Drawing as assessment in Human Anatomy & Physiology courses

Megan McKeon[1], Tara Slominski[2], Lisa Montplaisir,PhD[2], [1]University of Illinois at Urbana-Champaign [2]North Dakota State University

Introduction

Recent research shows that drawing can be used as an effective form of evaluation in undergraduate education, providing a creative way to gather misconceptions and giving insight to alternative conceptions [2]. This type of evaluation provides valuable insight on students' misconceptions and spatial understanding. In addition, drawing requires a higher level of cognitive thought, as shown by Bloom's Taxonomy [1]. This study uses drawings to asses students' understanding of cell structure.

Research Questions

- What misconceptions are held by students concerning the structure of the cell?
- How can student generated drawings asses student understanding?

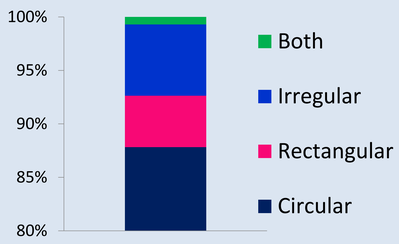
Methods

- Human Anatomy and Physiology class (400+ students)
- Weekly in-class drawing assignments, previous to instruction
- Coding based off a previous study [3]
  - Drawings were sorted into three categories (Table 1)
  - Students were evaluated on the correctness of the content they included, regardless of the amount
  - Cell shape identified, organelles tallied (8.3 average labels), ER relationships noted

Table 1. Coding Categories

	Description
A	Correct -Everything drawn was correct, regardless of completion
B	Partially Correct -At least one structure correct, one structure incorrect
C	Incorrect -Nothing identified correct

Results: Cell Shape



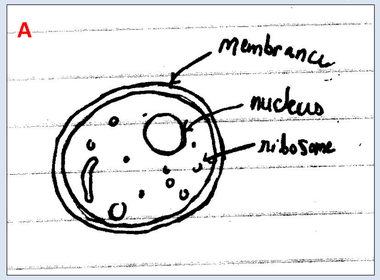
- Intended cell type cannot be determined by the drawn shape of the cell
- Three students drew both a circular animal cell and a rectangular plant cell
- The most common shape drawn was "circular" at 88%
- Only two students drew a rectangular cell with a cell wall
- No students included all three components (cell wall, rectangular shape, chloroplast) necessary for a plant cell

Cell Question

-Start by drawing a cell
- -Include and label significant parts
- -Which parts are involved in the following typical cell activities?
- -Protein Synthesis, Energy transformation, Acquisition of materials & removal of wastes, Distribution of materials, Communication with other cells, structural support

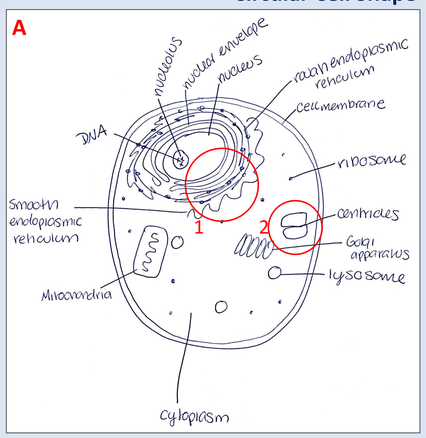
A	51% of drawings
B	45% of drawings
C	3% of drawings

Circular Cell Shape



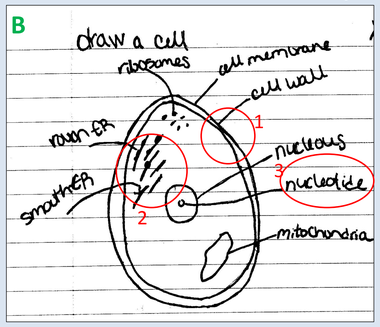
Everything labeled is correct

Circular Cell Shape



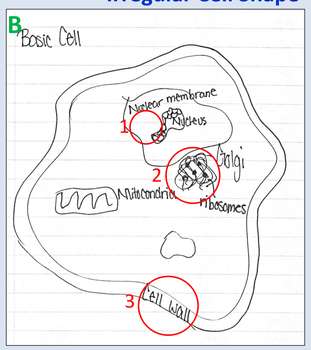
1. ER continuous with nucleus
2. Presence of centrioles

