WHAT IS BIOPHYSICS 2018?

Andrea Giansanti
Dipartimento di Fisica, Sapienza Università di Roma

Andrea.Giansanti@roma1.infn.it

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DIPARTIMENTO DI FISICA

SAPIENZA
UNIVERSITÀ DI ROMA

What is biophysics

- http://www.biophysics.org/Education/WhatisBiophysics/tabid/2287/Default.aspx

DEDICATION TO:

Previous dedicatees: Umberto Eco, James Cameron, Anna Tramontano

This year dedicatee: Prof. Enrico Gratton UCI

https://www.lfd.uci.edu/~gratton/

Outline of the 2018 course

We basically follow the track of the 2017 course with something new: The structure will be 4-partite: F-facts, C-concepts, A-arguments, T-echniques

- Probabilistic modelling (A, T)
- Biology by the numbers (F)
- Molecular structure (proteins)
- Techniques (x-rays, NMR, Cryo EM)
- Enzyme kinetics
- Biology of superresolution
- Machine learning and evolution

What is biophysics?

www.biophysics.org (the standard bla bla: critical reading of. Q Is it Convincing?)

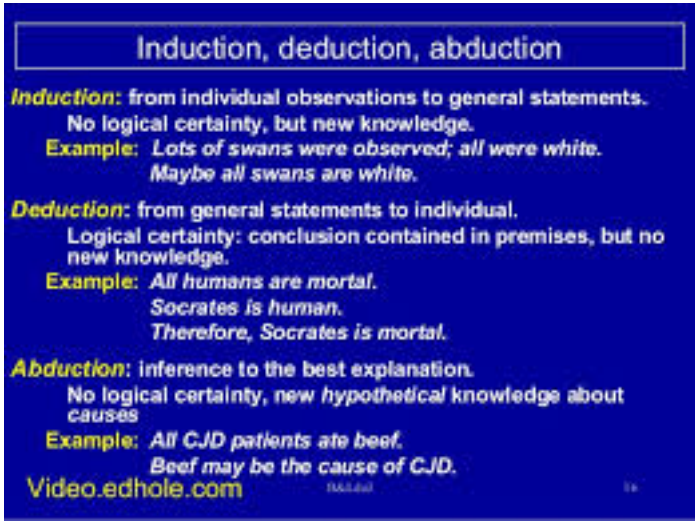
STYLES

Physical Biology vs Biological Physics

Biology (wet) /Physics (dry) (readings)

Single cases – abduction – general statement

Principles (models) – deduction – prediction of single cases



PRIMA LETTURA: OVVERO FISICA E BIOLOGIA

Mattia era concentrato sul suo lavoro e non alzava gli occhi da almeno un quarto d'ora. Non gli piaceva la biologia, ma stava svolgendo il compito con lo stesso rigore che dedicava a tutte le discipline. La materia organica, così violabile e piena di imperfezioni, gli risultava incomprensibile. L'odore vitale che quel pezzo di carne molliccia si ostinava a emanare non suscitava in lui nient'altro che un lieve fastidio.

Con un paio di pinzette estrasse un sottile filamento bianco e lo depose sul vetrino. Avvicinò gli occhi al microscopio e aggiustò la messa a fuoco. Sul quaderno a quadretti prese nota di ogni particolare e fece uno schizzo dell'immagine ingrandita.

Da: Paolo Giordano, *La solitudine dei numeri primi*, Mondadori 2008, p.59.

“Mattia was intent on his work and hadn't looked up for at least a quarter of an hour. He didn't like biology, but he pursued the task with the same rigor he applied to all subjects. Organic matter, so violable and full of imperfections, was incomprehensible to him. The vital odor of the soft piece of meat aroused nothing in him but a faint disgust.

With a pair of tweezers he extracted a thin white filament and deposited it on the glass slide. He brought his eyes to the microscope and adjusted the focus. He recorded every detail in his squared notebook and made a sketch of the enlarged image.

”

Excerpt From: Paolo Giordano. “The Solitude of Prime Numbers.”

