A Tale of Two Papers

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James Frederic Danielli (1911 - 1984)

- Davson-Danielli model for cell membrane
- Established the Center for Theoretical Biology, SUNY/Buffalo
- Founding Editor of:
  - Journal of Theoretical Biology
  - International Review of Cytology
- My boss, along with Robert Rosen and Conrad Waddington, 1969-1972

Two Papers Were Announced at the Same Press Conference in Buffalo, New York in 1970

- A: Jeon, K.W., I.J. Lorch & J.F. Danielli (1970). Reassembly of living cells from dissociated components. *Science* ***167***, 1626-1627***.***
- B: Gordon, R., R. Bender & G.T. Herman (1970). Algebraic reconstruction techniques (ART) for three-dimensional electron microscopy and x-ray photography. *J. Theor. Biol.* ***29***(3), 471-481***.***

News Reports Touted:

- A: Synthesis of Life!
- B: Reconstruction from Projections!
  - (A mouthful: the phrase Computed Tomography had not yet been coined.)

Newspapers Reports

- A: Went around the world
- “tried to construct an artificial ‘cell‘”
  - http://en.wikipedia.org/wiki/James_Danielli
- B: Only reported in the local Buffalo newspaper

Citations to Date (ISI)

- A: 18 citations
- B: 710 citations

Abstract of A

- Combining the techniques of nuclear transplantation and cytoplasmic transfer, dissociated amoeba nuclei, cytoplasm, and membranes were reassembled to form viable amoebae. The techniques of cell reassembly appear to be sufficiently adequate so that any desired combination of cytoplasm, nucleus, and membrane can be assembled into living cells.

Abstract of B

- We give a new method for direct reconstruction of three-dimensional objects from a few electron micrographs taken at angles which need not exceed a range of 60 degrees. The method works for totally asymmetric objects, and requires little computer time or storage. It is also applicable to X-ray photography, and may greatly reduce the exposure compared to current methods of body-section radiography.

Venter: Not listed yet in ISI:

- Gibson, D.G., J.I. Glass, C. Lartigue, V.N. Noskov, R.-Y. Chuang, M.A. Algire, G.A. Benders, M.G. Montague, L. Ma, M.M. Moodie, C. Merryman, S. Vashee, R. Krishnakumar, N. Assad-Garcia, C. Andrews-Pfannkoch, E.A. Denisova, L. Young, Z.-Q. Qi, T.H. Segall-Shapiro, C.H. Calvey, P.P. Parmar, C.A.H. III, H.O. Smith & J.C. Venter (2010). Creation of a bacterial cell controlled by a chemically synthesized genome. *Science, 10.1126/science.1190719.*
- *(as of June 30, 2010)*

Abstract from Venter's Group

- We report the design, synthesis and assembly of the 1.08-Mbp *Mycoplasma mycoides* JCVI-syn1.0 genome starting from digitized genome sequence information and its transplantation into a *Mycoplasma capricolum* recipient cell to create new *Mycoplasma mycoides* cells that are controlled only by the synthetic chromosome. The only DNA in the cells is the designed synthetic DNA sequence, including "watermark" sequences and other designed gene deletions and polymorphisms, and mutations acquired during the building process. The new cells have expected phenotypic properties and are capable of continuous self-replication.

Danielli's Prediction

- There "…will be a considerable effort to synthesize new genes and to incorporate these genes into chromosomes or other cellular organelles. As this goal is achieved, biology also must develop a technic for adding these synthetic chromosomes to living cells. When this has been done, it will be feasible to transfer both synthetic and natural genes into a considerable variety of organisms."
- Danielli, J.F. (1972). Context and future of cell synthesis. *N Y State J Med* ***72***(22), 2814-2815.

Perspective

- Synthesis of the first complete gene, a yeast tRNA, was demonstrated by Har Gobind Khorana and coworkers in 1972.
- Synthesis of the first peptide- and protein-coding genes was performed in the laboratories of Herbert Boyer and Alexander Markham, respectively.
- http://en.wikipedia.org/wiki/Artificial_gene_synthesis

First synthesis of a complete gene

- Khorana, H.G., K.L. Agarwal, H. Buchi, M.H. Caruthers, N.K. Gupta, K. Kleppe, A. Kumar, E. Otsuka, U.L. RajBhandary, J.H. Van de Sande, V. Sgaramella, T. Terao, H. Weber & T. Yamada (1972). Studies on polynucleotides. 103. Total synthesis of the structural gene for an alanine transfer ribonucleic acid from yeast. *J Mol Biol* ***72***(2), 209-217.

First synthesis of peptide gene

- Itakura, K., T. Hirose, R. Crea, A.D. Riggs, H.L. Heyneker, F. Bolivar & H.W. Boyer (1977). Expression in *Escherichia coli* of a chemically synthesized gene for the hormone somatostatin. *Science* ***198***(4321), 1056-1063**.**

First Synthesis of Protein Gene

- Edge, M.D., A.R. Green, G.R. Heathcliffe, P.A. Meacock, W. Schuch, D.B. Scanlon, T.C. Atkinson, C.R. Newton & A.F. Markham (1981). Total synthesis of a human leukocyte interferon gene. *Nature* ***292***(5825), 756-762**.**

First synthesis of a virus

- Cello, J., A.V. Paul & E. Wimmer (2002). Chemical synthesis of poliovirus cDNA: generation of infectious virus in the absence of natural template. *Science* ***297***(5583), 1016-1018.

Summary

- Danielli “created life” by reassembling major components
- Khorana and others synthesized genes & viruses
- Venter stripped down a genome to a perhaps minimal set, and synthesized it
- When combined with other intact components, it worked, so he too “synthesized life”
- Those other cell components have yet to be synthesized

Next Challenge

- Just, Ernest E.* (1939). *The Biology of the Cell Surface*. Philadelphia, Blakiston.
- i.e., it's not all in the nucleus and we have much work ahead of us
- *Manning, K.R. (1983). *Black Apollo of Science. The Life of Ernest Everett Just. New York, Oxford University Press.*