

A summary from two opportunities
to explore the Intersection of
**Biology and Physics: Research and
Education**

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Summer 2014, AAPT



2013-2014

... A perfect storm of biology and physics

CBE—Life Sciences Education (LSE)
Special Issue: Integrating Physics
and Biology Education, June 2013

IPLS Conference
Arlington Virginia, March
2014

American Journal of Physics
Theme Issue: The Intersection of
Biology and Physics, May 2014

*Gordon Research Conference: Physics
Research and Education*
Mt. Holyoke College, June 2014

**** coming into this as an outsider**

AMERICAN JOURNAL *of* PHYSICS



**Gordon
Research
Conferences**

Rich History:

The Theme Issue of the AJP every other summer aligns with the theme of the GRC: Physics Research and Education

Jan Tobochnik & Harvey Gould edited the December 1999 theme issue of the *American Journal of Physics* and started a new series of Gordon Conferences on Physics Education and in 2000.

AMERICAN JOURNAL *of* PHYSICS



**Gordon
Research
Conferences**

Rich History:

The Complex Intersection of
Biology and Physics
Astronomy's Discoveries and
Physics Education
Experimental Research and Labs
in Physics Education
Computation and Computer-
Based Instruction
Electromagnetism
Mechanics
Quantum Mechanics
Statistical & Thermal Physics

**Save the dates:
2016 - General Relativity and
Gravitational Waves**

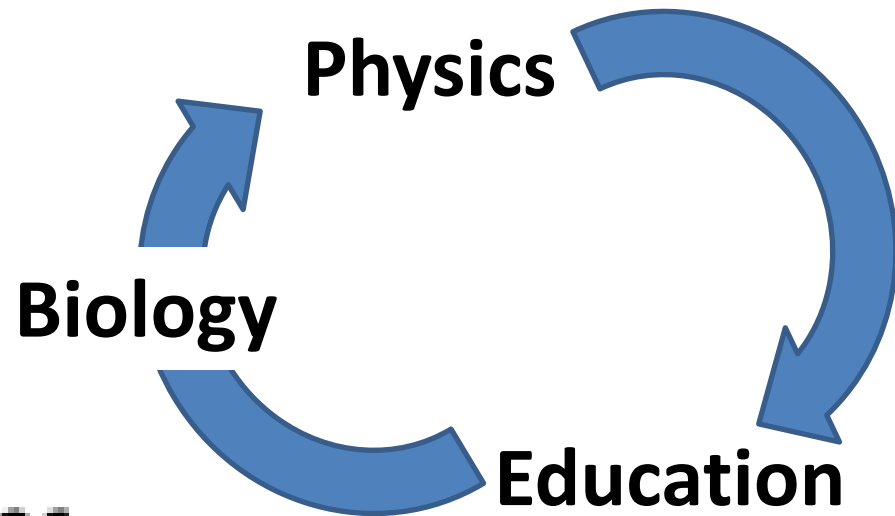
2018 - Energy

AMERICAN JOURNAL *of* PHYSICS

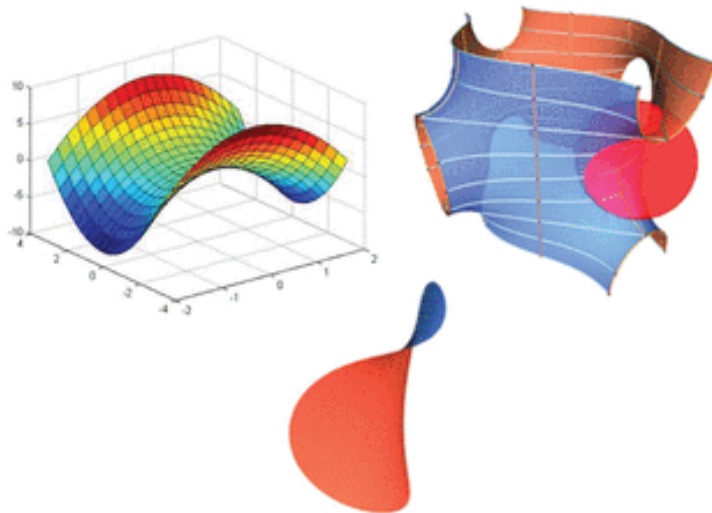
Bring together content
researchers,
instructors, education
researchers.



