTIVITY 1 | ACTIVITY 2 | ACTIVITY 3 |
|---|---|---|
| | | |

Read this first

## Year 2033

**For nine years it hasn't rained like it used to.**

**In the Priorat, the vines are dying of thirst.**

You are the team of scientists who must design a bacterium that can save them. If you succeed, these vineyards will keep making wine for centuries. If not, this landscape disappears.



How it works

## You have 20 minutes

1. Three piles of cards on the table. One per activity, in order. Each activity gives you a number. The three of them open the lock on the box.
2. Write everything on the team sheet.
3. You win if you open the box.

**Don't open a new pile until you have finished the previous one.**



Activity 1

## Who will do the job

**We need a microorganism that lives in the soil and helps the vine's roots.**

- It must live in the soil, attached to the roots.
- It must survive months of drought without dying.
- It must be safe for the plant and for people.

Take out the four candidate cards. Only one meets all three conditions.



Candidate

## Bacillus subtilis

Lives in the soil and colonises roots.

Forms spores: survives months without water.

Grows very slowly in the lab.

**4**



Candidate

## Escherichia coli

Grows very fast.

Lives in the gut.

Can't survive extreme conditions.

**1**



Candidate

## Saccharomyces

Very resistant and very well studied.

It is a fungus.

Thanks to it, we make wine.

**3**



Candidate

## Pseudomonas

Lives in the soil and colonises well.

Some species make the plant sick.

It is hard to control.

**6**



Activity 1 · close it

## Write it down

**Write the name of the organism you chose and its number on the team sheet.**

**Keep the card.**

**The number is the FIRST digit of the lock.**

Activity 2

## The anti-stress module

**When a plant is stressed, it makes a hormone that stops the root from growing.**

**We want our bacterium to cut this hormone off before it forms. The module exists and has a name, but it is encrypted. Find out what it is called.**



Activity 2 · the message

## Twelve numbers

**This is the module's name, encrypted.**

| | | | | | |
|---|---|---|---|---|---|
| 2 | 3 | 3 | 5 | 6 | 2 |
| 1 | 7 | 8 | 2 | 4 | 6 |

Turn over the next 2 cards



Activity 2 · table A

## Number to symbol

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 |



Activity 2 · table B

## Symbol to letter

| | | | | |
|---|---|---|---|---|
| A | C | D | E | I |
| M | N | O | R | S |



Activity 2 · close it

## Count

The number of **C** letters is the SECOND digit of the lock.



Activity 2 · what you found

## ACC deaminase

**When the vine is thirsty, it builds up ACC. ACC turns into ethylene, the hormone that makes the root stop.**

**ACC deaminase is a bacterial tool that breaks down ACC before it becomes ethylene. The root never gets the order to stop and keeps growing towards the water deeper down.**



Activity 3

## Holding water

**Now the most important part: keeping the water close to the root so it doesn't drain away.**

**We are looking for a molecule the bacterium can make that acts like a sponge around the roots. You have four candidates, each with its own amino acid sequence.**



Candidate

## Keratin

**Makes hair, nails and feathers strong.**

AMINO ACID SEQUENCE

| | | | | |
|---|---|---|---|---|
| Cys | Ser | Leu | Cys | Val |

Candidate

## γ-PGA

A long, sticky chain that traps water and holds it around itself, like a gel.

AMINO ACID SEQUENCE

| | | | | |
|---|---|---|---|---|
| Val | Asp | Ala | Leu | Ser |



Candidate

## Lipase

Breaks fats into small pieces.

AMINO ACID SEQUENCE

| | | | | |
|---|---|---|---|---|
| Ile | Pro | Arg | Ser | Gly |



Candidate

## Luciferin

Makes an organism glow in the dark.

AMINO ACID SEQUENCE

| | | | | |
|---|---|---|---|---|
| Ser | Thr | Pro | Leu | Arg |



Activity 3 · how to do it

## From amino acid to RNA

**Each amino acid is written with three RNA letters. These three letters are a codon.**

Use the genetic code and the features of the organism from activity 1. Write the five codons in a row: this is the first strand. Underneath, write the complementary strand.

