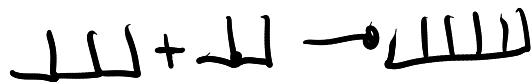
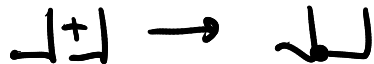


A: Fundamentals of Life

- Definition of Life
- Logic of Molecular Biology
- History of Biology
- Becoming alive
- Soup of Life
- Selection: before and in life
- Three faces of Entropy
- Death and equilibrium
- Missing non-equilibrium
- Structure of Origin of Life
- Modes of non-equilibrium
- Examples of evolution



B: Physics for Chemistry

Polymerization

- Theory of polymerization
- P. by fast cooling
- P. by stacking with 3'-5'-Ph.
- Activation groups
- P. on clay
- P. by thermophoresis
- Phase transitions with DNA
- Sedimentation of DNA
- Drying and its problems
- Elegance of air interface

Replication

- Templated polymerization
- Ligation
- Strand separation problem
- PCR in convection
- Ribo-PCR in convection

C: Evolution Machines

Replication with accumulation

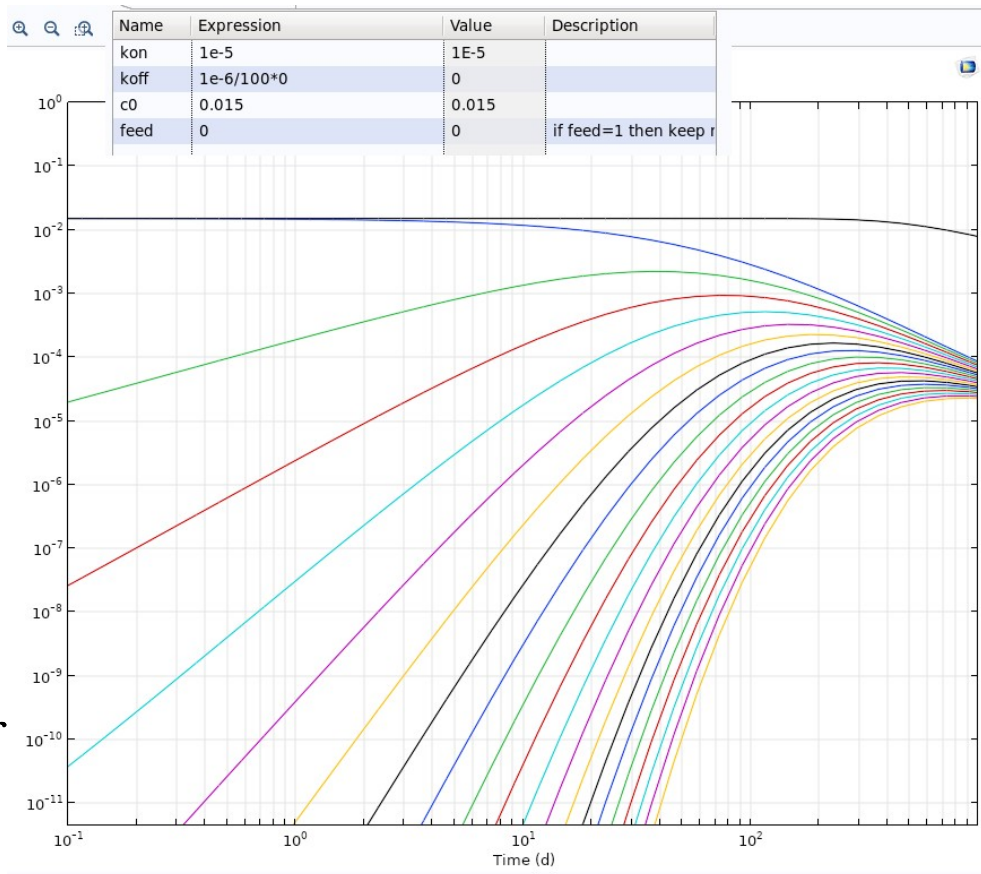
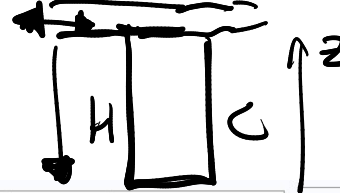
- Case of Ribo-PCR
- Spiegelman problem
- Case of trapped PCR
- Trapped PCR with flow
- Feeding problem
- Replication with heated tRNA
- Replication in driven Fog

