TABLE 1

Experimental block design showing alternating PLA presence in Sections A and B of an introductory biology course.

Unit	PLA presence Section A	Section B	Exam questions aligned with Clickers	Open-response group activities
1. Molecules of Life	X		5	5
2. Energy Processes		X	5	5
3. Information Flow	X		5	5
4. Trait Inheritance		X	5	5

Note. Presence is indicated by an "X," and the number of clicker questions and open-response group activities aligned with exam questions is provided for each

TABLE 2

Example of clicker question and open-ended response activity questions with their aligning exam questions.

Question type	Example activity
Clicker question (Unit 1)	**Six glucose molecules are bonded to form a polysaccharide. The molecular formula of glucose is $C_6H_{12}O_6$. What is the molecular formula of the polysaccharide?** A. $C_{36}H_{60}O_{30}$ C. $C_{36}H_{62}O_{31}$ B. $C_{36}H_{72}O_{36}$ D. $C_{36}H_{82}O_{41}$
Corresponding exam question (Unit 1)	(2 pts) Rutinose is a disaccharide found in some plants that is composed of a glucose molecule bonded to a rhamnose molecule. If glucose has a molecular formula of $C_6H_{12}O_6$ while rutinose has a molecular formula of $C_{12}H_{22}O_{10}$, the molecular formula of rhamnose is _____.
Open-response group activity question (Unit 4)	Bananas at the store came from plants that cannot reproduce sexually. Somatic cells of the plants are triploid (3n), which results in sterility. Use your knowledge of mitosis and meiosis to explain why the plants can be propagated asexually (using stems from the parent plant) but not sexually.
Corresponding exam question (Unit 4)	(2 pts) Which of the following organisms will likely have problems with sexual reproduction? a) organisms that produce gametes with three sets of chromosomes b) organisms with somatic cells that have two sets of chromosomes c) organisms with somatic cells that have five sets of chromosomes d) organisms with somatic cells that have four sets of chromosomes e) organisms that produce gametes with eight sets of chromosomes

TABLE 3

Survey responses regarding students' perceptions of their interactions with PLAs.

Theme	Survey item	Overall agree (%)	Overall disagree (%)
PLA practices	The PLAs can explain concepts in a manner that is easy to understand.	88.6	3.8
	When interacting with PLAs, they provide me with feedback that is individualized and/or specific to my question.	89.4	2.5
	When I ask a question about content, the PLA responds with guiding questions to lead me to a solution (without giving me the answer).	88.9	4.7
	When I ask a question about content, PLAs give me an answer without encouraging me to think about it first.	20.3	65.7
	The PLAs help me identify what I don't know or don't understand.	83.9	6.8
	The PLAs explain concepts in a way that is different from my instructor.	81.8	5.9
Trust in PLAs	I feel comfortable asking the PLAs questions about course content.	91.5	4.7
	After interacting with a PLA, I feel more confident with my responses to clicker questions.	86.0	3.3
	After interacting with a PLA during a group activity, I have a better understanding of the content involved in that activity.	89.4	3.3
	I am confident in the instructional abilities of the PLAs.	84.8	8.9
	The PLAs have a sufficient understanding of course content.	90.7	3.8
Value of PLAs	I value the support provided by the PLAs in the class.	88.6	4.2
	I would rather attend a section of BIOL 1107 without PLAs.	7.2	70.1
	The feedback that PLAs give me is helpful for my learning of course content.	89.8	2.5
	I find the interactions with PLAs during group work in class helpful.	91.5	4.2
	I prefer to learn course content through lecture without group work and PLAs.	22.5	61.0
Study Design	I felt more prepared for the unit exam when PLAs were present during that unit.	67.4	11.9
	I believe I did better on unit exams when PLAs were present during that unit.	57.6	15.3
	The time allotted to interact with PLAs when they are present in class is sufficient to support my learning.	73.7	16.1

Note. Overall disagree includes strongly (dis)agree, (dis)agree, and somewhat (dis)agree.