**A goes with U, G goes with C.**



Activity 3 · close it

## Count the G's

**Look at both complete strands and count how many G's there are in total.**

If the result has two digits, add them together.

Example: 13 gives 1 + 3 = 4

This number is the THIRD digit of the lock.



Inside the box

## You're not done yet

**You've reached the last level. But the design is incomplete.**

The bacterium can't be switched on all the time: it would use up energy non-stop and die. It has to wait for a signal and switch on only when the vine really needs it.

Which signal should it detect?



Activity 4 · how to play

## Memory

Six cards face down. They make three pairs. Take turns flipping two. If they don't match, turn them back over. Once you have all three pairs, decide which one best describes a vineyard dying of thirst. Open the envelope of that pair's colour.



Ochre envelope

## Congratulations



**High temperature and salinity. Correct.**

When the soil heats up and runs out of water, salts become concentrated. These two signals only happen together during a real drought. The bacterium switches on exactly when needed. Your design is complete: you've beaten the game.

Turquoise envelope

## Try again

### Light and CO2.

These two signals are always there, rain or shine. The bacterium would be on all year round and run out of energy long before the first dry summer. Go back to the box and try another envelope.



Red envelope

## Try again

### Water and infections.

An infection has nothing to do with drought, and if the signal is water, the bacterium would switch on just when the vine no longer needs it. Go back to the box and try another envelope.



Gold envelope · bonus point

## Gold Medal



### The bacterium works. Now you have to make sure it stays where you put it.

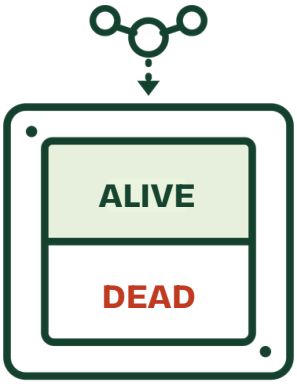
If it escapes the vineyard and colonises a stream or the neighbour's field, no politician will let you take it out of the lab. Choose one of the next three cards and imagine how you would do it. You don't need to know: just imagine.

Explain it to the person running the activity and you get the badge.



