Harnessing Life's Molecular Machines: From AIDS Tests to Hydrogen Cars – Fall '09

Meeting time: WF 3-4:15, 203A (or B) near Starbuck in the ZSR Library
Office hours: M 2-3:15 or anytime by appointment
Instructor: Jed Macosko (Olin 215, Telephone x4981, macoskjc@wfu.edu)
Textbook: The Machinery of Life, 2nd edition, 2009, Goodsell, David S. (Springer) available at the bookstore and by searching by title in the catalog (http://catalog.zsr.wfu.edu), and clicking on "EBL Electronic Book" next to View Linked Resource. You will need to login using your WFU login and password.

Grading: 100-93, A; 93-90, A-; 90-86, B+; 86-83, B; 83-80, B-; 80-76, C+; 76-73, C; etc.
40% papers, 30% presentations/projects, 12% tests, 10% quizzes, 8% blogs/teams/discussions

4 papers: 1) genetic code, protein folding, cellular architecture 2) molecular machines, 3) how to harness molecular machines, and 4) your reflections and plans
3 team presentations or projects (topics typically correspond to the first three papers)
3 tests on textbook/lectures (20 minutes to complete each one)
10 quizzes (5 minutes each) on students' presentations and instructor's lectures
3 or more opportunities to get discussion points (team points or blog points can also count)

Schedule of lectures, quizzes/test, papers and reading/video/blogging assignments:

Aug 26, Movie Time I, genetic code cards, colorful soccer balls, etc.
Reading (due on Aug 28): Preface and chapters 1-3 of textbook (50 pages)
Blogging (due Aug 28): What about molecular machines could save our economy?

Aug 28 Movie Time II: Voyage through the cell and through a glossary of terms
Reading (due on Sep 2): Chapters 4-6 of textbook (54 pages)
Video/Blogging (due Sep 2): Watch videos online*, blog thoughts about videos

* "walking machines" http://multimedia.mcb.harvard.edu/anim_innerlife.html
"cell voyage" http://v.blog.sina.com.cn/b/1429696-1275908237.html (Takes a while to launch)
a higher res version of the first 4 minutes is at http://www.youtube.com/watch?v=1B4F2V0_yYg
Note: the first movie, with music, can be watched at:
http://aimediaserver4.com/studiodaily/videoplayer/?src=ai4/harvard/harvard.swf&width=640&height=520
Team project (due Sep 2): finish definitions from sheet using text or internet

Sep 2 Molecular machines and their building block. Discussion: Are we just machines?
Reading (due Sep 4): Chps 7-9 (48 pages) and
http://www.zyvex.com/nanotech/feynman.html *
Blogging (due Sep 4): Continue the discussion about "are we just machines?"
Team points (**due Sep 4**): Answer "How do cells bury their proteins waist deep in membrane?"

***Prizes Offered by Richard Feynman**
A defining moment in the history of molecular-scale technology was a 1959 speech at the California Institute of Technology by Nobel Laureate physicist Dr. Richard P. Feynman. "There's Plenty of Room at the Bottom," he declared in his discussion of the possibilities of molecular-scale engineering. To spur work in that direction, he offered $1,000 prizes from his personal funds to the first person to construct a working electric motor 1/64 inch or less on a side, and to the first person to produce written text at 1/25,000 scale (the size required to print the entire *Encyclopedia Britannica* on the head of a pin).

The motor prize was claimed in 1960 by an engineer who found a way to construct a very small motor using conventional mechanical techniques. Dr. Feynman had unfortunately set the size limits slightly too large to require breakthrough technology. He paid anyway. The printing challenge took longer; but in 1985 a Stanford University graduate student named Thomas Newman reproduced the first page of Charles Dickens'

novel, *A Tale of Two Cities*, on a page measuring only 1/160 millimeter on a side (20 times smaller than the human eye can see), using electron beam lithography. Dr. Feynman paid that prize enthusiastically, since it had produced technological advance.

Sep 4 The physics of the really small. Discussion: How much can nanomachines do for us?
Take quiz 1 today about Feynman's talk, **whole textbook!** vocab definitions.
Reading (due Sep 9): re-read Chp 1 of textbook (and the preface)
Blogging (due Sep 9): review Chp 1 and answer, "will machines will ever have consciousness?"
Form teams and pick presentation topics (the outline is due in a week)
Opportunity for team points (due Sep 9): make a model of a peptide or of the genetic code
Sep 9 Harnessing molecular machines to create value. Discussion: are we our brothers' keepers?
Reading (due Sep 11): Chapter re-read Chp 2 of textbook
Blogging (due Sep 11): continue discussing our responsibility to developing countries

Sep 11 Library Presentation – How do we find good information about molecular machines?
Take test 1 today on Chapter 2 (amino acids, DNA bases, etc.) and first four lectures
Reading (due Sep 16): re-read Chp 3 of textbook
Blogging (due Sep 16): Write down your opinions of the BioBotz venture
Team points opportunity (due Sep 16): color your own genetic code!