**Gordon
Research
Conferences**



Special Issues ... of CBE-LSE & AJP



Special Issue: Integrating Physics
and Biology Education



Edited by Eric Brewe, Nancy J. Pelaez, and Todd J. Cooke



“... articles that comprise this special issue of *CBE—Life Sciences Education (LSE)* take important steps toward responding to [the] call” from the Vision and Change Report, “stressing the urgency for undergraduate biology and physics educators to develop, assess, and revise content materials, pedagogical strategies, and epistemological perspectives for encouraging student learning in interdisciplinary biology and physics classes.” ... from the editorial

<http://www.lifescied.org/content/12/2>

Edited by Mel Sabella and Matt Lang



“... includes papers on new advances in the fields of biological physics, new advances in the teaching of biological physics, and new advances in education research that inform and guide instruction ... support the reader in making connections, not only at the intersection of biology and physics, but also at the intersection of research, education, and education research.” ... from the editorial

<http://scitation.aip.org/content/aapt/journal/ajp/82/5>

American Journal of Physics

Papers focused on:

- education research to ground instructional efforts at the intersection of Biology and Physics.
- novel experiments and theory and computational techniques in both research and instruction.

IPLS



Focused on introductory physics courses taken by the full spectrum of life science students, including pre-medical and other pre-health students, biology students aiming for careers in biological research or biotechnology, and students interested in ecology and related areas.

from <http://www.compadre.org/ipls/>

GRC



Focus on discoveries, technologies, and experiments that excite students and emphasize the physics content in ways that help physicists use them in their teaching at all levels; the development of new laboratories and curricula by infusing them with biologically- and medically-related topics; Research into student learning at the interface of physics and biology at the college level.

<https://www.grc.org/programs.aspx?year=2014&program=physres>

7 of 842 Gordon Conferences focus on Science Education

Conference Name	Discipline	Status	Initial Year
Chemistry Education Research & Practice	Chemical	Active	1994
Materials Education	Physical	Inactive	1998
Physics Research & Education	Physical	Active	2000
Science Education	Chemical	Inactive	1990
Undergraduate Biology Education Research	Biological	New	2015
Undergraduate Microbiology Education	Biological	Inactive	1999
Visualization in Science & Education	Physical	Active	1994

Contributors



Physics Education Research
Leadership and Organizing
Council (**PERLOC**)

GRC

125 participants

Diverse community (undergraduates, graduate students, post docs, TYC faculty, Small College faculty, MSI faculty, R1 faculty, ...)

Funding from NSF, GRC, APS, AAPT, PERLOC to support travel and registration for speakers and participants and to support social functions (~85K).

<https://www.grc.org/programs.aspx?year=2014&program=physres>



The Complex Intersection of Biology and Physics: Perspectives from Res. and Ed.

Mike Klymkowsky, Howard Berg, Edward "Joe" Redish

Mtg the Needs of Life Sci. Students in Intro. Phys. Through Course Transformation

Marta Dark, Catherine H. Crouch, Dawn C. Meredith, Robert C. Hilborn

Single Cell and Molecular Techniques Involving Biological Motors at the Boundary of Biology and Physics

Mark Reeves, Jonathon Howard, Wonmuk Hwang

New Trends in Soft Condensed Matter Physics: Research and Education

Enrique M. De La Cruz, David A. Weitz, Jennifer Ross, Edit Yerushalmi

Novel Laboratory Activities for the Biophysics and Bio-Engineering Curriculum

Steven Vogel, Steven Wasserman, Barbara Hughey

Improving the Scientific Competencies and Attitudes of Biology and Pre-Med Students Through Multidisciplinary Reform

Kenneth Heller, Todd Cooke, Ross Nehm, Kimberly D. Tanner

Effective Use of the Textbook at the Intersection of Biology and Physics

Ruth Chabay, Philip Nelson, Jané Kondev

Understanding Current Health Needs and Novel Techniques in Biomedicine: Teaching and Research

Juan R. Burciaga, Wolfgang Losert, Ralf Widenhorn, Manu O. Platt

Involving Undergraduates in Cutting Edge Biophysics Research and Its Implications for Instruction

Sean P. Robinson, Ashley R. Carter, Carlos Castro

What we did at the GRC ...

- Ate breakfast together
- Attended 3 morning talks
(40 min + 20 min of questions)
- Ate lunch together
- Had free time ...
- Poster sessions / Social time
discussed a variety of topics
- Ate dinner together
- Attended 2 evening talks
(40 min + 20 min of questions)
- Social time at poster area

(for over 4 days ...)... many shared experiences

a few other things we did ...

Themed discussions in the afternoon ...

Steve Vogel, Mike Klymkowsky, Jean Louis Sikorav led discussions on Tuesday and Thursday afternoon on topics they thought would be valuable to the community.

- How do biologists, chemists, and physicists think and talk about energy?
- What topics in Physics might matter to the contemporary biologists and how do we integrate these topics into our respective disciplines?
- How do the systems we investigate in biology and physics differ in terms of historic contingency and complexity?
- How does the messy world of real data look in the biology and physics curriculum? What can we learn from each other and what are the concerns we share about moving away from hands on activities?
- How can we clarify the philosophical and logical structure of biology and its major theories?



GRC Cornhole



Cornhole, also known as **Tailgate**, [bean bag toss](#) and variants is a [lawn game](#) in which players take turns throwing bags of corn at a raised platform with a hole in the far end. A bag in the hole scores 3 points, while one on the platform scores 1 point. Play continues until a team or player reaches the score of 21.