Circular Cell Shape



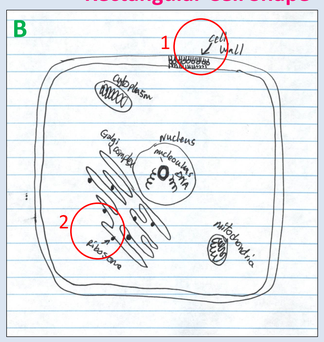
1. Cell wall though circular
2. ER not continuous with nucleus
3. Incorrect terminology

Irregular Cell Shape



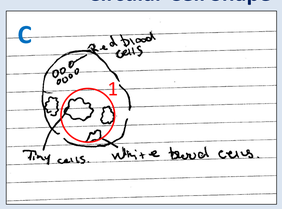
1. Size of nuclear membrane
2. Ribosomes in golgi
3. Cell wall though irregular

Rectangular Cell Shape



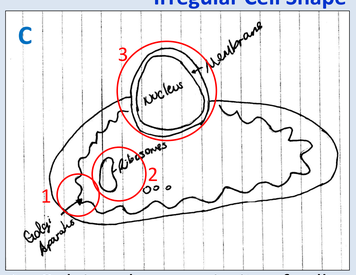
1. Correct cell wall
2. Ribosomes in golgi

Circular Cell Shape



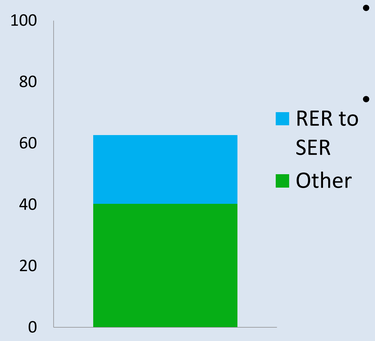
1. Cells labeled in cell

Irregular Cell Shape



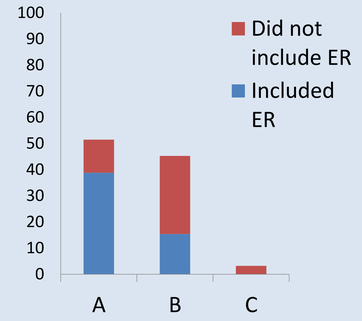
1. Golgi encloses majority of cell
2. Ribosomes in golgi
3. Nucleus protrudes from cell body

Results: Endoplasmic Reticulum



- 300 drawings (69%) included some form of the endoplasmic reticulum.
- Of these, 62.6% drew the ER continuous with the nucleus.
  - 22% drew the correct RER into SER formation
  - 78% drew "other" which includes SER and RER not continuous, SER into RER, and incomplete ER

- A level drawings had a higher percentage of drawings including some form of the ER
- No C level drawings included an ER



Findings

- For the most part, there is a basic understanding of the presence of the structures of the cell
- In situations where structural location and shape is crucial to function, there is misalignment in functional organization, such as the flow of information from nuclear envelope to RER to SER
- Most misconceptions were due to size, shape and location of the organelles
- The inclusion of an organelle does not necessarily mean the function is understood
- Features exclusive to plant cells, such as a cell wall, are rarely paired with correct shape (rectangular) or specific organelles (chloroplast)

Conclusion

- Student generated drawings force students to create their own representation of a cell, choosing what they think is important.
- Most students tended to draw a generalized cell instead of identifying organelles to a specific type of cell.
- Therefore, inclusion of an organelle represents a structural component rather than a functional component.

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