Primary School Activities: Synthetic biology with everyday objects

Introduction

Any iGEM project can be taught to primary school children with a few everyday objects, a question and a measurement they make themselves. This kit shows you how to design that activity for your own project, without a lab and without living organisms. This is thought for iGEM teams running activities with children aged 6-10 and it is based on our session with a 5th-grade class at Col·legi Badalonès (10 June 2026), described as a worked example at the end. Here, you will find:

1. Design principles
2. Designing your activity in steps
3. Object analogy library
4. Session template
5. Adapting by age
6. Materials, safety and consent
7. Measuring what children took away
8. Worked example: Vinesys
9. Printable templates

Design principles

These principles come from our session and from inquiry-based learning. You should check your plan against each one before finishing the design of your activity.

1. **Open with a question.** One driving question frames the whole session and gets answered at the end by the children. To ensure both feedback from the beginning and the end of the session, ask the same question twice and see how much it changes because of your activity.
2. **Start from something they already know.** A recent school trip, a topic from class or a local problem gives children a way in before any new vocabulary appears. It also helps you adapt all the concepts you want to explain to what they already know so following becomes easier for them.
3. **Predict and then measure.** Children commit to a prediction, then measure something (volume, colour, time). This way the result is theirs and they are more eager to find it.
4. **Say where the analogy breaks.** Once they have the idea, tell them what the object doesn't do that the real biology does. This helps avoiding misconceptions of concepts because of the analogies you use to explain yourself in that audience.
5. **Close the loop.** End by returning to their first prediction, so they can see what changed in their own thinking.

Designing your activity in steps

1. **Write your project in one sentence a 10-year-old would understand.** No complicated words, just simple ideas, like: *"a bacterium that helps soil hold water so vineyards survive drought."*
2. **Pick one mechanism children can see.** A key thing when working with kids is making sure they understand and see a visible or measurable effect, there's no need for them to understand the whole project with all details. Focus on things like holding water, changing colour, glowing, breaking something down…
3. **Find the object.** Look for a cheap, safe object that does the same thing as in a way children can handle. The analogy library below has starting points you could consider.
4. **Turn it into a prediction and a measurement.** Set up two or three conditions (with and without your bacterium or whatever you are talking about in your activity), decide what children measure and how and write the question they predict on the beginning of the activity.
5. **Build the session around the experiment.** Use a five-phase template:
    a. Anchor with the knowledge kids already have.
    b. Explore the basic content related to your project and the activity with the kids, always asking questions and making sure they give you initial feedback.
    c. Do the experiment.
    d. Connect your project completely with everything done previously during the session.
    e. Close with an easy summary kids can remember.
6. **Test it with a teacher.** Send the full plan to the class teacher before the session because they know the group's level, what they've covered and how long they can focus, so you can adapt your activity depending on their feedback.

Object analogy library

Find the row closest to your project and adapt it. Every analogy is only partly true, so the last column is what you tell children once they have the idea.

If your project involves…	Object activity	What it shows	Where it breaks down
Biofilms, water retention, soil health	Pieces of kitchen sponge mixed into soil: pour the same amount of water on each cup and measure what drains the most depending	A material made by bacteria can hold water around roots.	Real EPS is a thin film made by living cells, not chunks of sponge.

If your project involves…	Object activity	What it shows	Where it breaks down
	on the added components.		
Biosensors with a colour output	Red cabbage juice in cups: add vinegar, baking soda dissolved in water, or plain water, and compare colours.	A detector can report what it senses by changing colour.	Cabbage juice is a chemical indicator, while a biosensor is a living cell that switches a gene on.
Genetic logic gates	A box with two locks that opens only when both keys are used (AND) or one lock with two keys that both fit (OR).	A circuit gives an output only for the right combination of signals.	In cells, inputs are molecules, outputs are proteins and switches are rarely fully on or off (there's a gradient).
DNA as instructions and gene editing	LEGO models built from a deck of instruction cards could represent DNA, while a change in one card would be gene editing and would cause rebuild of the model.	A sequence of instructions determines the product and one change alters the result.	DNA is read through RNA into proteins and edits are chemical changes.
Plasmids and genetic parts	Bead bracelets on a closed string, one bead colour per part (promoter, RBS, gene, terminator).	Bacteria carry circular DNA built from interchangeable parts.	Real plasmids are thousands of letters long and copy themselves inside the cell.
Enzymes and protein production	Jelly made with fresh pineapple next to jelly made with canned pineapple, prepared the day before.	Fresh pineapple contains an enzyme that breaks down gelatine, so that jelly stays liquid, while canning heats the enzyme and stops it	It shows one natural enzyme at work, but not a cell programmed to make one

If your project involves…	Object activity	What it shows	Where it breaks down
Microbes that make products	Baker's yeast, sugar and warm water in a bottle with a balloon over the top.	Living microbes turn food into something new. Here, that thing is a gas that inflates the balloon.	Yeast is a natural, food-safe fungus, not an engineered bacterium.

