Large, Inexpensive Models for Large, Student-Centered Classrooms

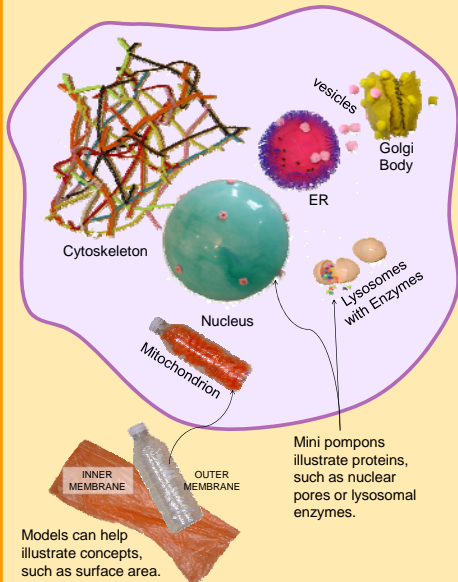Jane E. Caldwell, West Virginia University, Morgantown, WV

ABSTRACT

Hands-on experience with models can help students learn (especially those who are tactile or kinesthetic learners), but how to do this in a large lecture class? Many commercially available models are too small to see, too expensive, or just not quite right for lecture purposes. Furthermore, teaching a large class with just one small model invites very passive learning and lecturing. When used effectively, however, models can transform large lecture classes into highly participatory, hands-on and minds-on events. Various options for building large-scale models will be presented, at a low enough cost that multiple copies can be brought into the classroom. Examples are presented, including photos and activities for (1) organelles and (2) molecules involved in transcription and translation. These examples include ways in which these models have been built into active learning exercises, as well as some preliminary assessment results.

ORGANELLE MODELS

Materials

- Various toys from major discount store:
  - beach ball
  - "whoopee cushions"
  - "hairball" frisbee with wiggly rubber extensions
  - bubble wand (to demonstrate vesicles)
- Various items from major craft store:
  - plastic Easter eggs
  - pom-pons, various sizes and colors
  - vinyl glue
  - magic marker
  - hot glue
  - rubber cement
- Items from my recycling bin:
  - empty plastic water bottles
  - empty colorful plastic bags from newspapers

Cytoskeleton
vesicles
Golgi Body
ER
Nucleus
Lysosomes with Enzymes
Mitochondrion
INNER MEMBRANE
OUTER MEMBRANE
Mini pompons illustrate proteins, such as nuclear pores or lysosomal enzymes.
Models can help illustrate concepts, such as surface area.

Classroom Activity with Organelles

- Before class, students complete a worksheet:
  - organelle descriptions
  - analogies between organelles and businesses (e.g. "Golgi body is like Fed Ex")
- During class
  - 6 copies of each organelle model are distributed throughout class
  - students pass models around during lecture
  - during lecture, students volunteer to answer questions, alone or with a partner:
    - Who has a model of this organelle? Why do you think so?
    - How does the model represent the organelle's structure & function?
    - What are the shortcomings of the model?
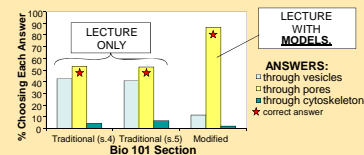
Worksheet

Assessment: Models Boost Concept Retention

CLICKER QUESTION: (Two weeks later)
Based on the structure of the nucleus, what would be the easiest way to get something OUT of the nucleus, into the cytoplasm?

LECTURE ONLY
LECTURE WITH MODELS.

% Choosing Each Answer

ANSWERS:
- through vesicles
- through pores
- through cytoskeleton
- correct answer

Traditional (s.4) Traditional (s.5) Modified
Bio 101 Section

Students enjoyed the models and the activity:

"…the organelle activity [helped me learn] because it was silly…"

"…demos in class, they may have been corny. But they stuck in your mind and I'm a visual learner so it helped me out a lot…"
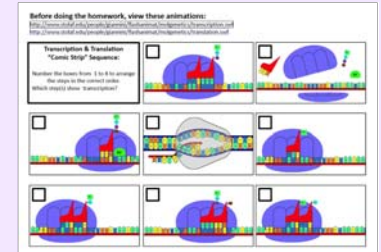*--Students in Bio 101, Spring 2007*

TRANSCRIPTION & TRANSLATION

Materials

- Items from craft/discount stores
  - Foam pool noodles (various colors)
  - Hot glue
  - Sheet foam (1/8" thickness), various colors
  - Yarn
  - Adhesive velcro (for "hydrogen bonds")
- Tools
  - Hole punch
  - Hot glue gun
  - Electric bread knife (cuts noodles easily)

Worksheet

Classroom Activity with Transcription & Translation

- Before class:
  - Students watch online animations of transcription & translation (from St. Olaf College)
  - Students complete worksheet
  - Students do a lab exercise with plastic models
- During class:
  - In groups, students write down steps of transcription and translation, in order
  - Two groups volunteer:
    - one group reads instructions, while…
    - the other group demonstrates with models; two students seated in chairs = ribosome
  - Classmates offer corrections and further details

DNA molecule
Transcription
Messenger RNA
New Polypeptide
tRNA
Amino acid
Translation
mRNA
RIBOSOME