Sep 16 Prof. Macosko's presentation – Good scientific writing
Outlines for 1st five-page paper and molecular machine presentation due
Reading (due Sep 18): re-read Chp 4 of textbook
Blogging (due Sep 18): Write down your opinions of Prof. Macosko's research and of cloning

Sep 18 BioBotz and CellCraft Presentation – teaching kids about molecular machines
Take quiz 2 today on Prof. Macosko's research, BioBotz, and Chapters 3-4
Reading (due Sep 23): re-read Chp 5 of textbook
Blogging (due Sep 23): Summarize reading/presentation

Sep 23 Prof. Macosko's lecture on The Machinery of Life, part I
Last day to give team members rough draft of 1st five-page paper for critiquing
Reading (due Sep 25): re-read Chp 6 of textbook
Blogging (due Sep 25): Summarize reading/presentations

Sep 25 Prof. Macosko's lecture – Kinesin and drug discovery
Reading (due Sep 30): re-read Chp 7 of textbook
Prof Macosko will hand back his critiques of the rough drafts today
Blogging (due Sep 30): Summarize reading/presentations

Sep 30 Prof. Macosko's lecture on The Machinery of Life, part II
Critiques due today, Give extra copy of critiques to Prof. Macosko today
Reading (due Oct 2): re-read Chp 8 of textbook

Blogging (due Oct 2): Summarize reading

Oct 2 Student Presentations – Team #1
Take quiz 3 today on Chapter 4-5
Reading (due Oct 7): re-read Chp 9 of textbook
Blogging (due Oct 7): Summarize reading/presentations

Oct 7 Student Presentations –Team #2
Reading (due Oct 9): Bionanotechnology (Front matter, Chp 1 and one chapter of your choice)
Blogging (due Oct 9): Summarize reading/presentations

Oct 9 Student Presentations – Team #3
1st Five-page paper due today, upload to blog
Take quiz 4 today on student presentations and Chapter 6
Reading (due Oct 14): Bionanotechnology (two chapters of your choice)
Blogging (due Oct 14): Write a review of The Machinery of Life, by Goodsell, post to Amazon
Oct 14 Introduction to entrepreneurship (guest lecture TBA)
Take test 2 today on textbook and molecular machines
Reading (due Oct 21): 12 molecules from "Molecule of the Month" (2000)
Outlines for 2nd five-page paper and 2nd presentation due today
Blogging (due Oct 21): Write down your thoughts about the guest speaker

Oct 21 Special lecture – TBA
Last day to give team members rough draft of 2nd five-page paper for critiquing
Team points opportunity (due Oct 23): color your own peptide genetic wheel!
Reading (due Oct 23): 12 molecules from "Molecule of the month" (2001)
Blogging (due Oct 23): What is your favorite molecule so far?

Oct 23 Prof. Macosko Presentation – How to start something while still in college
Critiques due today
Reading (due Oct 28): 12 molecules from "Molecule of the month" (2002)
Blogging (due Oct 28): Summarize reading/presentations

Oct 28 Student Presentations round 2 – Team #3
Take quiz 5 today on Profs. Kuhn and Macosko's presentations and Molecules from 2000-02
2nd five-page paper due today, upload to blog
Reading (due Oct 30): 12 molecules from "Molecule of the month" (2003)
Blogging (due Oct 30): Summarize reading/presentations

Oct 30 Student Presentations round 2 – Team #1
Reading (due Nov 4): 12 molecules from "Molecule of the month" (2004)
Blogging (due Nov 4): Summarize reading/presentations

Nov 4 Student Presentations round 2 – Team #2
Outlines for 3rd five-page paper and presentation due today
Reading (due Nov 6): 12 molecules from "Molecule of the month" (2005)
Blogging (due Nov 6): Summarize reading/presentations

Nov 6 Field trip to Atkins High
Take quiz 6 today on student presentations (teams 1 & 2) and Molecules from 2002-2005
Reading (due Nov 11): 12 molecules from "Molecule of the month" (2006)
Blogging (due Nov 11): Summarize reading/presentations