Session template

This is the 90-minute structure we used with 10-year-olds, but this should be shortened for younger groups (see the next section), or if you feel the experiment is too dense for the kids to be involved in the same activity for too much time.

Phase	Time	What goes in it
1. Introduction: anchoring	15 min	Introduce yourselves, recall what the class already knows about the topic, write the driving question on the board and make children record a first prediction.
2. Exploration	20 min	Explain the minimum biology they need, such as what bacteria are, how small they are and the one mechanism your object stands for.
3. Experiment	25 min	Set-up, predict, measure, then each group shares its result and the class draws the conclusion.
4. Connection	20 min	Explain you do this for real, with a formal team and project. Add a peer-teaching activity such as character cards, so children can understand better the bases of your project. Also, keep in mind having additional time

Phase	Time	What goes in it
		in this part for their questions.
5. Closing	10 min	Kids revisit their first prediction: "Now I think… because…" and the class answers again the driving question.

Adapting by age

We tested the template with 10-year-olds, but for younger groups there should be more considerations in terms of the time spent doing the activity and other adaptations. We always encourage you confirm all the details with the teacher with enough time in case you need to change anything.

	Ages 6-8	Ages 9-12
Total length	45-60 min.	Up to 90 min, in phases of 15-25 min, like the one proposed in this kit.
Predictions	Thumbs up or down or a sticker on the board.	A post-it with a short sentence.
Measuring	Compare by eye: more, less, the same.	Measure in ml or seconds and subtract or add.
Recording	Drawing.	A results table explained previously and with help while doing it.
New words	One key word repeated often.	Three to five terms, each with an image.
Group size	3-4, with an adult per group.	5-9

Materials, safety and consent

Check every item before the session. Remember you are working with vulnerable people and should always be conscious of what you are doing and how so no one is put in danger.

- No engineered organisms leave the lab. If you use anything alive, keep it to food-safe microbes such as baker's yeast.
- Materials come from a supermarket or the school: no lab reagents and no glassware.
- Ask the school about food allergies before using food (pineapple, gelatine, sugar).
- Sharp or hot preparation (cutting sponges, piercing cups) is done by an adult beforehand, not in front of the children.
- Children wash their hands after handling soil or food.
- Add photos to your wiki only with the school's permission and avoid showing faces unless the school has consent from families.
- Same amount of material in every condition, so the comparison is fair.
- A try run of the experiment by the team, timed, before the day, so you are aware of the difficult parts and can help children.

Measuring what children took away

The before-and-after predictions are your simplest evidence, so keeping them and counting how many changed is a way of taking feedback home. However, here we leave a list of three more ways to collect evidence without turning the session into a test:

- **Results on the board.** Photograph each group's measurements and if most groups got the expected result, then the experiment worked as designed.
- **One recall question.** At the end, ask a question from the phase of exploration ("What does our bacterium do?") and note how many hands go up and what they say.
- **Teacher feedback.** Ask the teacher two questions afterwards: what worked and what they would change for this group. You could also consider asking the teacher to check how many children actually remember concepts of your activity some days after doing it.

Worked example: Vinesys

Here is how the different steps played out for our project, an engineered *Bacillus subtilis* that helps grapevines resist drought. The full session is in our specific kit for this activity (check the Education page to find the other pdf).

Step	Our answer
1. One sentence	A bacterium that helps soil hold water, so vineyards survive drought.
2. Visible mechanism	*B. subtilis* builds gamma-PGA, that holds water, around roots.
3. Object	Pieces of kitchen sponge mixed into soil.

Step	Our answer
4. Prediction and measurement	Three cups (dry soil, normal soil, soil + sponge), putting 50 ml of water in each one. Children predict which keeps the most, then measure what drains.
5. Anchor	The class's recent visit to the Besòs river.
6. Teacher review	We sent the full plan to the teachers before the session.

The class stayed engaged for the full 90 minutes and groups worked out for themselves that the soil with sponge kept the most water.

Printable templates

Fill in the blanks for your project, then print.

Template 1 · Predictions (one per child, but this also can be done as post-its)

Before: I think _____ because _____

After: Now I think _____ because _____

Template 2 · Results sheet (one per group)

Group name: _____

Our prediction: _____

Condition	What we did	What we measured (unit: ____)	What we saw
Without your bacterium/product			
With your bacterium/product			

Condition	What we did	What we measured (unit: ____)	What we saw
Extra condition (optional)			

1. Which condition gave the biggest effect? _____
2. Was our prediction right? _____
3. What does the object stand for in real life? _____

Template 3 · Structure character card

Species name · "Nickname"
Role ? What you product does.
Superpower ? The mechanism your project uses, explained with an everyday comparison.
Did you know? ? One surprising, verified fact.
Mission ? How it helps people or the planet in your project.

Make two different cards, so children can explain theirs to a classmate holding the other.