Biocontainment

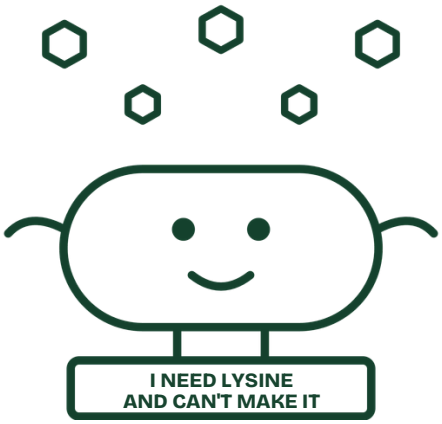
## Kill switch






Biocontainment

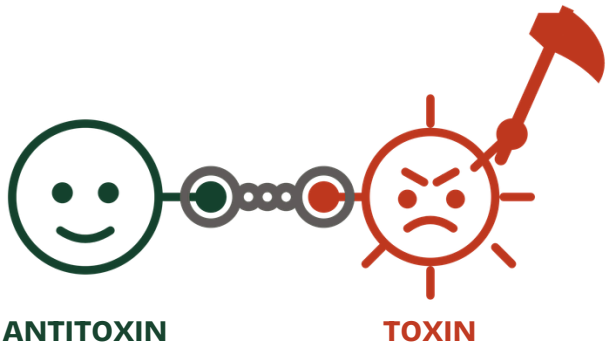
## Auxotrophy






Biocontainment

## Toxin and antitoxin








### High temperature





### Salinity



Light





$CO_2$





Water





Infections

MEMORY
Operation Priorat

MEMORY
Operation Priorat

MEMORY
Operation Priorat

MEMORY
Operation Priorat

MEMORY
Operation Priorat

MEMORY
Operation Priorat

Operation Priorat

ACTIVITY 1

Operation Priorat

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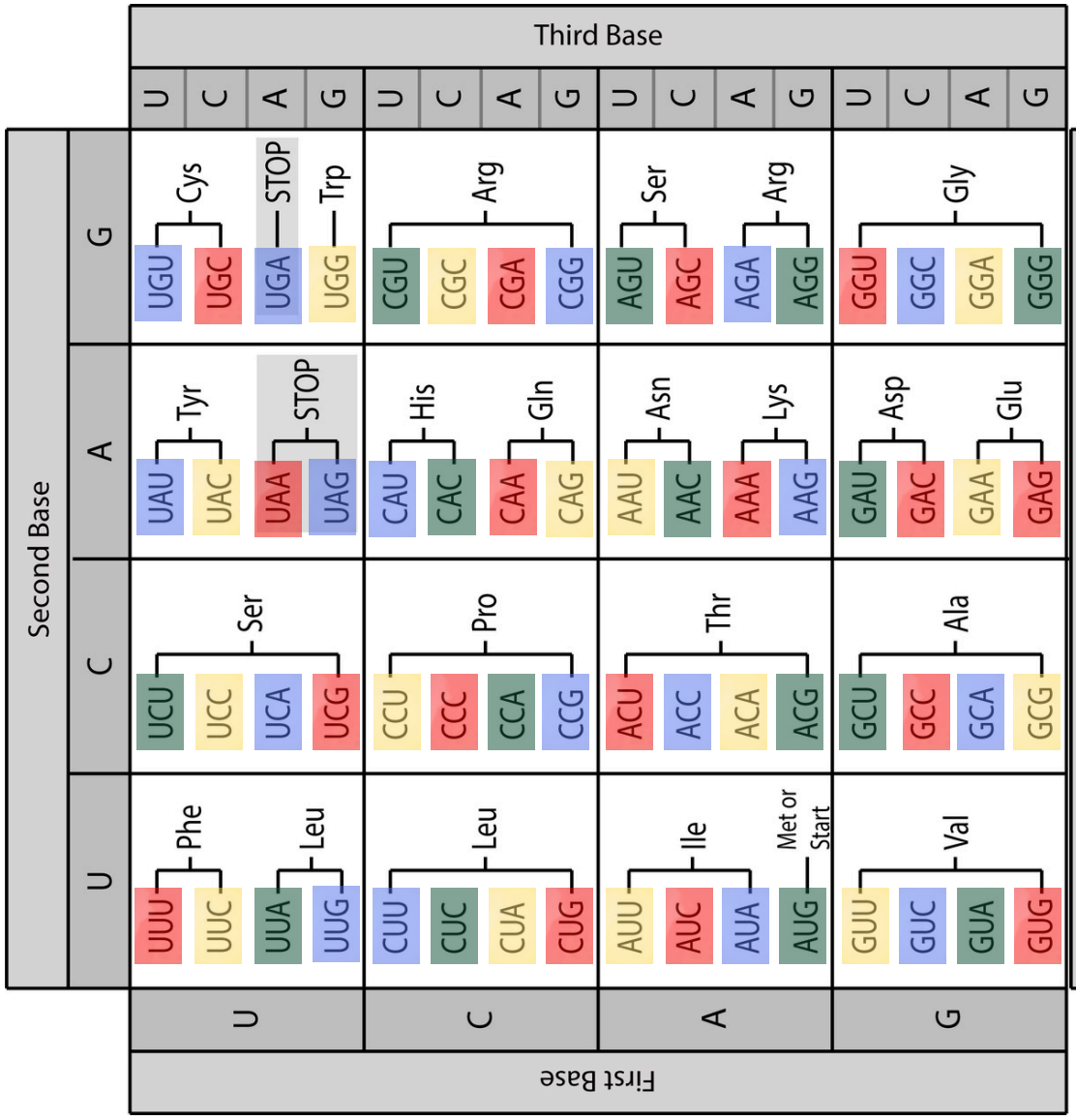
GOLD MEDAL

Operation Priorat

GOLD MEDAL

B. Subtilis | E. Coli | Pseudomonas | Saccharomyces

# Genetic Code




B. Subtilis | E. Coli | Pseudomonas | Saccharomyces

# Genetic Code

