Invention Activities

Using Invention to Change How Students Tackle Problems.

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Today…

- Provide some background information about invention activities.
- Allow you to try an invention activity or two.
- Give you an opportunity to design an activity or two.

What is an Invention Activity?

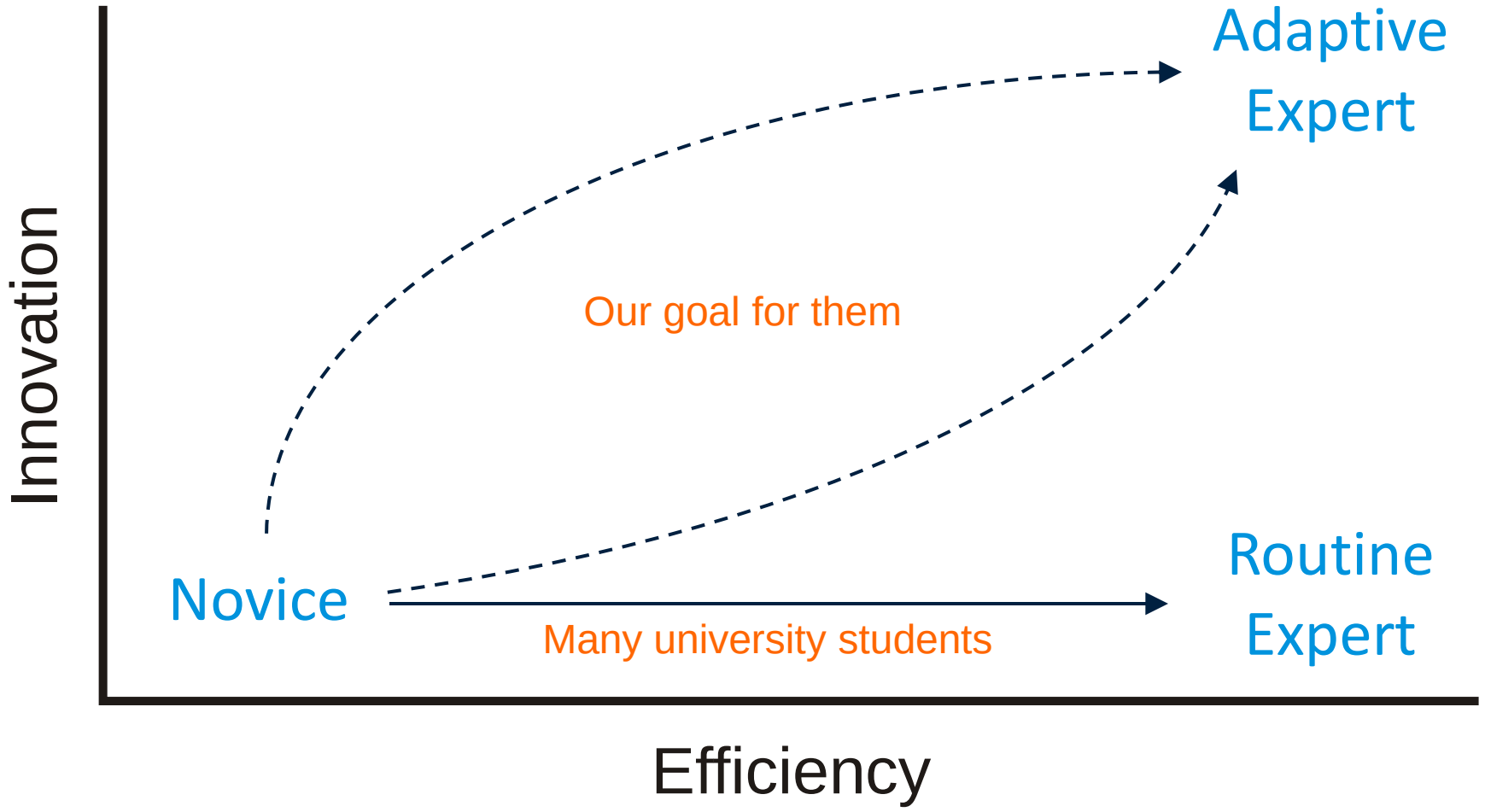
- Invention activities, based on the work of Daniel Schwartz (Stanford), are activities designed to encourage students to think about deep-structure elements of problems, rather than surface details.
- The ultimate goal is to promote ***transfer*** and ***innovation***…but what do we mean by these terms?

Transfer and Innovation

- ***Transfer***
  - Applying previous learning to a new situation.
- ***Innovation***
  - Generating new behaviours and ideas.

- ***Innovation*** vs. ***efficiency***
  - Different types of learning/thinking.

Innovation vs. Efficiency



Adapted from Dan Schwartz's presentation at UBC, April 2008

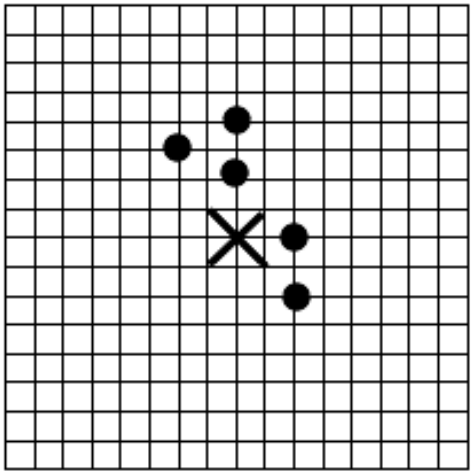
Inventions, Innovation, and Transfer

- Our current goal for invention activities in first year biology is to change the way students think.
- Students should be able to:
  - Transfer concepts.
  - Explore beyond "only one right answer" thinking.

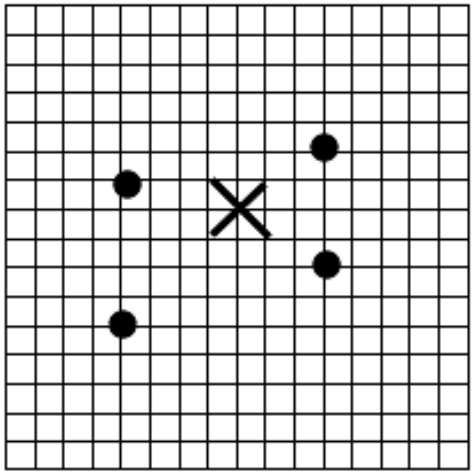
Inventions: Basic Characteristics

- Invention activities:
  - Present novel problems before instruction.
  - Require solutions based on previous knowledge and experience.
  - Do not appear related to the course.
- Exploring the basic principles of cell function.