Wikipedia

TERMINOLOGY:

Ace or cow pie: A bag lands on the board, which is worth one point. [\[5\]](#)[\[6\]](#)

Altamira: A bag that goes "nothing but hole" even though there is a "blocker" and "backstop" (in reference to entering a cave of the same name)

Back door: A cornhole that goes over the top of a blocker and into the hole. [\[5\]](#)[\[6\]](#)

Cornado: When a player dominates a game in such a way that he/she destroys everyone in his/her wake.

Cornament: A cornhole tournament

Cornfusion: When players or teams cannot agree on the scoring of a given inning. [\[5\]](#)

Cornhole or **Drãno:** A bag that falls in the hole, which is worth three points. [\[5\]](#) The alternative name is a reference to a trademark, that of a sink clog clearing product.

Cornstar: A person who defines supreme confidence, nearly divine ability, and a frequent disregard for authority. [\[7\]](#)

Dirty bag: A bag that is on the ground or is hanging off the board touching the ground. [\[6\]](#)

Dirty roll up: A point scored when the bag hits the ground before landing on the

What people liked about the GRC...

- Diversity of topics and speakers
- Open and inclusive discussions and conversations
- Good mix of education and research with speakers showing a good effort in making the connection

What people disliked about the GRC...

- Too much on the cell/molecular biology side
- Some of the talks did not resonate with some participants
- More opportunities to share out materials
- Cornhole ...

... common themes from the AJP, GRC, and IPLS

Important underlying themes ...

Learning respect for each other and each other's disciplines is extremely important (recognize our differences and similarities)

- Biology and physics faculty tend to have dramatically different views about the nature and structure of knowledge that is appropriate to teach in classes ... Including biological authenticity shows respect for the interdisciplinarity ...
(Redish et. al., AJP May 2014)
- Cell biologists and Organismal Biologists also have diverse perspectives on what the crucial ideas are ...
- Lunch is important ...

There are a number of ways to motivate students at this intersection

- Utilize biologically rich contexts (Crouch, AJP May 2014)
Gene circuits and feedback, applying electrostatics to bimolecular interactions, MRIs, nerve electrophysiology, bioelectrical characteristics of the human body, ... (Cahn & Mochrie, Roth & Hobbie, Doerr & Yu, Klee, Mylott et al., AJP May 2014)
- Activism and policy work can engage HS and College students and promote global science.
The Platt Lab @ Georgia Tech uses the social commitment of the students as a resource to motivate topics.

There are a number of ways to motivate students at this intersection

– Everyday life examples

- Students in “Science and Cooking: From Haute Cuisine to Soft Matter Science” had just burst into applause ... because Professor Michael Brenner had just unveiled the equation of the week: a heat transfer equation. The applause became a tradition in the course ... “ (Harvard Magazine, 2010) ... “Nearly 700 students wanted to enroll. By lottery, 300 got in ... “ (NYT, 2010)
- Investigating the Young's Modulus of the cell wall, fracture stress, strain energy, etc, by looking at cantilever-based experiments using carrots and celery. (Pestka, AJP May 2014).

There are a number of ways to motivate students at this intersection

- Utilize modern pedagogy in class, labs, problems by incorporating modeling, design, interdisciplinary thinking, ... (Hoskinson et al., Moore, AJP May 2014)
- The MCAT is changing and physics teachers need to understand and adapt to the new role of physics in the revised MCAT.
MCAT 2015 will have a greater emphasis on interdisciplinary contexts and inquiry and reasoning skills (Hilborn, AJP 2014)

Sustainability needs to be considered

- Physics faculty must be willing to teach IPLS, medical physics, or biophysics courses.
- Many of us don't have the background to tackle some of the biology applications (or we may feel uncomfortable including certain biology applications).

There are great opportunities for interdisciplinary learning

- Themes that we might think are unifying might not be – Energy is one example: energy, free energy, chemical energy, micro vs. macro
... but these are opportunities to learn the material in different ways and provide contexts to generate deeper understanding (Geller et al., Dreyfus et al. AJP May 2014)
- Provides opportunities for interdisciplinary teams of students to engage in collaboration with each member contributing– a physics major, a biomolecular engineering major, a biochem major ... projects require biological contributions for completion (Deutsch, AJP May 2014)
- There are shared instructional considerations instructors need to be aware of - like physics, biology has common sense words that have specific meaning in biology that often differ from our everyday definitions: “intentionality” and “selective pressure”

Most of the GRC/IPLS participants were excited to learn about how they can incorporate biology into their physics courses at the intro and the advanced level ... and many were planning changes to their courses.

The biologists challenged us to think about what physics is important to college biology majors and reminded us that:

“[physicists] are not in the game alone ... [biologists] can help”

“physicists are not always as helpful as they might be ...”
(IPLS 2014)

So ... many exciting opportunities and challenges!