Robustness of evolution

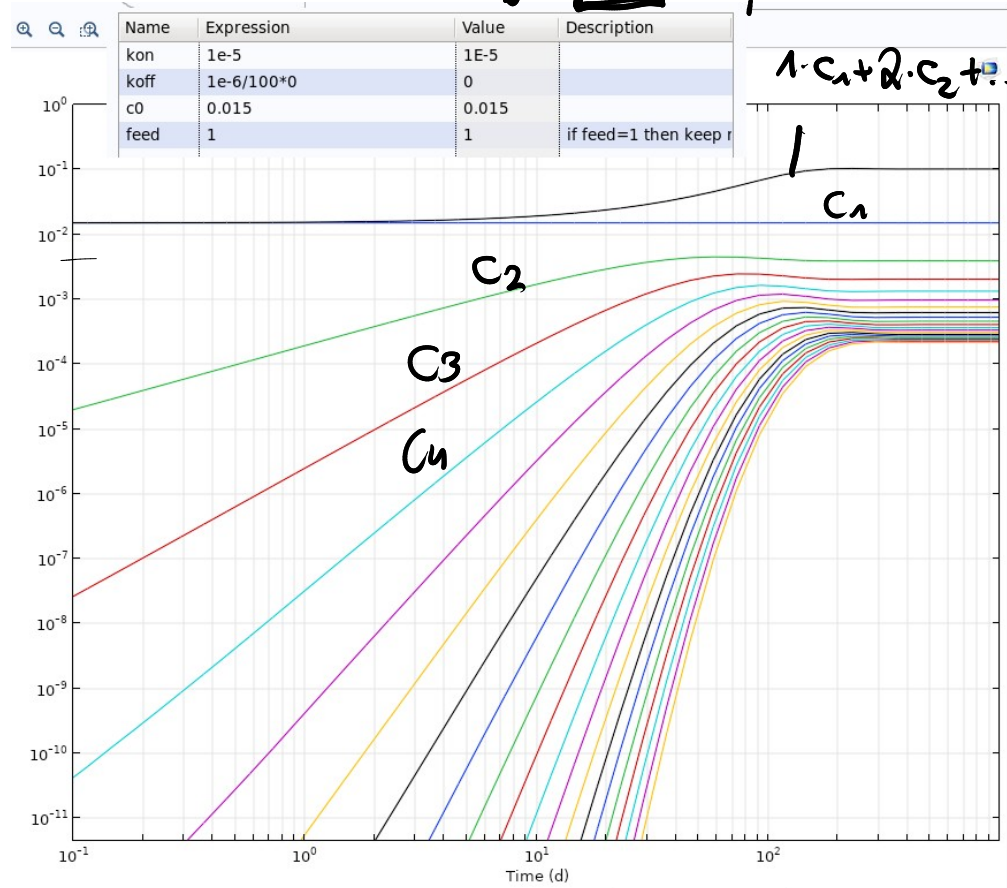
- Error threshold
- Instability of four bases
- Hypercycles with ligation
- Spont. Symmetry breaking
- Spont. sequence selection
- Cooperation within cells