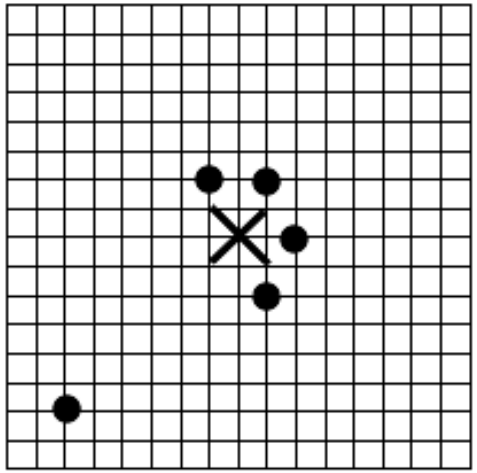
Examples (Schwartz)



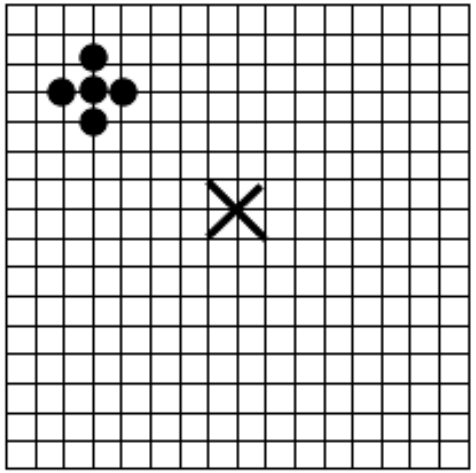
Ronco Pitching Machine



Big Bruiser Pitchomatic

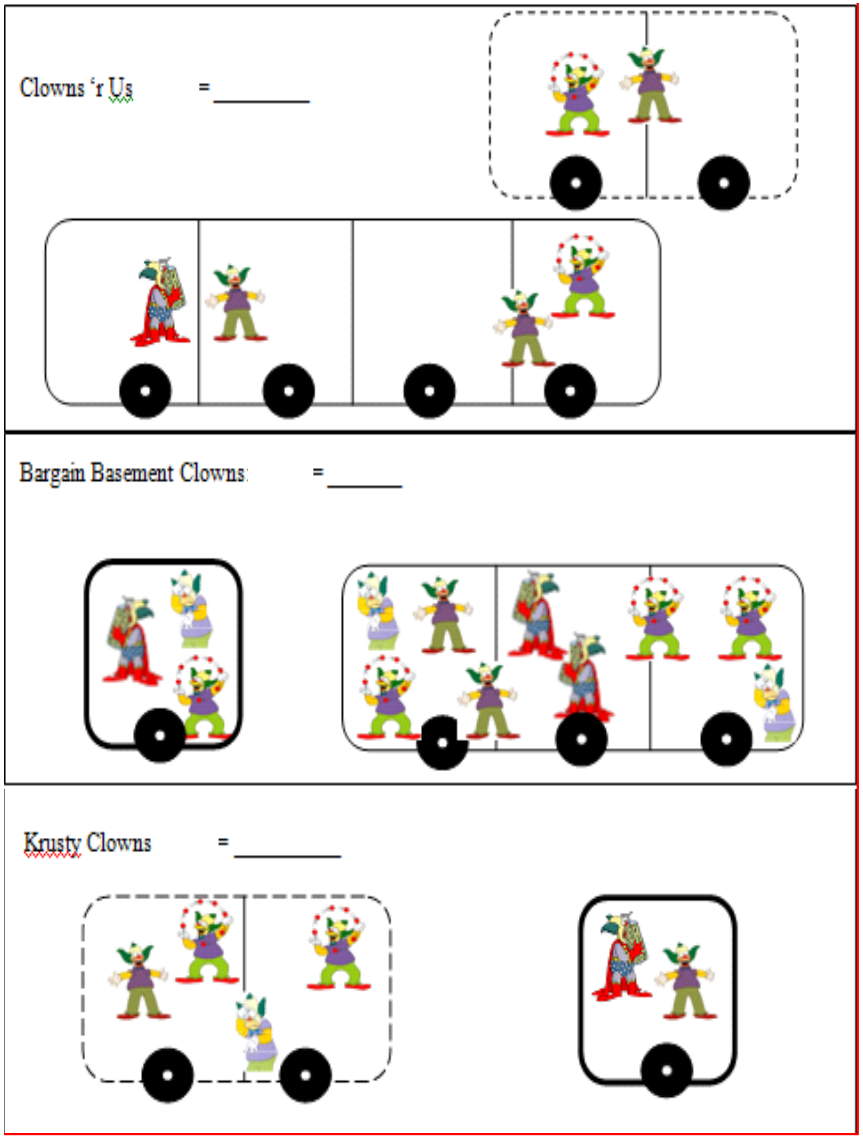


Fireball Pitchers



Smyth's Finest

Examples (Schwartz)

