

Teaching Undergraduate Biomechanics

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100 years of living science

100

Mandate

The main goal of this workshop is to gather ideas about how best to teach and stimulate interest in biomechanics (or mechanobiology) among bioengineering students.

Date	Topic	Reference¹
Wed Jan 5	Introduction to Biomechanical Engineering, The Cell	2.1, 2.2
<u>Cellular Biomechanics</u>		
Friday Jan 7	The cytoskeleton: overview	2.3, 2.4
Wed Jan 12	Methods for measuring response of individual cells	2.5
Friday Jan 14	Lumped parameter model of the cell	2.6.1
Wed Jan 19	Tensegrity modelling of cellular biomechanics	2.6.2
Friday Jan 21	Actin filament modelling, Cellular biomechanics in whole tissue	2.6.3 – 2.8
<u>The Respiratory System</u>		
Wed Jan 26	Lung structure and function / Mechanics of breathing	7.1, 7.2, Lab
Friday Jan 28	Mechanics of breathing (continued)	7.3
Wed Feb 2	Alveolar mass transfer	7.4.1
Friday Feb 4	Overall mass balance	7.4.2
<u>The Circulatory System</u>		
Wed Feb 9	Blood rheology	3.1
Friday Feb 11	Steady flow in large vessels	3.3.2
Wed Feb 16	No class – Reading Week	-
Friday Feb 18	No class – Reading Week	-
Wed Feb 23	Unsteady flow in large vessels	3.2.3
Friday Feb 25	Flow in the microcirculation	3.3
Wed Mar 2	Arterial pulse propagation	4.3.1-4.3.3
Friday Mar 4	Arterial pulse propagation (continued)	4.3.4
Wed Mar 9	Arterial pulse propagation (continued)	4.3.5-4.3.6
Friday Mar 11	Capillaries and fluid transport	4.4
<u>The Musculoskeletal System</u>		
Wed Mar 16	Muscle structure, function and mechanics	9.1, 9.3.1
Friday Mar 18	Muscle/bone interactions	9.3.2
Wed Mar 23	Muscle/bone interactions (continued)	9.3.2
Friday Mar 25	Good Friday – no lecture	-
Wed Mar 30	Gait analysis	11.2
Friday April 1	Gait analysis (continued)	11.3
Wed Apr 6	Bone structure and function / Cortical bone mechanics	10.1, 10.2
Friday Apr 8	Trabecular bone mechanics / Bone fracture mechanics	10.3, 10.4

Outline

- Get students interested
- Keep students interested
 - What do effective teachers do?
 - Give them some practical experience (labs)

What Gets Students' Attention?

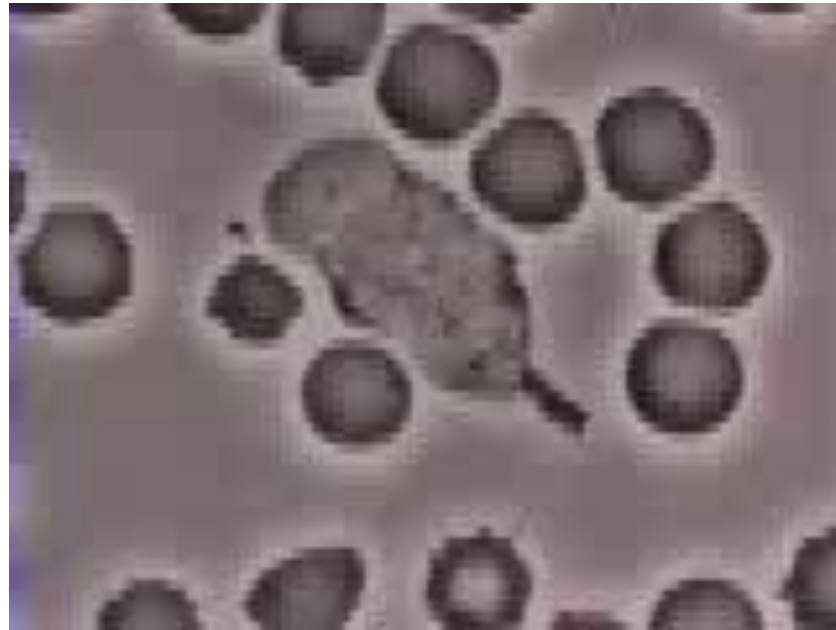


Movies!

A special note

- This slide was not shown during my talk at SBC2009.
- Some of the movies shown on the following slides are copyrighted.
- I have attributed each movie to its source as completely as possible.
- It is your responsibility to obtain permission if you plan to disseminate these movies for any purpose outside fair use provisions, see e.g. http://en.wikipedia.org/wiki/Fair_use