SECONDA LETTURA: LA RIMOZIONE GALILEIANA DELL'ANIMALE

Per tanto io dico che ben sento tirarmi dalla necessità, subito che concepisco una materia o sostanza corporea, a concepire insieme ch'ella è terminata e figurata di questa o di quella figura, ch'ella in relazione ad altre è grande o piccola, ch'ella è in questo o quel luogo, in questo o quel tempo, ch'ella si muove o sta ferma, ch'ella tocca o non tocca un altro corpo, ch'ella è una, poche o molte, né per veruna imaginazione posso separarla da queste condizioni; ma ch'ella debba essere bianca o rossa, amara o dolce, sonora o muta, di grato o ingrato odore, non sento farmi forza alla mente di doverla apprendere da cotali condizioni necessariamente accompagnata: anzi, se i sensi non ci fussero scorta, forse il discorso o l'imaginazione per se stessa non v'arriverebbe già mai. Per lo che vo io pensando che questi sapori, odori, colori, etc., per la parte del suggetto nel quale ci par che riseggano, non sieno altro che puri nomi, ma tengano solamente lor residenza nel corpo sensitivo, sì che rimosso l'animale, sieno levate ed annichilate tutte queste qualità;

[...] Ma che ne' corpi esterni, per eccitare in noi i sapori, gli odori e i suoni, si richiegga altro che grandezze, figure, moltitudini e movimenti tardi o veloci, io non lo credo; e stimo che, tolti via gli orecchi le lingue e i nasi, restino bene le figure i numeri e i moti, ma non già gli odori né i sapori né i suoni, li quali fuor dell'animal vivente non credo che sieno altro che nomi, come a punto altro che nome non è il solletico e la titillazione, rimosse l'ascelle e la pelle intorno al naso [...]

G. Galilei, Il Saggiatore, cap. 47. In varie edizioni.

Therefore I say that upon conceiving of a material or corporeal substance, I immediately feel the need to conceive simultaneously that it is bounded and has this or that shape; that it is in this place or that at any given time; that it moves or stays still; that it does or does not touch another body; and that it is one, few, or many. I cannot separate it from these conditions by any stretch of my imagination. But that it must be white or red, bitter or sweet, noisy or silent, of sweet or foul odor, my mind feel no compulsion to understand as necessary accompaniment. Indeed, without the senses to guide us, reason or imagination alone would perhaps never arrive at such qualities. For that reason, I think that tastes, odors, colors, and so forth are no more than mere names so far as pertains to the subject wherein they reside, and that they have their habitation only in the sensorium. Thus, if the living creature were removed, all these qualities would be removed and annihilated. [. . .]

> *[. . .] I do not believe that, for exciting in us tastes, odors, and sounds there are required in external bodies anything but sizes, shapes, numbers, and slow or fast movements; and I think that if ears, tongues, and noses were taken away, shapes and numbers and motions would remain but not odors or tastes or sounds. These, I believe, are nothing but names, apart from the living animal—just as tickling and titillation are nothing but names when armpits and the skin around the nose are absent [. . .]*

- The galilean paradigm: based on the “removal of the animal”
- What is physics: the study of material bodies, localized in space and time
- Reference frames + clocks (newtonian time, not percolating, it uniformly flows, always at the same rate
- Biology is based on the careful observation of single cases, then correlated in a qualitative way, based on senses, into classes (classification) (e.g. species)
- The darwinian shift biological time vs physical time
- The molecular revolution (Watson & Crick) Macroscopic genetic laws can be explained by looking at molecular materials

Phylogenetic trees: evolutionary vs newtonian time

(A)