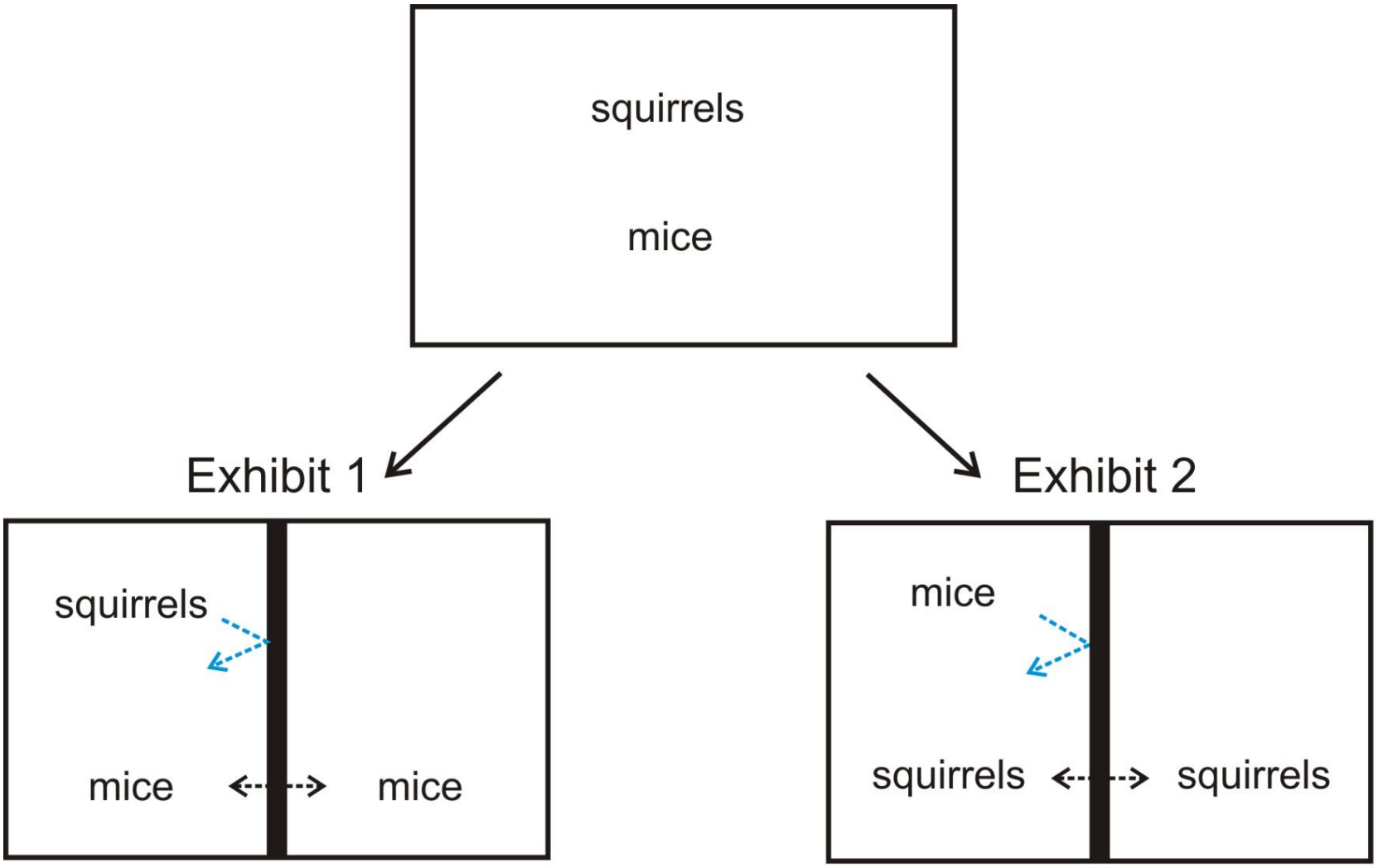


Try One!

- In groups of 4-6, work on the invention activity in front of you (10-15 minutes).
- Draw out your ideas on the large paper, and be ready to present a summary of your inventions.

Squirrel
25 cm long, 8 cm wide
400 g

Mouse
7 cm long, 2 cm wide
20 g



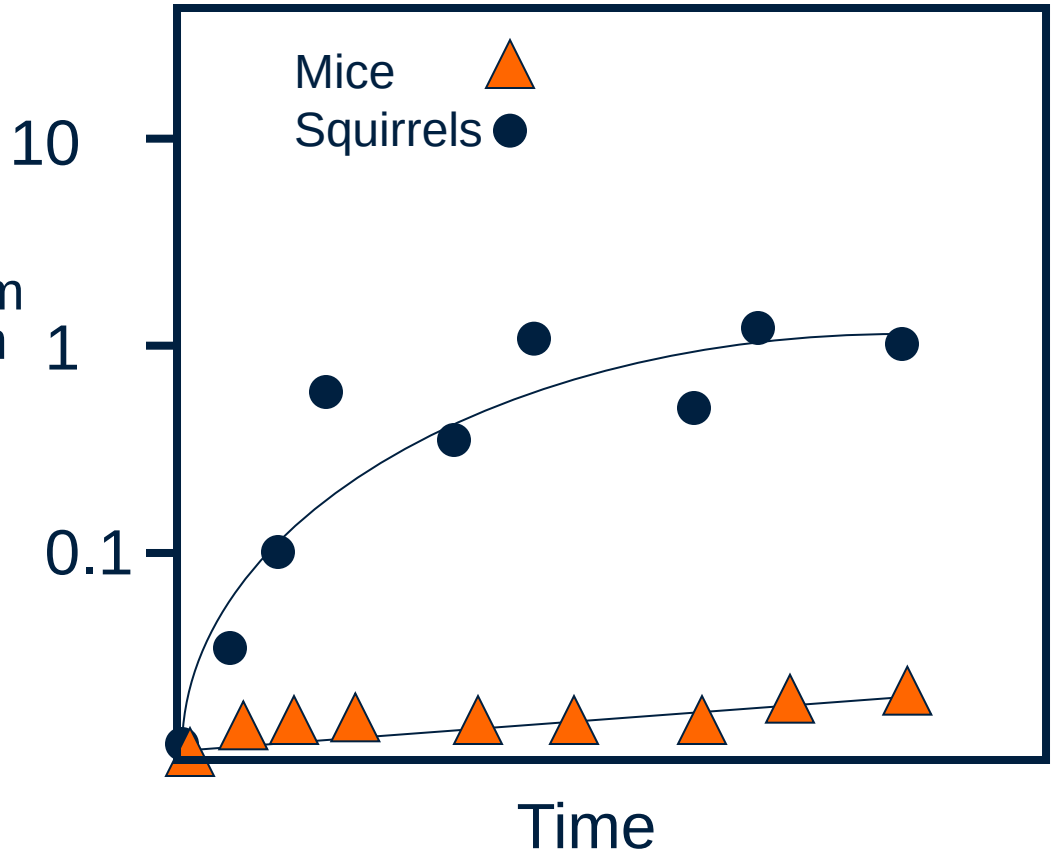
Squirrels must remain in left room. Mice must be able to pass from room to room so that they are more or less evenly distributed.

Mice must remain in left room. Squirrels must be able to pass from room to room so that they are more or less evenly distributed.

Imagine a rat gets into the exhibits, and it has the same body size and weight as the squirrels. Based on your inventions for Exhibits 1 and 2, could the rat cross through the wall in either case? Why or why not? Write a short explanation.

