Early Embryonic Development Role-Playing in a Large Introductory Biology Lecture

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INTRODUCTION

Animal development in introductory biology texts is generally described as a series of four coordinated and controlled phases of cell growth and movement: Body Axis, Segmentation, Segment Structures/Characteristics and, finally, Differentiation. The ultimate fate of each cell is regulated by location, contact with other cells, and exposure to gradients of morphogens laid down prior to fertilization. The descriptive text is usually dense and contains a large number of new words and concepts that students must master for successful learning. Moreover, the development chapter almost always falls near the end of the semester, resulting in superficial treatment of the material by the instructor. Or, it might be ignored altogether, with the assumption that students will learn about development in upper-level classes.

In an ongoing effort to reform my teaching practices and place my introductory biology lectures within the context of student’s lives, I began teaching the development chapter as one possible outcome of the transcription and translational processes. During this process, I realized that students were having difficulty visualizing what was happening during early embryonic development. This activity was created to expose students to early embryonic development by making them move and change in a manner similar to what a cell in the embryo might undergo.

PROCEDURE

Preparation

Prepare four sets of sheets of paper or note cards that are easily distinguishable (four colors, four shapes, etc.). Assuming a class of 300, each set should contain 100 individual sheets. Scale up or down the amount accordingly for your lecture size.

Activity

At the appropriate time during the lecture, one set of note cards is passed from the front, another from the back, and one each from the left and right sides of the classroom. Students are asked to stand up next to their seats and face the front of the auditorium. They are instructed that they are all individual cells that have been dividing in a developing animal zygote (the classroom). Based on commands from the instructor, each cell will respond appropriately and move as directed.

Body axis (Phase 1)

“The cards you have received are an example of a morphogen determining the identity of cells or nuclei in the early embryo. If you find for any reason that you are not in your appropriate group (same card color(s)), please move now. GO!” When all cards are passed out and students are assorted correctly, the classroom should be arrayed in a tic-tac-toe arrangement. Four sets of students will have two cards (at the corners), four sets of students will have one card (middle, outer rows), and students in the middle will have no card. Discussion focuses on how four morphogens can determine nine different outcomes and provide positional information. This is analogous to posterior/anterior (p/a) and dorsal/ventral (d/v) layout of the early embryo.

Segmentation (Phase 2)

“Staying within your card-determined position, organize everyone in your group, with blondes in the back and brunettes in front. If your hair fits somewhere in the middle of these two extremes, find your place within the gradient of hair color from brunette to blonde. GO!” When completed, students will be in the tic-tac-toe arrangement and within their group they will be further divided by hair color. This creates segments within the p/a and d/v positional information. Discussion focuses on how one instruction has now further changed and defined the location of students (cells) in their segment.

Segment structures/characteristics (Phase 3)

“If you are annoyed with this activity, face towards the rear of the lecture hall. If you are having fun with this activity,
face towards the front of the lecture hall. GO!” Segment characteristics and different structures have now been overlaid onto positional and segmental information. Discussion focuses on how one instruction has now further changed and defined the location of students (cells) in their segment.

Differentiation (Phase 4)

“Reach out with both hands and touch two different students on the shoulder. Introduce yourself to them if you do not know them, say hello if you do, and tell them where you started your trip in development. GO!” Cell to cell contact has been made and each cell is different and communicating with different cells.

“Look around you and note the complex structure that we have created. Please be seated in your original seat.”

DISCUSSION

Once students are seated, the active learning experience is reinforced with discussion in either small groups or with the whole class. Discussion is best focused on how four different commands can determine an extremely complex structure. Possible questions for group discussion:

1. Which of the instructions was analogous to what happens during segmentation? Why?
2. Which of the instructions was analogous to what happens during building of segment structures? Why?
3. Which of the instructions was analogous to what happens during differentiation? Why?

Caveats: This activity focuses on a generic, global concept understanding of early embryonic development and, therefore, may not be appropriate for any one specific organism. With slight adjustments to the directions though, this activity should work just as easily in an upper-level development class or for the development program of a specific organism.

CONCLUSION

The majority of students confronted with development in an introductory biology lecture rarely grasp the elegance and overall simplicity of the development plan. They struggle with learning the biology language and memorizing how content relates to the whole. This role-playing activity provides an added opportunity to engage students by using movement and visualization of change over time.

While rigorous assessment of this activity remains to be undertaken, it is encouraging that it provides a way for students to visualize early embryonic development using the large number of students that routinely populate introductory biology classes. Rather than being a hindrance, this activity actually takes advantage of the large number of students. Students report that the role-playing activity has helped them understand and visualize early embryonic development in a way that the text and presentation of content during a traditional lecture did not. And not so surprisingly, the majority of the students were still facing forward (enjoying the activity) when given the opportunity to voice their opinion during Phase 3.

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