Neutrophil taxis/phagocytosis



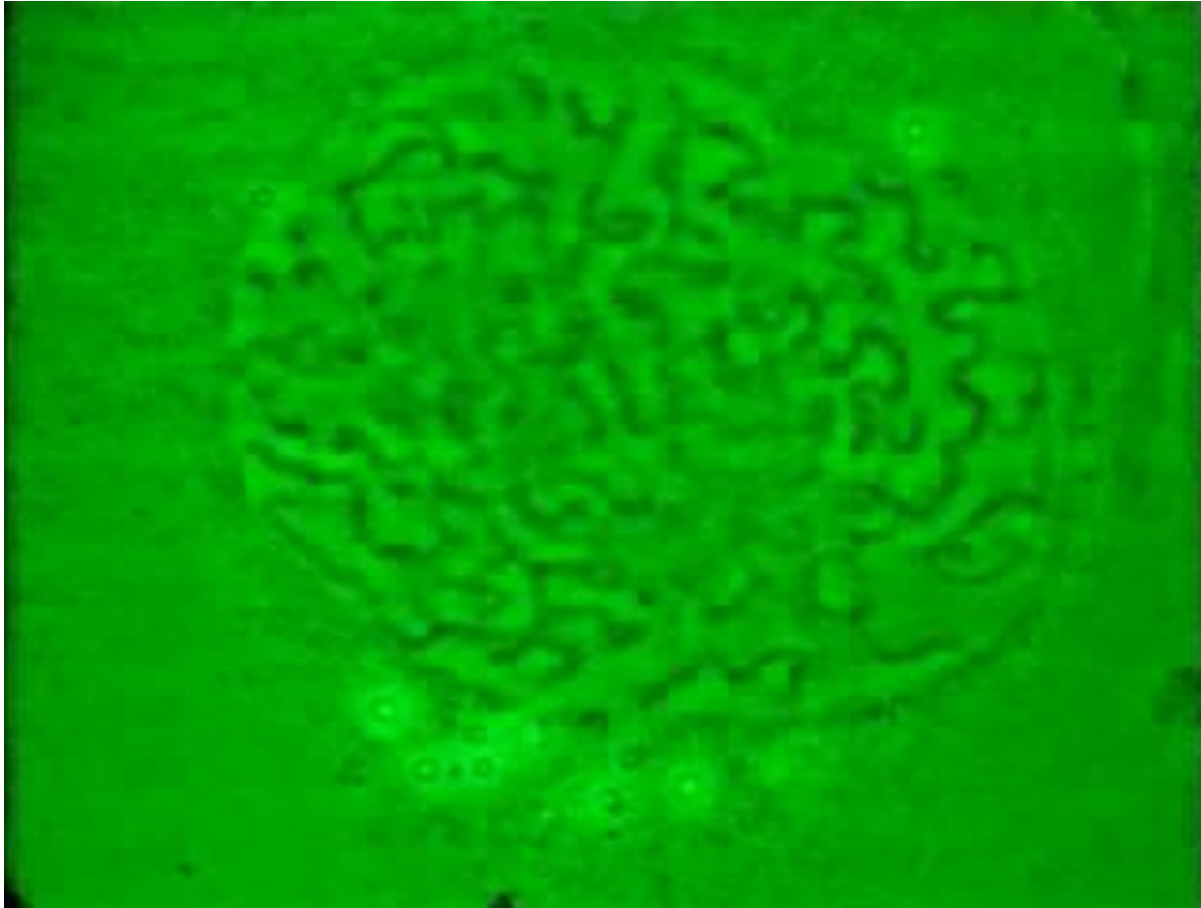
David Rogers, Vanderbilt U. Copyright uncertain: see <http://www.biochemweb.org/neutrophil.shtml>

Zebrafish embryo development



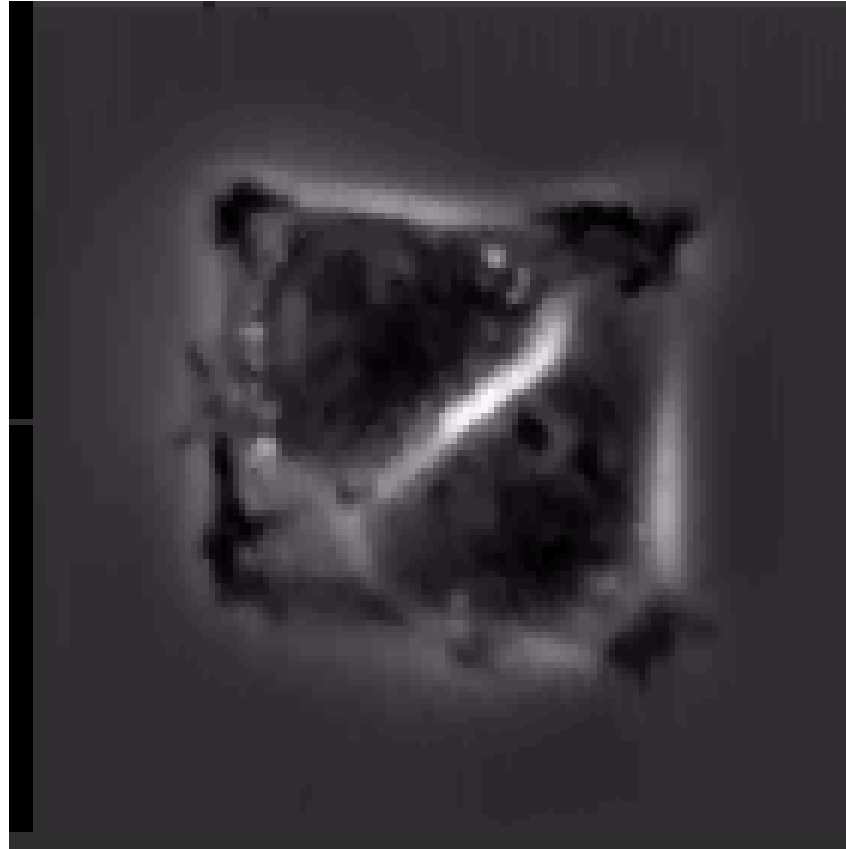
RO Karlstrom and DA Kane, A flipbook of zebrafish embryogenesis, *Development* (1996) 123:461. Usage: See <http://www.bio.umass.edu/biology/karlstrom/ZFFlipbooks.html>