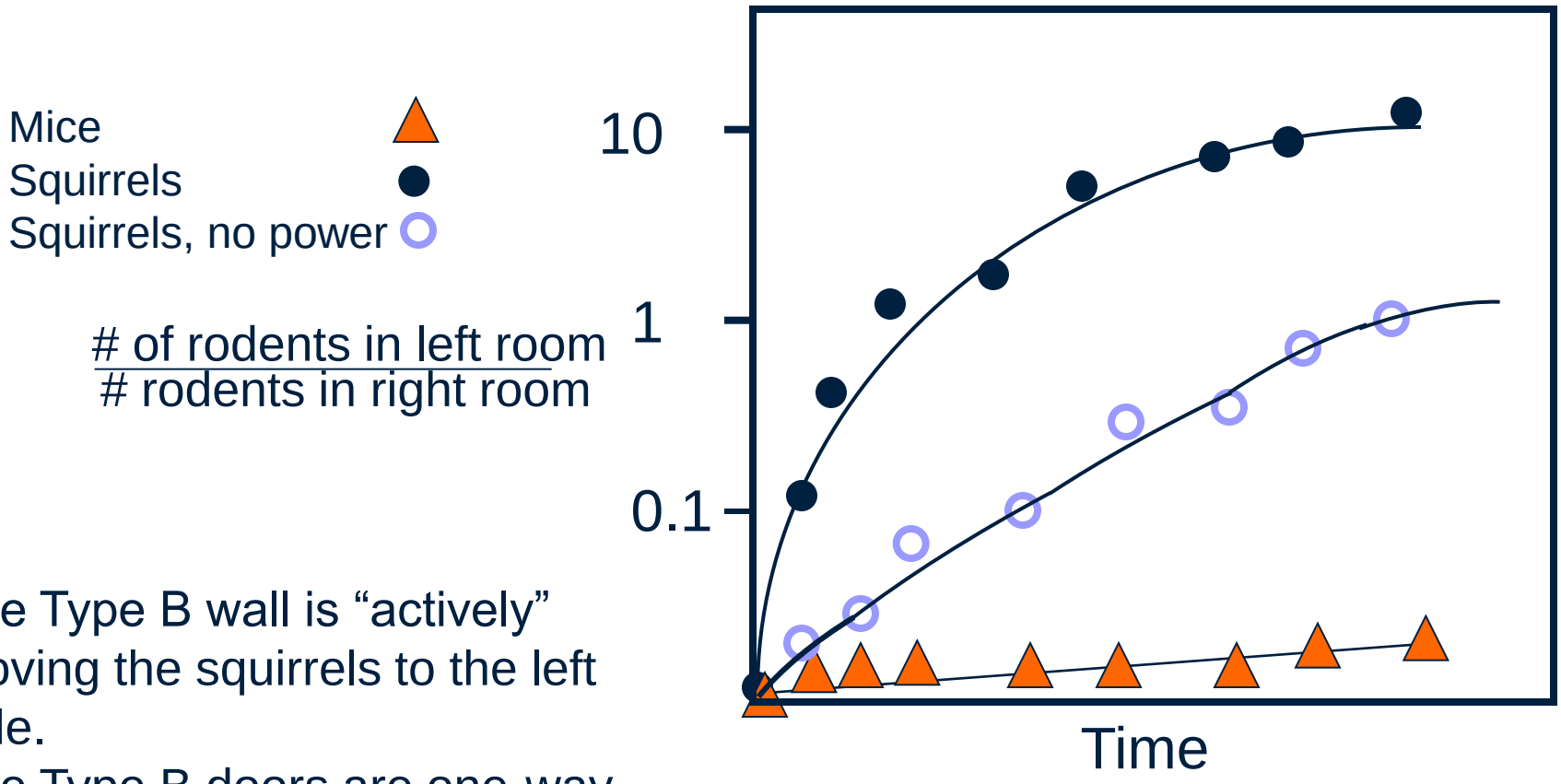
Suppose you set up several exhibits with walls with different types of doors.

You then set up some starting distributions of mice and squirrels observe the ratio of each in the two sides over time. Consider the following scenario.



1. The doors “prefer” squirrels over mice.
2. The squirrels can move both ways.
3. The mice can move both ways.
4. The mice can get through slowly,

A. All 4 are reasonable
B. 1 is the only reasonable conclusion
C. 2 and 4 are the only reasonable conclusions
D. 1, 3 and 4 are reasonable
E. 1, 2 and 4 are reasonable.



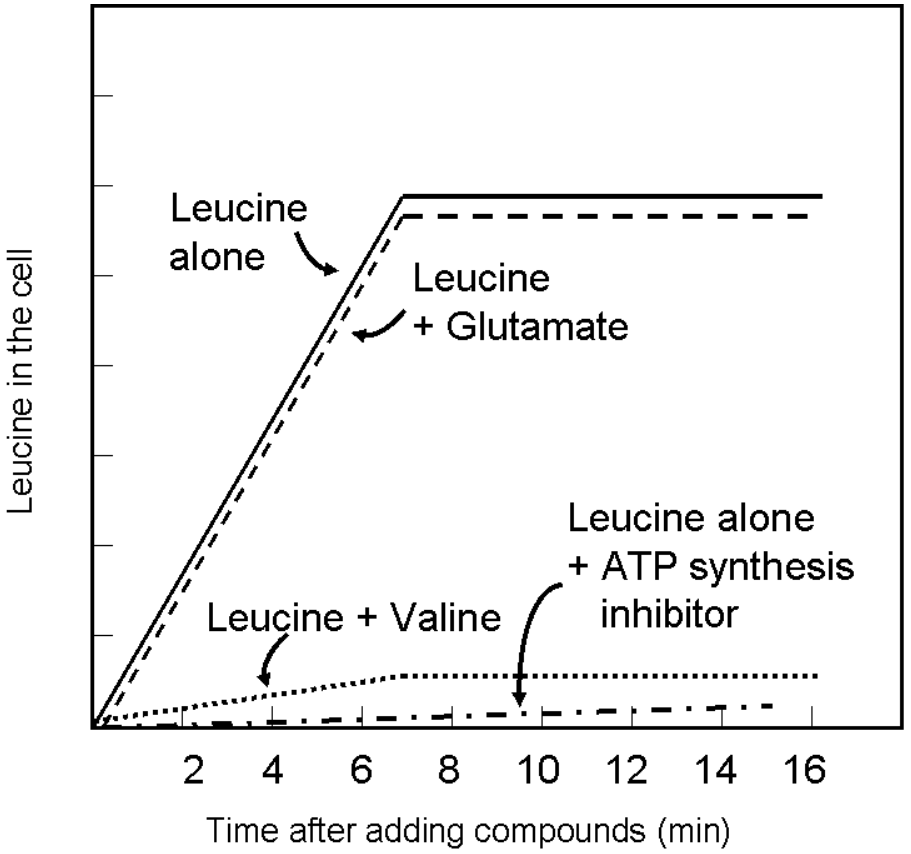
1. The Type B wall is “actively” moving the squirrels to the left side.
2. The Type B doors are one-way so squirrels can only move from right to left, not the reverse.
3. The Type B wall has more doors than the one in the first test.
4. The Type B wall has a much better sensor to discriminate between mice and squirrels,

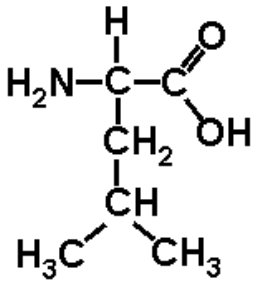
A. All 4 are reasonable
B. 1 is the only reasonable conclusion
C. Only 1 and 2 are reasonable conclusions
D. Only 3 and 4 are reasonable
E. Only 1, 2 and 4 are reasonable.

