

Mapping the Failure, Which Step Breaks for a Cleft Lip Versus a Cleft Palate

If you are handed a specific cleft, can you read it backward to the one developmental step that failed?

CARRY FORWARD

IRF6-dependent periderm acts as a temporary non-stick surface that prevents the wrong oral tissues from adhering.

10-YEAR TAKEAWAY

A cleft pattern narrows the failed developmental checkpoint, but it rarely identifies one unique cause.

Cells differentiate	Development sculpts	Cells move	Development can go wrong
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1. Observe the analogy before naming the biology

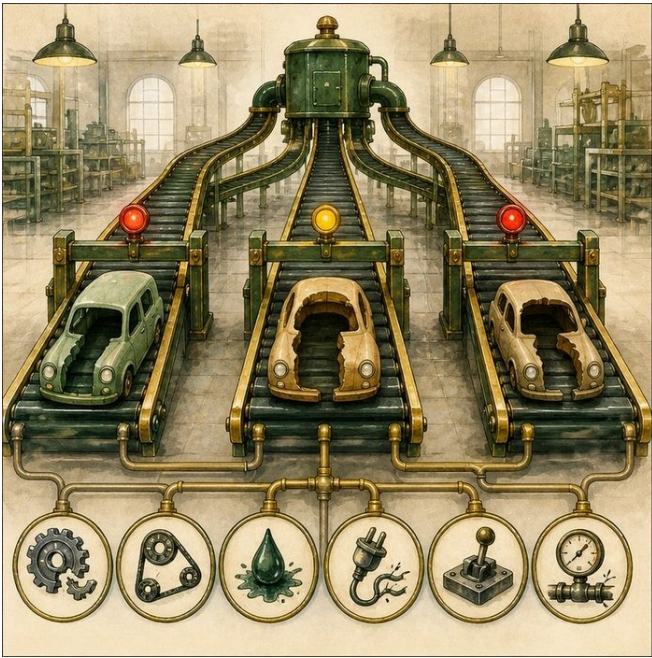


Illustration: A stopped assembly line reveals a checkpoint, not the culprit

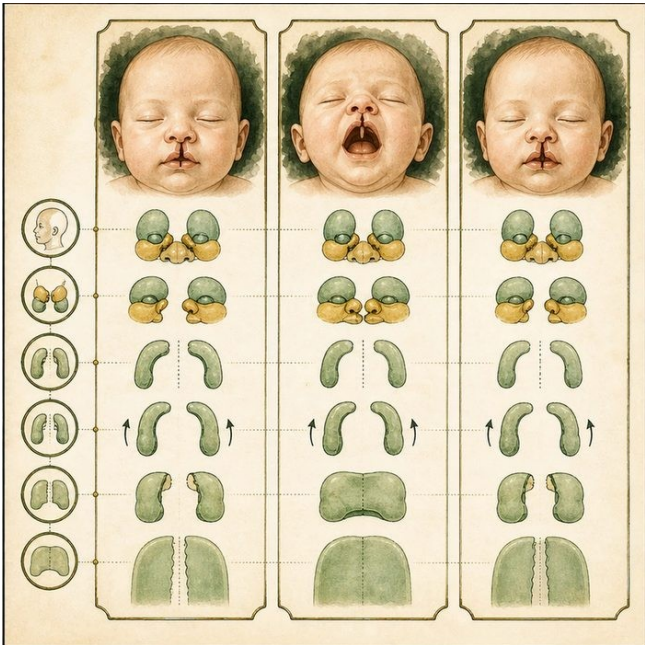
1. Which station is the first place unfinished work appears?
2. Can several failures stop the line at the same station?
3. What extra evidence is needed to identify the cause?

2. Turn observations into rules

- 1. Rule 1: Work backward to the earliest failed checkpoint. Explain it in your own words.
- 2. Rule 2: Different causes can create a similar endpoint. Explain it in your own words.
- 3. Rule 3: Phenotype localizes a process better than a molecule. Explain it in your own words.

Where the analogy stops: Development is a branching network, not a single conveyor belt.

3. Map the rules onto the biomedical example



Biomedical teaching illustration: Read three cleft patterns backward

Analogy step	Biology step	How the relationship stays the same
Station before the stop	Last developmental step completed	
Stopped station	Failed growth, movement, adhesion, or fusion checkpoint	
Fault investigation	Genetic, environmental, and model evidence	

DEVELOPMENTAL LESSON 14 | CASE FILE AND DECISION

4. Use the case evidence

ID	Finding supplied in the case	Why it matters
DEV14-E1	Cleft lip points to an early upper-lip growth and fusion boundary.	The phenotype localizes an early facial checkpoint.
DEV14-E2	Cleft palate can result from failed shelf growth, elevation, adhesion, or seam removal.	Several mechanisms share the palate endpoint.
DEV14-E3	Mateo has both cleft lip and palate.	His pattern spans connected but distinguishable developmental events.

5. Make the clinical decision

You are triaging three cases for a developmental review board. Case A has cleft lip only. Case B has cleft palate only. Mateo has both.

- A. Assign each pattern to the narrowest supported checkpoint list.
- B. Assign one gene to each pattern from anatomy alone.
- C. Treat all three patterns as the same developmental event.

Decision. Choose the triage method and explain why the palate list remains broader.

Claim ceiling: You may narrow checkpoints from anatomy. You may not assign one unique molecular cause from phenotype alone.

Claim. State the choice you can defend.

Evidence. Use these labeled IDs: DEV14-E1 + DEV14-E2.

Reasoning. Explain why the evidence supports the claim and stays inside the claim ceiling.

6. Reduce the lesson to one lasting idea

Take-home. A cleft pattern narrows the failed developmental checkpoint, but it rarely identifies one unique cause.

- 1. Why does cleft palate have several possible checkpoints?
- 2. What can phenotype support more strongly than it supports a specific gene?

Glossary

Term	Plain-English definition
phenotype	The observable traits of an organism, such as appearance or function, that result from its genotype combined with environmental influences.
fusion failure	When tissue layers that should join during development do not merge, leaving a gap such as a cleft lip or palate.
patterning defect	A mistake in the body plan set early in development, where signals place or shape parts wrongly so a structure forms in the wrong arrangement.
isolated defect	A birth difference that occurs on its own, without other linked malformations or a broader syndrome accompanying it.

Next lesson unlock

We can now map which step failed and see that Mateo's looks like an isolated fusion failure. But mapping a failure is not fixing it. Each step happens in a narrow calendar window. Is there a moment after which the step can no longer be repaired, so the cleft becomes locked in?

The journal links on the lesson page are optional. Everything required for this guided-notes set is already supplied here and in the case file.