Cell division



Lodish et al., Molecular Cell Biology, 4th edition, Chapter 19, WH Freeman and Co, 2000. ISBN 0-7167-3136-3. See http://www.whfreeman.com/lodish4e/con_index.htm?ggvos

Cell-cell interaction



Source: Don Ingber Lab, Harvard University. See <http://www.childrenshospital.org/research/ingber/movies.html>

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Bloom's Taxonomy

- A widely accepted method for classifying educational objectives.
- Ranks "learning" from least to most complex.

Level	Definition
1. Knowledge	Be able to recall basic facts, definitions and data.
2. Comprehension	Understand the meaning and interpretation of instructions and problems.
3. Application	Use a concept in a new situation or unprompted use of an abstraction.
4. Analysis	Separate material or concepts into components.
5. Synthesis	Build a structure or pattern from diverse elements.
6. Evaluation	Make judgments about the value of ideas or materials.

Bloom's Taxonomy - implications

- Lower levels are obtained as (or more) efficiently from independent reading, the internet, etc.
- Lecturers “add value” primarily at the higher levels of the taxonomy.
- How do we add value?
 - Get students interested in the material through our own enthusiasm.
 - Challenge/encourage them to think critically about the material - best done through dialogue.

Determinants of Effective Teaching

- What specific in-class teaching behaviours of university professors are correlated with high teacher ratings?
- Highly-rated instructors have been shown to produce more learning in students.

Murray HG (1991). Effective teaching behaviors in the college classroom. In JC Smart (Ed.), Higher education: Handbook of theory and research. Volume 7. Kluwer: New York.

Effective Teaching Study - Methods

- 48 lecturers selected: 16 “good”, 16 “average”, 16 “bad” (based on previous, consistent ratings on teacher evaluation forms).
- All lecturers were full-time faculty members in Social Science (UWO); had taught at least 5 undergraduate courses.
- Good/average/bad groups were matched for mean age, rank, class time of day, male/female ratio.
- Each teacher was observed 3 times (1 hr each) by each of 5-7 observers.

Effective Teaching Study - Methods

- Observers had taken an introductory course in each teacher's area, but had not previously had that particular teacher.
- Each observer rated each teacher on a 62-item questionnaire (e.g. "moves back and forth in front of class", etc), + "write-in" items.
- χ^2 test used to test for association between relative frequency of occurrence of specific in-class behaviours and past teacher ratings.

Effective Teaching Study - Results

- 53 different behaviours showed a statistically significant association with teacher ratings.
- The “Top 5” (all positively correlated with good ratings):
 - Speaks expressively.
 - Moves back and forth in front of class.
 - Tells jokes or anecdotes.
 - Enthusiastic.
 - Shows strong interest in subject matter.
- Note that all are “attention-getting” behaviours!!!

Effective Teaching Study - Results

Affect

- Excited
- Concerned
- Enthusiastic
- Nervous ☹️
- Agreeable
- Expressive
- Sad ☹️

Speech

- Speaks slowly ☹️
- Speaks softly ☹️
- Speaks expressively
- Voice fades periodically ☹️
- Speaks with excellent clarity
- Speaks in monotone ☹️
- Pauses frequently in mid-sentence ☹️

Effective Teaching Study - Results

Mannerisms

- Moves back and forth in front of class
- Exhibits distracting mannerisms ☹️
- Gestures with hands and arms
- Maintains eye contact with students
- Rocks or sways on heels ☹️
- Walks up aisles beside students
- Shows facial gestures or expressions

Organization

- Puts outline of lecture on blackboard
- Gives preliminary overview of lecture
- Provides detailed outline of course as a whole
- Covers very little material in class ☹️

Effective Teaching Study - Results

Interaction

- Solicits questions and comments from students
- Asks questions of students
- Praises students for good ideas
- Encourages class discussion
- Fails to take initiative in classroom interactions ☹️

Interest

- States own viewpoint on controversial issues
- Tells jokes or anecdotes
- Shows strong interest in subject
- Reads lecture from prepared notes ☹️
- Presents challenging, thought-provoking ideas

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Labs

- Microfluidics (Fahraeus-Lindqvist effect) –
see cml.mie.utoronto.ca/IntroductoryBiomechanics.html
- Gait Analysis (requires a local gait lab)
- Physical Fitness (exercise physiology)
- Pulmonary Function

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