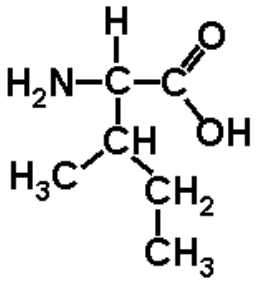
Selective permeability of amino acids into a bacterial cell.

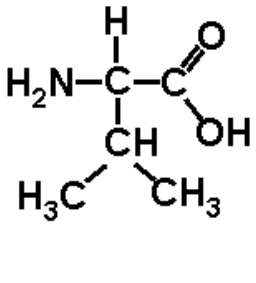
Uptake of Leucine into a bacterial cell under 4 conditions:

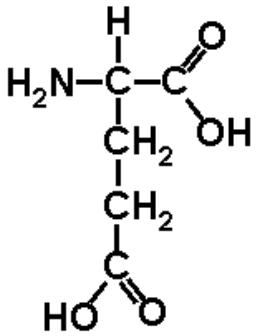
1. Alone (———)
2. With 50 times more glutamate (– – –)
3. With 50 times more valine (·····)
4. Alone, with ATP synthesis inhibitor. (– · – ·)




Leucine


Isoleucine

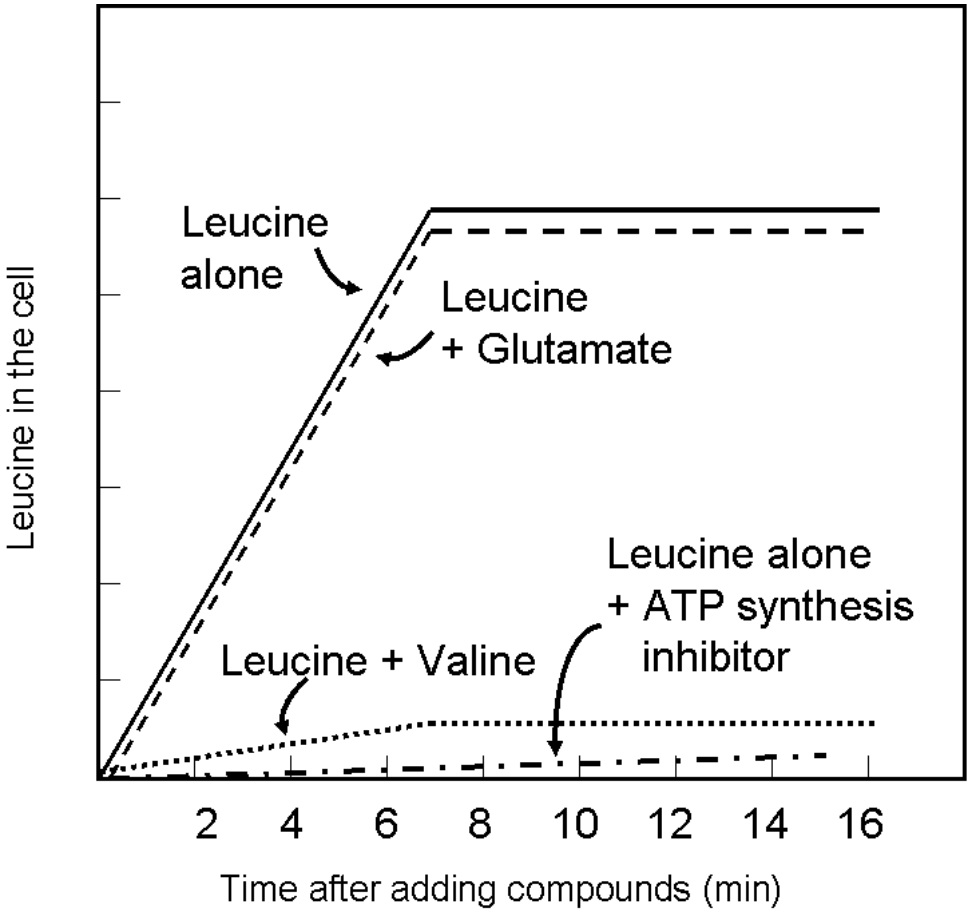

Valine


Glutamate

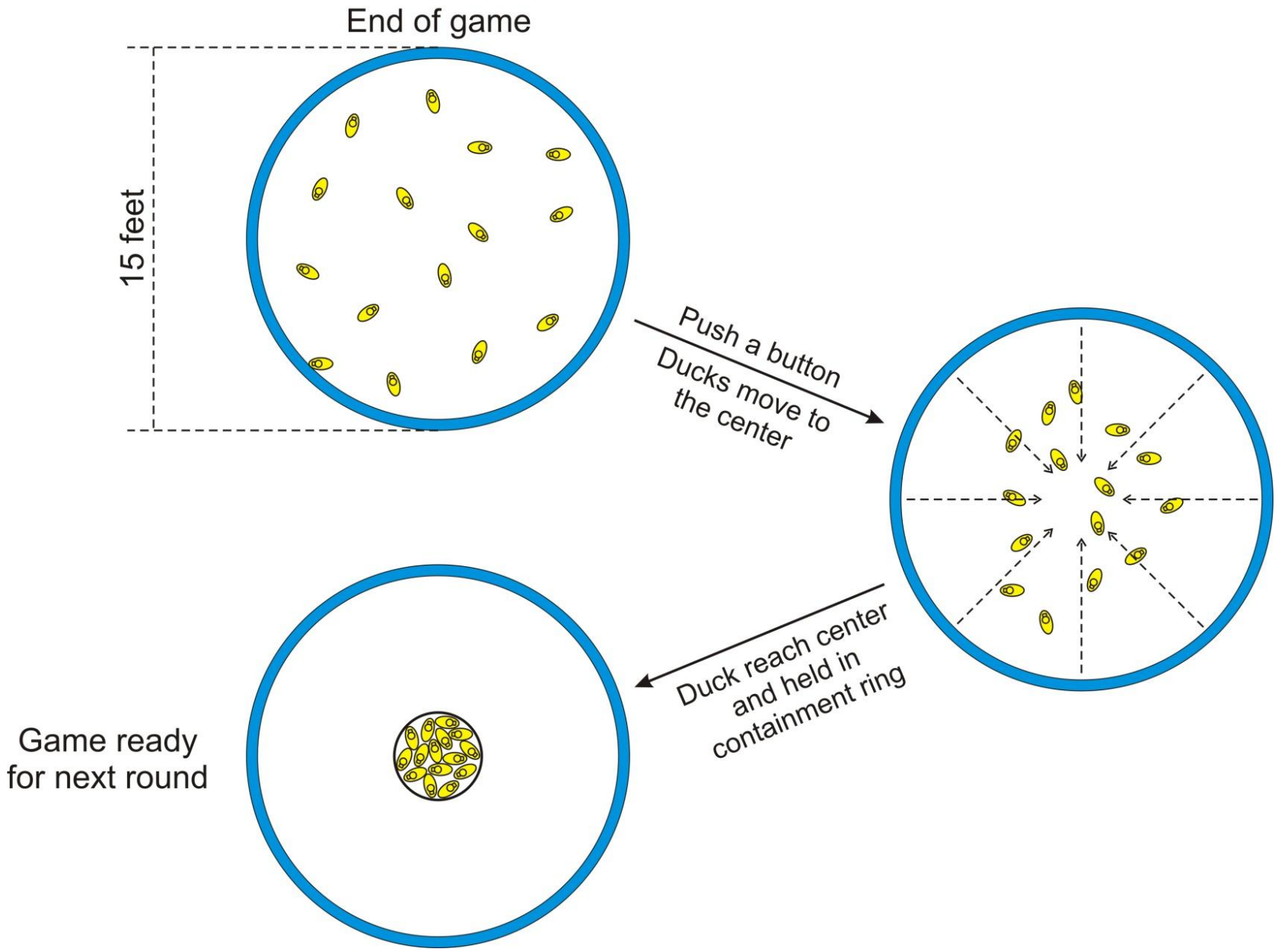
Chemical structures of 4 amino acids.

