Extract, Test, Refine

Designing DNA-extraction methods for different cells

GEN.1A.5 "Enrichment: Use an engineering design process to refine the methodology to optimize the DNA-extraction process for various cell types.*"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each step the teams change, circle what they keep the same, and number the ways they check the results. Use your marks to trace how they decide whether a change improves the method.

One Method Does Not Fit Every Cell

1. Two teams receive equal masses of spinach leaves and equal numbers of collected cheek cells. Both want DNA that can be tested later, not just a dramatic white clump. Detergent disrupts cell membranes, while salt and cold alcohol help DNA separate from other cell materials and come out of solution. Leaf cells also have rigid walls, so crushing the leaves before adding detergent can release more cell contents. Cheek cells have no cell wall, but rough mixing can break long DNA strands. Each team starts with the same basic steps: disrupt cells, filter debris, and add alcohol to the filtered liquid.

2. The first leaf trial uses thirty seconds of grinding; its partner uses ninety seconds, with the same leaf mass, detergent volume, salt amount, and alcohol temperature. The longer-ground sample gives more DNA in a DNA-specific fluorescence test. A separate cheek-cell trial compares gentle inversion with hard shaking. With equal numbers of cells and the same solution, gentle inversion produces longer DNA strands when the samples are run through a gel. These trials each change one step at a time. They do not prove that unlimited grinding or mixing will help, since excess force can damage DNA or add debris.

3. To refine the method, teams repeat each trial three times and compare DNA recovered per starting sample. They also check whether leftover protein contaminates the DNA, since the largest yield may not be the cleanest. Their goal is enough clean, intact DNA for a later test, using only classroom-safe materials and the available class period. If extra grinding raises yield but adds too much contamination, a team could test a shorter grind or improve filtration while keeping other steps fixed. The team records the change, measures the new result, and decides whether to keep or revise its procedure.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why is grinding time a useful step to test with leaf cells? Name two factors the teams keep the same to make the comparison fair.

2. If a later test needs long DNA strands, which mixing method should the cheek-cell team choose? What result supports your choice?

3. Extra grinding increases leaf DNA yield but also increases protein contamination. What two changes could the team test next, and how should it test them fairly?

4. Why should the teams repeat trials and compare DNA recovered per starting sample before choosing a method?

3 YOUR TURN

Your own words

Baker's yeast has tough cell walls. Design a fair, classroom-safe test of one change that might improve its DNA extraction. State your prediction, what you will keep the same, how you will check DNA yield and quality, and a result that would make you revise your method.

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PART 1 · READ AND MARK

Underline each step the teams change, circle what they keep the same, and number the ways they check the results. Use your marks to trace how they decide whether a change improves the method. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why is grinding time a useful step to test with leaf cells? Name two factors the teams keep the same to make the comparison fair.	**Grinding can break rigid leaf cell walls and release cell contents. Accept any two: leaf mass, detergent volume, salt amount, or alcohol temperature.**
2	If a later test needs long DNA strands, which mixing method should the cheek-cell team choose? What result supports your choice?	**Choose gentle inversion. The gel showed longer DNA strands after gentle inversion than after hard shaking.**
3	Extra grinding increases leaf DNA yield but also increases protein contamination. What two changes could the team test next, and how should it test them fairly?	**Test a shorter grind and improved filtration in separate trials, changing only one step in each trial while keeping the other steps fixed.**
4	Why should the teams repeat trials and compare DNA recovered per starting sample before choosing a method?	**Repeats help show whether a result is consistent. Comparing yield per starting sample accounts for differences in the amount of material used.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would mash equal masses of baker's yeast for 30 or 90 seconds before adding detergent. I predict the longer mash will break more cell walls and increase DNA yield. I would keep the detergent, salt, alcohol temperature, and filtration method the same and repeat each condition three times. I would compare DNA recovered per gram using a DNA-specific fluorescence test and check strand length with a gel. If longer mashing raises yield but leaves shorter strands, I would test a time between 30 and 90 seconds.

Accept other classroom-safe changes if the student compares two conditions fairly and checks both yield and quality. A revision should respond to a stated result, not simply repeat the original test.