Teacher Guide (Page 1-3) & Rubric (Page 4-5) for HOA Module 4 Lesson C - HOA C1
Metabolic Simulation IPM Sprint (Game-Based Activity)
Grouping: Small groups (3–4 students)
Time Required: 35-40 minutes (one class period)

Teacher Guide

A. Activity Overview & Intent

Purpose:
This HOA utilizes the Digital Cell Puzzles app to extend Module 4, Lesson C, content on **plant growth, defense, and integrated pest management (IPM)** into a **game-based modeling exercise**.

Students work in teams to:

- Explore either:
  - **Prevent a Disease – Save our citrus trees!** (plant defense & pathogen disruption) or
  - **Cell Factory – Turn microbes into microscopic factories** (microbial production of useful compounds).
- Conduct **2–3 simulation "runs"** with different strategies.
- Interpret game outputs and connect them to:
  - **Growth–defense trade-offs**
  - **Biocontrol / IPM tools**
  - **IPM pyramid** and **action thresholds** for real citrus systems.

This HOA is optional but **strongly supports** Lesson C's goals around system thinking, modeling, and translating cell-level mechanisms into field-scale decisions.

B. Alignment to Module 4 & Standards

- **Module 4 Lesson C Focus:**
  - Balancing **plant growth** and **defense**.
  - Using **IPM** to reduce chemical inputs and support long-term sustainability.
  - Understanding how **cellular processes** and **microbial tools** can be engineered to prevent disease.
- **What this HOA adds:**
  - Concrete practice with **digital models** of plant and microbial systems.
  - A playful context where students can **test hypotheses** and see immediate feedback.
  - A bridge between **cell biology**, **bioengineering**, and **field IPM decisions**.
- **NGSS / CTE connections (examples):**
  - MS/HS-LS1-1, LS1-2: Structure and function in cells.

- LS2-3: Cycles of matter and energy in ecosystems.
- ETS1: Engineering design.
- CTE: Agriculture & Natural Resources; Biotechnology; Environmental Resources.

C. Facilitation Notes

1. Framing the Activity

- Remind students of the **Lesson C narrative**:
  - Plants constantly allocate resources between **growth** and **defense**.
  - IPM aims to keep pests/diseases below damaging levels, rather than at zero, by employing a combination of tools.

- Introduce **Digital Cell Puzzles** as:
  - "A way to think like a **bioengineer + plant pathologist** on fast-forward."
  - A safe space to **try strategies, fail quickly, and improve**.

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2. Choosing Pipelines & Games

- Encourage **choice with intention**:
  - If you want them to stay closest to citrus and plant disease, steer more groups to **Prevent a Disease – Save our citrus trees!**
  - If you want a stronger connection to the circular economy / bio-based inputs, steer more groups toward **Cell Factory** (biofuel, shark-friendly vaccine, biodegradable plastic).
- Each team should **stick to one pipeline** for the whole HOA to allow deeper exploration.

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3. Supporting Student Thinking

- Emphasize **evidence-based reasoning**:
  - "What did the run outputs show?" vs. "What do you *feel* is better?"
- As they record runs, circulate, and ask:
  - "What changed between Run 1 and Run 2?"
  - "Did you reduce disease risk or increase product yield? What did you lose?"
  - "Where would this strategy sit on the IPM pyramid?"
- Connect back to **real citrus systems**:
  - Many biocontrols or plant defense inducers start as **ideas at the cell level**.

D. Differentiation & Extensions

- **For support/scaffolding**
  - Provide **sentence starters** on the Data Worksheet (e.g., "We changed ___ pathway, which caused…").
  - Pre-select one pipeline (e.g., *Prevent a Disease*) for classes that are less comfortable with open choice.

- **For extension/enrichment**
    - Have students compare **two pipelines** (Prevent a Disease vs. Cell Factory) in a short written reflection.
    - Ask advanced students to sketch how a **bioengineered microbial product** could become a new **IPM tool** (steps from lab → field trial → grower adoption).

E. Teacher Reflection

After the activity, you might jot quick notes:

- Did the **Digital Cell Puzzles** app help students see cell-level processes in a new way?
- Were students able to **link the game to real-world citrus IPM decisions**?
- What would you change next time (timing, grouping, number of runs, etc.)?

Assessment & Rubric (Teacher-Facing)

You can score this HOA formatively (using a checklist) or summatively (on a 3-point scale). Below is a **single-point style** rubric with descriptors you can adapt.

Suggested Criteria (3 = Exceeds, 2 = Meets, 1 = Developing)

1. **Simulation Use & Data Quality**
2. **Interpretation of Trade-Offs (Growth–Defense / Yield–Sustainability)**
3. **IPM Strategy & Pyramid Placement**
4. **Threshold & Monitoring Plan**
5. **Communication & Collaboration**

Criterion	3 – Exceeds	2 – Meets	1 – Developing
1. Simulation Use & Data Quality	Team runs **≥2 well-documented simulations** with clearly described settings. Data Collection Worksheet includes **specific features from the app** (e.g., named pathways, defense molecules, product yields). Comparisons between runs are **precise and clearly justified** with numbers or visual outputs.	Team runs at least **2 simulations** and records main changes and outcomes.Data is generally clear, though some details are **approximate or qualitative**. Shows **basic understanding** of how their changes affected the outcome.	Only **1 run** recorded, or records are very vague (e.g., “we changed stuff”). Limited or **no mention** of specific game outputs.
2. Interpretation of Trade-Offs	Clearly identifies **trade-offs** (e.g., more defense vs. slower growth; high product yield vs. more waste/energy use). Connects trade-offs to **real-world constraints** (grower budgets, yield stability, pesticide reduction).	Notes at least **one trade-off** between protection/product and some “cost”.Provides a **reasonable explanation**, even if not fully detailed.	Treats the “best” run as simply **“highest defense” or “highest product”** with no discussion of costs or side effects.

3. IPM Strategy & Pyramid Placement	Proposes a **clear, realistic strategy** (e.g., boosting a specific defense pathway or using a microbial product as a biocontrol). Correctly places it within the **IPM pyramid** and justifies the choice using both game data and real-world reasoning.	Identifies a **reasonable strategy** and places it on the IPM pyramid. Justification **references outcomes** from the game, though may be brief.	Strategy is **unclear**, purely hypothetical, or misaligned with IPM categories.Minimal or **no explanation**.
4. Threshold & Monitoring Plan	Writes a **specific threshold rule** (e.g., "If >10% of leaves show early symptoms for 2 weeks, then…").Suggests a **feasible monitoring method** (scouting pattern, sampling plan, or use of decision support tools).	States a **threshold in general terms** (e.g., "If a lot of trees are sick…").At least **mentions monitoring** in some form.	**No threshold** proposed, or threshold is unrelated to disease/pest risk.No **monitoring plan**.
5. Communication & Collaboration	Team share-out is **clear, concise**, and uses correct vocabulary (cell factory, defense pathway, pathogen, IPM, threshold). **All team members** contribute in some way.	Team explains their strategy and results **understandably**. Participation by **more than one** member.	Explanation is **very brief or off-topic**; mainly one student speaks; others are **disengaged**.