What conclusions can you draw from the graph?

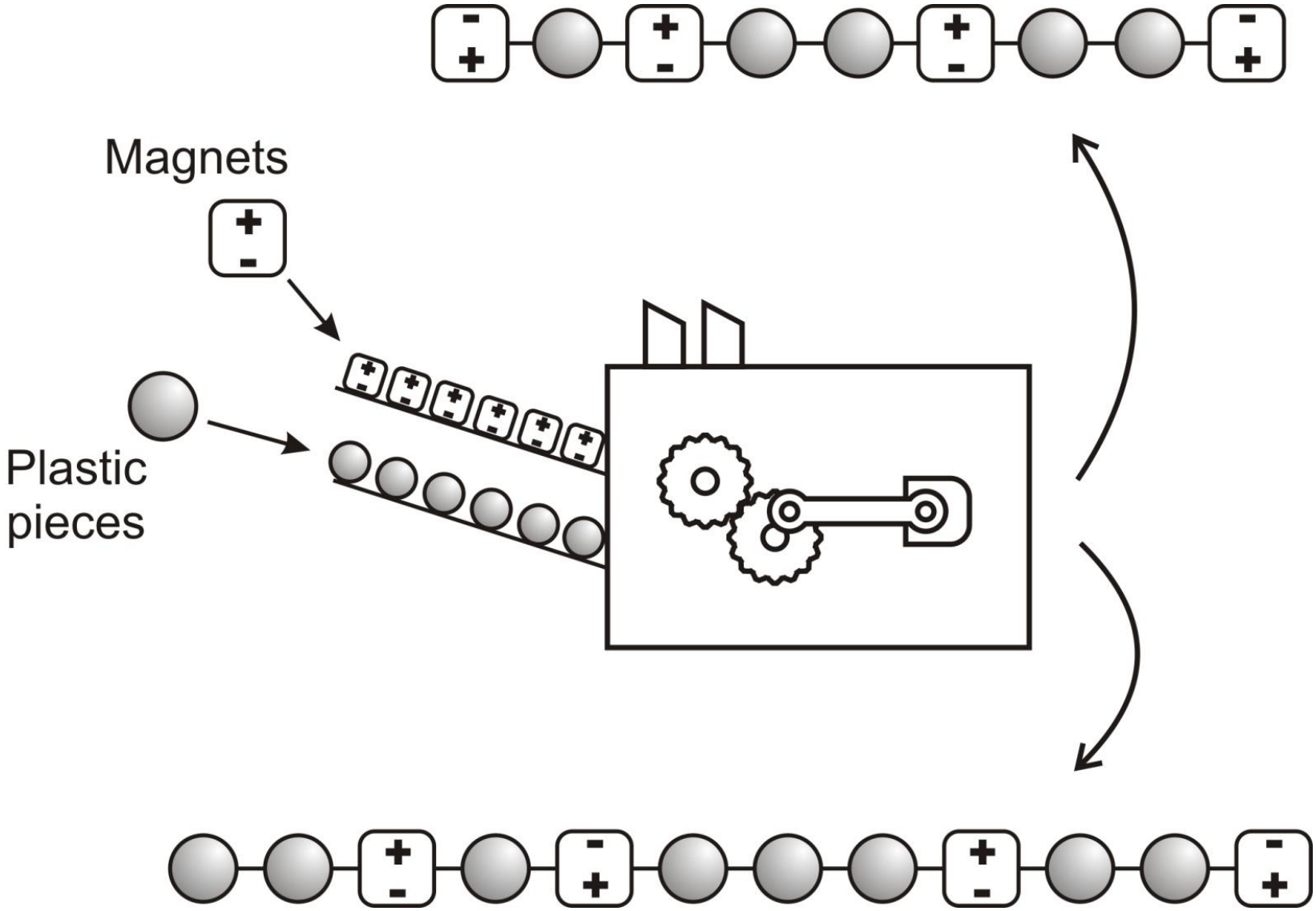
1. Leucine, valine and glutamate all enter through the same transporter.
2. Glutamate and valine enter through the same transporter.
3. Valine and leucine enter through the same transporter.
4. Leucine transport requires ATP.
5. There is a separate transporter for all 3 amino acids.