Nov 11 Prof. Macosko Presentation – Obstacles to entrepreneurship
Take quiz 7 today on student presentation (team 3) and Molecules from 2006-2007
Last day to give team members rough draft of 3rd five-page paper for critiquing
Reading (due Nov 13): 12 molecules from "Molecule of the month" (2007)
Blogging (due Nov 13): Summarize reading/presentation

Nov 13 Prof. Macosko Presentation – TBA
Critiques due today
Reading (due Nov 18): 12 molecules from "M-of-M" (2008)
Blogging (due Nov 18): Summarize reading/presentations

Nov 18 Student Presentations round 3 – Team #2
3rd five-page paper due today, upload to blog
Take quiz 8 today on *all* molecules of the month
Reading (due Nov 20): 12 from "M-of-M" (2009)
Blogging (due Nov 20): Summarize reading/presentations

Nov 20 Student Presentations round 3 – Team #3
Take quiz 9 today on key class concepts and team #2's presentation
Outline for 4th five-page paper due today
Reading (due Dec 2): 10 from PSI Features (2008)
Blogging (due Dec 2): Summarize reading/presentations

Dec 2 Student Presentations round 3 – Team #1
Take test 3 today on the five components of this class: science, student presentations, discussions, guest lectures, and outside reading/video
Blogging (due Dec 4): Summarize reading/presentations
Reading (due Dec 4): 10 from PSI features (2008)

Dec 4 Summary: What have we learned and what will we do?
Last day to give team members rough draft of 4th five-page paper for critiquing
Take quiz 10 today on last two student presentations and on Prof. Macosko's lectures
Blogging (due Dec 7): Write down your thoughts about the things we've learned this semester

Dec 7
Email critiques to Prof. Macosko and team members
Blog about your class experience (due Dec 11)

Dec 11. Final five-page paper due today, upload to blog

#	Molecule of the Month
1	Myoglobin
2	Bacteriophage phiX174
3	DNA Polymerase
4	Collagen
5	Cytochrome c Oxidase
6	HIV-1 Protease
7	Nucleosome
8	Restriction Enzymes
9	Lysozyme
10	Ribosome
11	Rubisco
12	Pepsin
13	Alcohol Dehydrogenase
14	Insulin
15	Transfer RNA
16	Aminoacyl-tRNA Synthetases
17	Cyclooxygenase
18	Myosin
19	Actin
20	Poliovirus and Rhinovirus
21	Antibodies
22	Photosystem I
23	DNA
24	Glycogen Phosphorylase
25	Thrombin
26	Nitrogenase
27	Bacteriorhodopsin
28	Anthrax Toxin
29	Penicillin-binding Proteins
30	Glutamine Synthetase
31	p53 Tumor Suppressor

32	Chaperones
33	Reverse Transcriptase
34	Dihydrofolate Reductase
35	Ferritin and Transferrin
36	Cytochrome c
37	Serum Albumin
38	Potassium Channels
39	lac Repressor
40	RNA Polymerase
41	Hemoglobin
42	Green Fluorescent Protein (GFP)
43	Src Tyrosine Kinase
44	Calmodulin
45	Estrogen Receptor
46	Trypsin
47	Simian Virus 40
48	Catabolite Activator Protein
49	Carbonic Anhydrase
50	The Glycolytic Enzymes
51	The Calcium Pump
52	Growth Hormone
53	Serpins
54	Acetylcholinesterase
55	DNA Ligase
56	Caspases
57	Catalase
58	G Proteins
59	Photosystem II
60	Ubiquitin
61	Phenylalanine Hydroxylase
62	Major Histocompatibility Complex
63	T-Cell Receptor
64	Kinesin
65	Self-splicing RNA
66	Carotenoid Oxygenase
67	TATA-Binding Protein
68	Neurotrophins

69	Cholera Toxin
70	Designer Proteins
71	Acetylcholine Receptor
72	ATP Synthase
73	Topoisomerases
74	Alpha Amylase
75	Tissue Factor
76	Hemagglutinin
77	Glucose Oxidase
78	Luciferase
79	Amyloid-beta Precursor Protein
80	AAA+ Proteases
81	Elongation Factors
82	Cytochrome p450
83	Fibrin
84	Transposase
85	Importins
86	Exosomes
87	Zinc Fingers
88	Clathrin
89	Aconitase and Iron Regulatory Protein 1
90	Fatty Acid Synthase
91	Thymine Dimers
92	Anabolic Steroids
93	Citrate Synthase
94	Superoxide Dismutase
95	Multidrug Resistance Transporters
96	Oxidosqualene Cyclase
97	Circadian Clock Proteins
98	Small Interfering RNA
99	Cadherin
100	Adrenergic Receptors
101	Prions
102	Lactate Dehydrogenase
103	Dengue Virus
104	Selenocysteine Synthase
105	Ribonuclease A