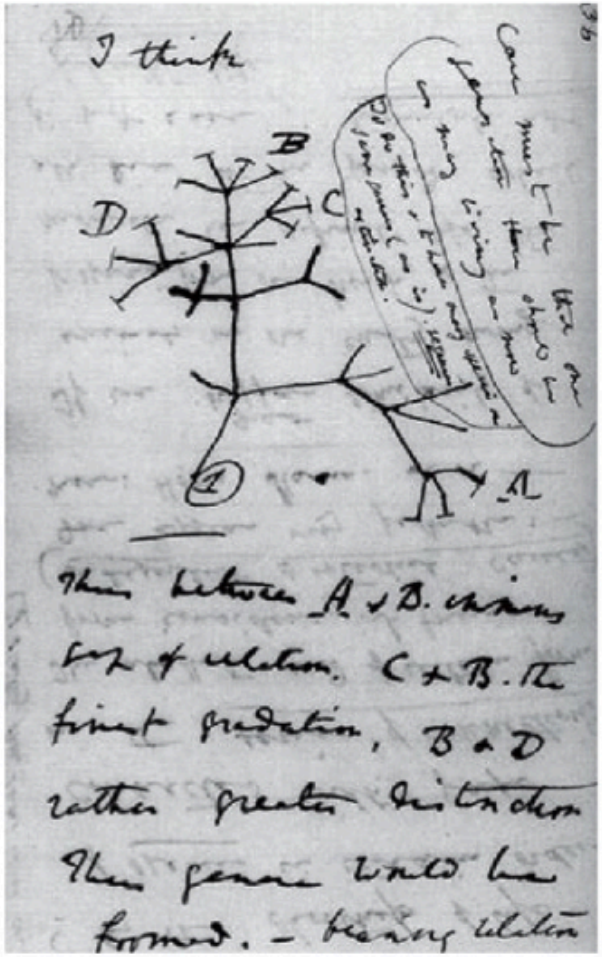


Figure 3.4 Physical Biology of the Cell (© Garland Science 2009)

(B)

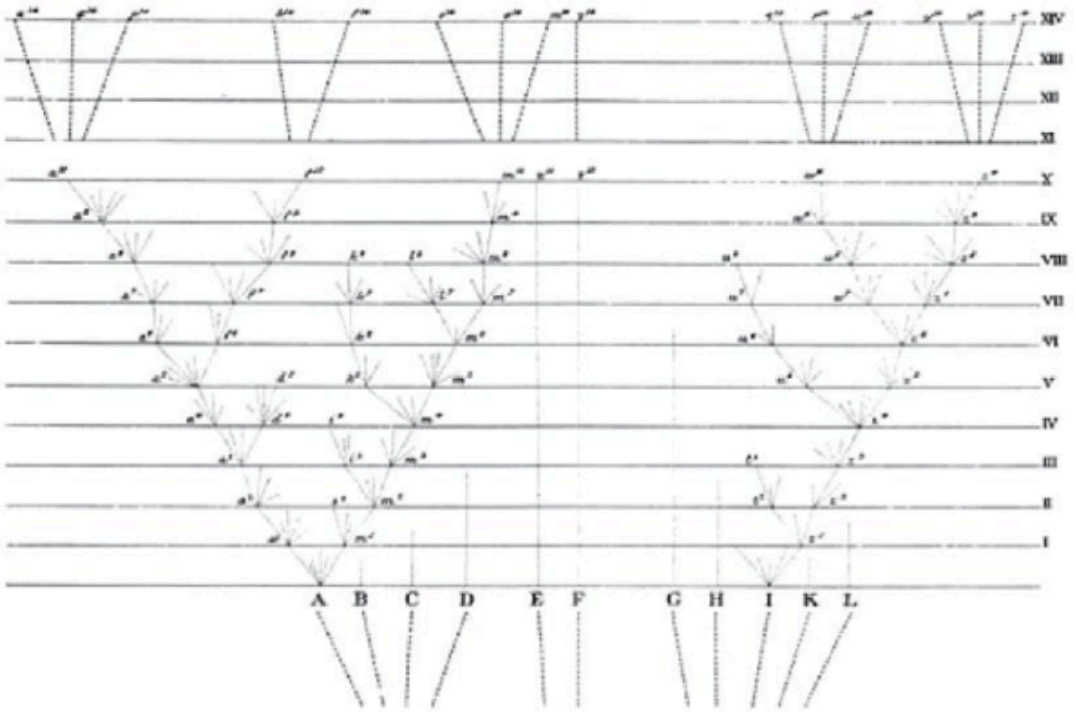


Figure 3.4 Two versions of Darwin's phylogenetic tree. (A) In his notebooks, Darwin drew the first version of what we now recognize as a common schematic demonstrating the relatedness of organisms. He introduced this speculative sketch with the words "I think" as his theory was beginning to take form. (B) In the final published version of *On the Origin of Species*, the tree had assumed more detail showing the passage of time and explicitly indicating that most species have gone extinct. (Adapted from C. Darwin, *On the Origin of Species*, London, John Murray, 1859. Courtesy of The American Museum of Natural History.)