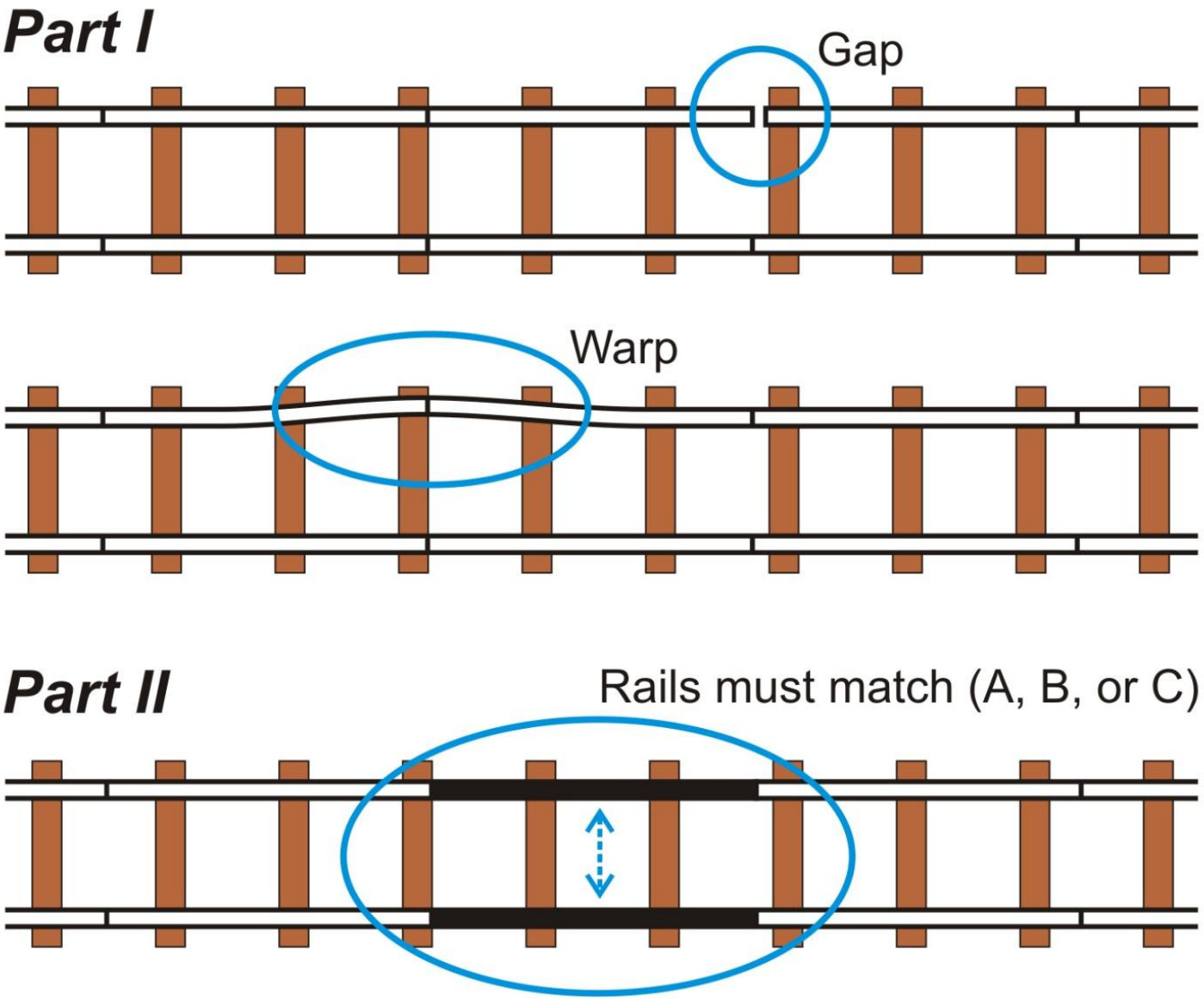
A. All 5 are reasonable.
B. Only 3 and 4 are reasonable.
C. Only 4 and 5 are reasonable.
D. Only 1, 2, 3 are reasonable.
E. Only 1 and 4 are reasonable.


End of game
15 feet
Push a button
Ducks move to
the center
Duck reach center
and held in
containment ring
Game ready
for next round

Some Other Examples

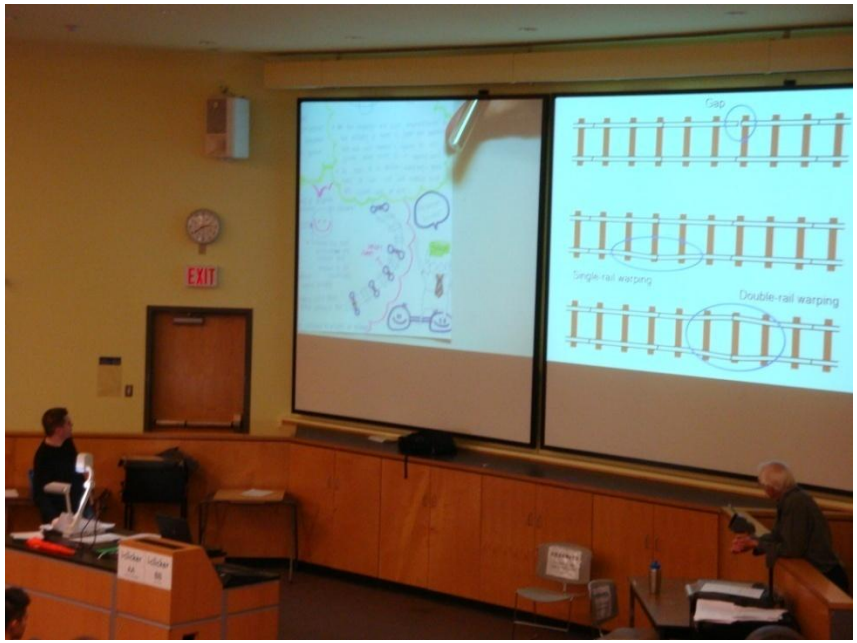


Some Other Examples



Inventions Activities in Large Lectures

- BIOL 112 = 280 students.
- Students form groups of 2-3.
- In a 50 min lecture:
  - Invention activity = 20 min
  - student presentations = 10 min (document camera)
  - Wrap-up = 5 min
  - Clicker questions = 10 min.
  - Collect and mark.



Invention Activity Characteristics

- have a clear goal.
- be intriguing.
- use a simple and familiar context.
- have an appropriate level of difficulty for group work.
- avoid concepts, elements, and terms taken directly from the course material.
- use contrasting cases.

Designing Invention Activities

- Involves three main steps:

1. Identify the critical structure or relationship that you want the activity to relate to.

2. Identify an over-arching analogy that uses a matching structure, or generate data that follows the desired relationship.