106	Poly(A) Polymerase
107	Mechanosensitive Channels
108	Hsp90
109	Tobacco Mosaic Virus
110	Auxin and TIR1 Ubiquitin Ligase
111	Hydrogenase
112	Oct and Sox Transcription Factors
113	Influenza Neuraminidase
114	Vaults
115	beta-Secretase
116	Sulfotransferases

2009 PSI
Toxin-antitoxin VapBC-5
Salicylic Acid Binding Protein 2
Lysostaphin
Hda and DNA Replication
Bacterial Leucine Transporter, LeuT
Ribonuclease and Ribonuclease Inhibitor
Aquaglyceroporin
CBS Domain Protein TA0289

2008 PSI
Imidazolonepropionase (HutI)
Scavenger Decapping Enzyme DcpS
Bacteriophage Lambda cII Protein
T-Rex
Aspartate Dehydrogenase
RNase T
SARS Coronavirus Nonstructural Protein 1
Chronophin
Cofactor F420 Synthesis
Glycerate Kinase

Truth, Reality, and Objectivity: Philosophical Themes in Physics

A First Year Seminar

Tuesdays and Thursdays 9:30 to 10:45 in Tribble A307 PM

Instructors

Ralph Kennedy
Department of Philosophy
Room B307 Tribble Hall

758-5747

Office hours: W 2:00 - 3:00 PM

kennedy@wfu.edu

Daniel Kim-Shapiro
Department of Physics
Room 208 Olin Physical Lab

758-4993

Office hours: T 3:00 - 4:00 PM

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In addition to our regular individual office hours, we will hold a joint office hour each Friday from 4:30 to 5:30 PM in Shorty's or Starbucks.

Pandemic Plan

Synopsis

Is all truth relative, contingent on social and historical factors? Does it make sense to speak of what is "real", independently of what anybody says or thinks? Is objectivity ever a reasonable goal? We will consider these philosophical questions with reference to natural science generally and quantum mechanics in particular, a field which poses acute challenges for traditional understandings of reality and objectivity.

Blackboard

Go to Blackboard page

Texts

Philosophy of Natural Science, by C.G. Hempel
The Structure of Scientific Revolutions, by T.S. Kuhn
Philosophical Concepts in Physics, by J. T. Cushing
Quantum Reality, by N. Herbert

Grading

Pre-class write-ups[1]	10%
Class Participation/On-line Discussion[2]	20%
Midterm (10/15)	10%
3 or 4 short papers[3]	40%
Final (12/9 at 9 AM)	20%

1. For each section, each student will have to come prepared with written answers to the discussion questions. The write-ups need not be wordy. They only need to provide information that can be used to help answer the questions during the discussions.

Students will be expected to e-mail writeups or hand in photocopied versions of these write-ups in the beginning of each class that begins a new section.

2. Questions used for writeups, in-class discussion, and exams will be posted under course documents. You should prepare for class discussion by making notes of your answers to these questions. The number of times you participate in class will be recorded and some assessment of the quality of your participation will also be noted. Each student will be expected to lead in-class discussions on a rotating basis. The discussion leader will be expeted to meet with an instructor prior to class to make sure that (s)he has prepared properly. The discussion leader is welcome to prepare additioal questions to those posted by the instructors on course info. Through Blackboard - communication - discussion board you can post and respond to questions and comments. Your class participation grade will be based mainly on your participation in the classroom but your participation in the discussion board can help improve your grade.

3. You will do 3 or 4 short papers. The topics and due dates will be posted under Blackboard - assignments. Your final grade on the papers will be the highest of the following three schemes:

Plan a

Paper #	**Weight**	**Length**
1	5%	<200 words
2	5%	about 500 words
3	15%	about 1000 words
4	15%	about 1000 words

Plan b

Paper #	**Weight**	**Length**
1	8%	<200 words
2	8%	about 500 words
3	24%	about 1000 words

Plan c

Paper #	**Weight**	**Length**
1	8%	<200 words
2	8%	about 500 words
4	24%	about 1000 words