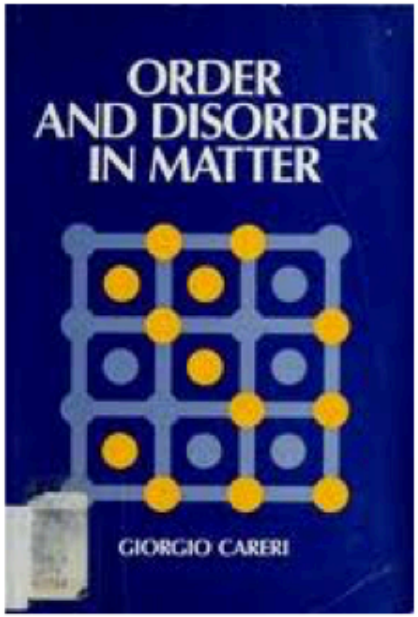
A basic critical distinction when reading the leaflet of the Biophysical Society:

Physics of Living systems (cell biophysics, integrative biophysics, systems biology)

Physics of parts of living systems (molecular biology/biophysics, Biomaterials, biophysical chemistry, in vitro, diluted solutions single molecule experiments)

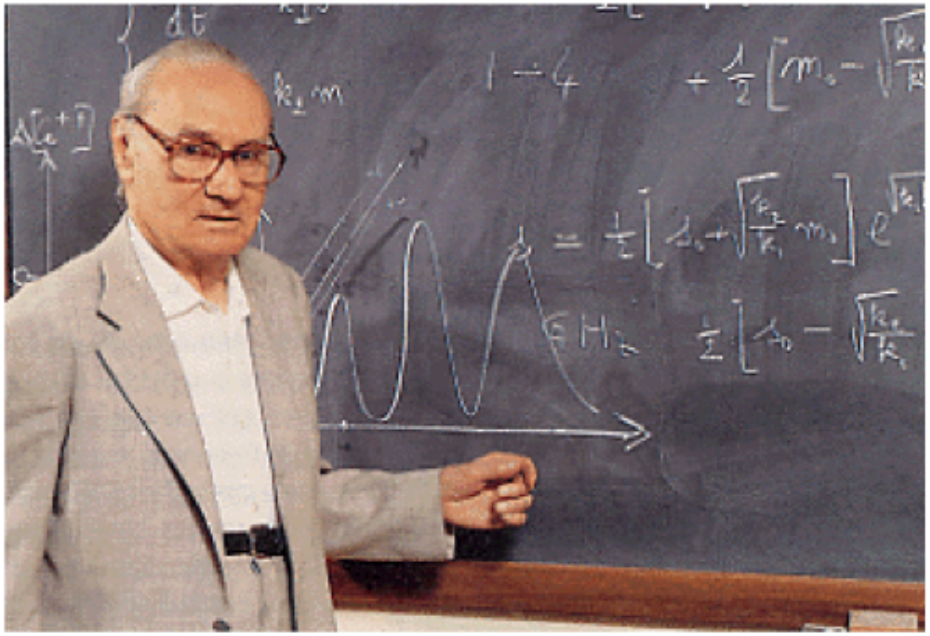
TWO DISTINGUISHED ROMAN SCHOOLS OF BIOPHYSICS

molecular biophysics / biophysical chemistry / molecular biology/critical phenomena/ superfluids/ superconductors



Giorgio Careri 1922-2008

Evolutionary biology/cell biophysics/ integrative biophysics/systems biology



Mario Ageno 1915-1992