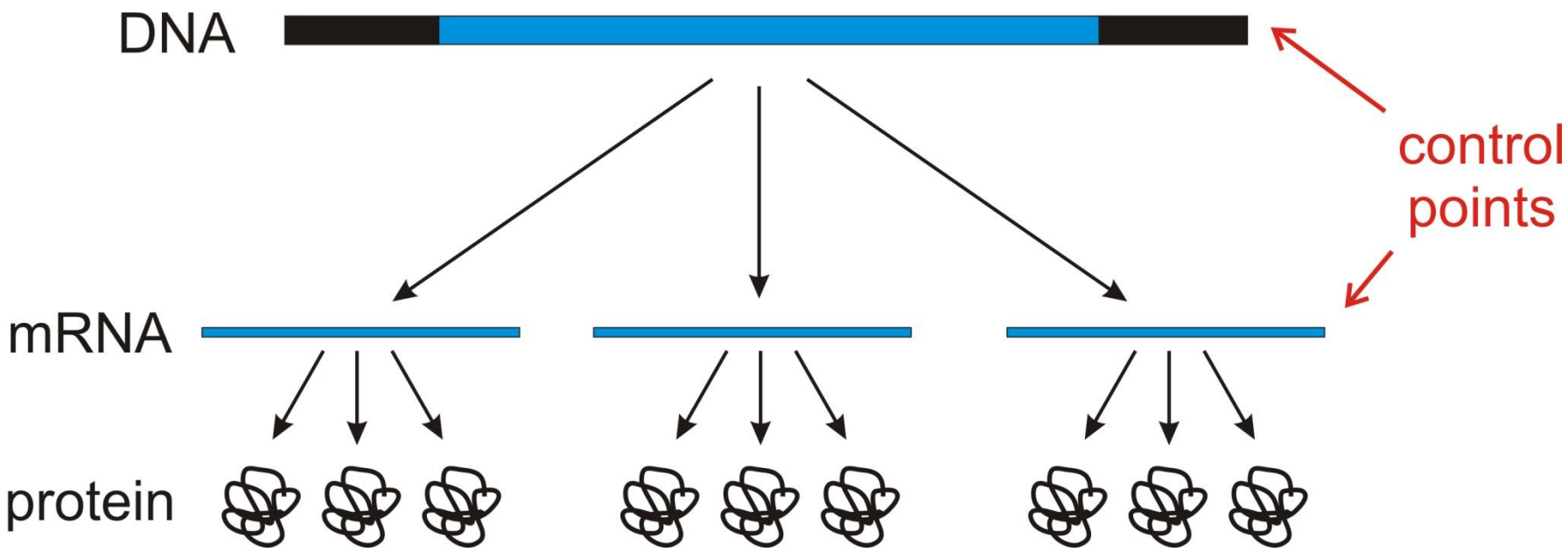
3. Generate contrasting cases (two or more different versions of the analogy, with different levels of complexity) to ensure the activities focus on the correct relationships or properties.

Designing an Invention Activity

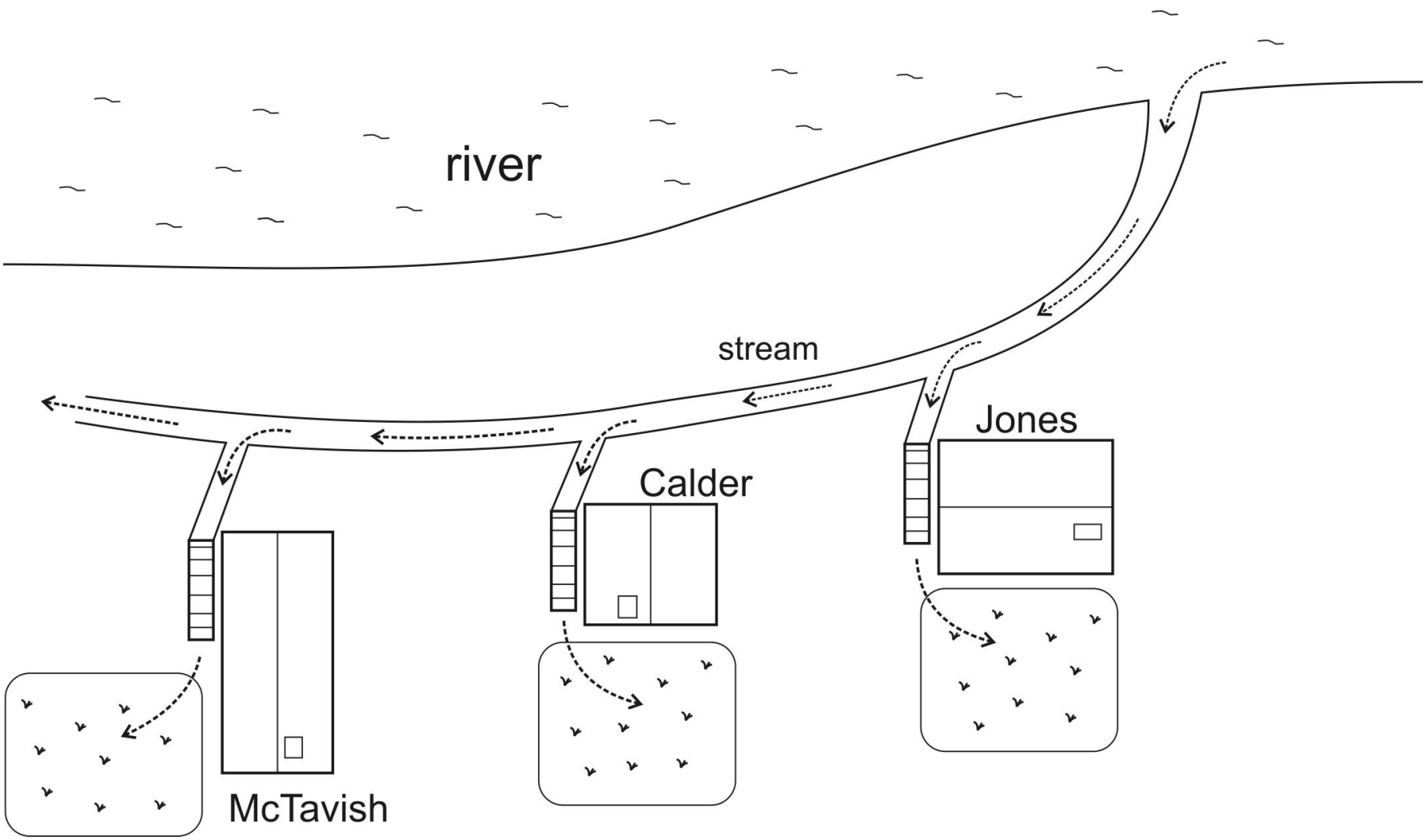
- **Task**: think of an invention activity which requires the student to design some kind of system that utilizes two levels of control.
  - You can think of these levels of control as course grain and fine grain control (or global vs. local control).
  - A good place to start is think up some kind of situation which is producing something, and the process needs to be controlled.
  - Remember, the students must be tasked with coming up with the control system.

Designing an Invention Activity

- Design an activity that represents multi-level control of protein production.



Our Invention: Water Wheels



Our Invention: Water Wheels

	Water and Power Demands		
Time of day	McTavish	Calder	Jones
Morning	Low (potential for flooding)	Low (potential for flooding)	High
Noon	Low (potential for flooding)	High	Low (potential for flooding)
Evening	High (potential for water shortage)	High	High

- With your group, discuss possible concepts for which an invention activity might be used.
- If time permits, choose one of the concepts and attempt to design an analogous situation that could be used for an invention activity.

Check out:

- Carl Wieman Science Education Initiative (CWSEI)
  www.cwsei.ubc.ca

- CBE- Life Sciences Education Highlights 2010
  "Using Invention to Change How Students Tackle Problems"

Recent publications from CWSEI:

- *Science* ***332, 862 (2011)***
  Improved Learning in a Large-Enrollment Physics Class*;*
  Louis Deslauriers, et al.

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