Theory of polymerization

$$\frac{d}{dt} A_2 = \underbrace{k_{on}}_{\text{kon}} \cdot A \cdot A$$



Comsol no feeding of monomers



Comsol with feeding of monomers

Theory of polymerization

Kinetics_system_generator_2.0.vi Front Panel

File Edit View Project Operate Tools Window Help

15pt Application Font

of Monomers: 20

Rate equation system

Conc. string: c

Kon String: kon

Koff String 2: koff

Not only Monomer addition

Add time derivative for Consol ODE

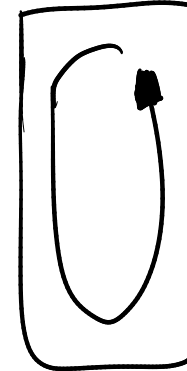
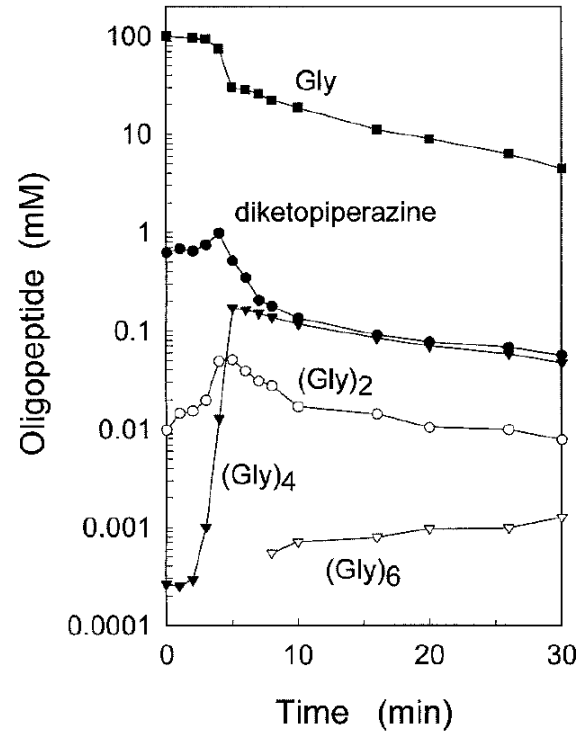
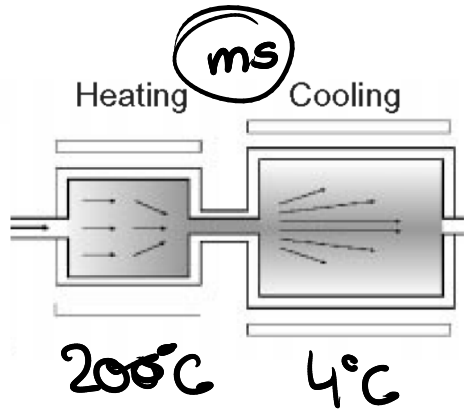
Open end (have off-rates for last term)

```
-c1t-2*kon*c1*c1-2*kon*c1*c2-2*kon*c1*c3-2*kon*c1*c4-2*kon*c1*c5-2*kon*c1*c6-2*kon*c1*c7-2*kon*c1*c8-2*kon*c1*c9-2*kon*c1*c10-2*kon*c1*c11-2*kon*c1*c12-2*kon*c1*c13-2*kon*c1*c14-2*kon*c1*c15-2*kon*c1*c16-2*kon*c1*c17-2*kon*c1*c18-2*kon*c1*c19-2*kon*c1*c20+
-c2t+1*kon*c1*c1-2*kon*c2*c1-2*kon*c2*c2-2*kon*c2*c3-2*kon*c2*c4-2*kon*c2*c5-2*kon*c2*c6-2*kon*c2*c7-2*kon*c2*c8-2*kon*c2*c9-2*kon*c2*c10-2*kon*c2*c11-2*kon*c2*c12-2*kon*c2*c13-2*kon*c2*c14-2*kon*c2*c15-2*kon*c2*c16-2*kon*c2*c17-2*kon*c2*c18-2*kon*c2*c19-
-c3t+2*kon*c1*c2-2*kon*c3*c1-2*kon*c3*c2-2*kon*c3*c3-2*kon*c3*c4-2*kon*c3*c5-2*kon*c3*c6-2*kon*c3*c7-2*kon*c3*c8-2*kon*c3*c9-2*kon*c3*c10-2*kon*c3*c11-2*kon*c3*c12-2*kon*c3*c13-2*kon*c3*c14-2*kon*c3*c15-2*kon*c3*c16-2*kon*c3*c17-2*kon*c3*c18-2*kon*c3*c19-
-c4t+2*kon*c1*c3+1*kon*c2*c2-2*kon*c4*c1-2*kon*c4*c2-2*kon*c4*c3-2*kon*c4*c4-2*kon*c4*c5-2*kon*c4*c6-2*kon*c4*c7-2*kon*c4*c8-2*kon*c4*c9-2*kon*c4*c10-2*kon*c4*c11-2*kon*c4*c12-2*kon*c4*c13-2*kon*c4*c14-2*kon*c4*c15-2*kon*c4*c16-2*kon*c4*c17-2*kon*c4*c18-
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-c6t+2*kon*c1*c5+2*kon*c2*c4+1*kon*c3*c3-2*kon*c6*c1-2*kon*c6*c2-2*kon*c6*c3-2*kon*c6*c4-2*kon*c6*c5-2*kon*c6*c6-2*kon*c6*c7-2*kon*c6*c8-2*kon*c6*c9-2*kon*c6*c10-2*kon*c6*c11-2*kon*c6*c12-2*kon*c6*c13-2*kon*c6*c14-2*kon*c6*c15-2*kon*c6*c16-2*kon*c6*c17-
-c7t+2*kon*c1*c6+2*kon*c2*c5+2*kon*c3*c4-2*kon*c7*c1-2*kon*c7*c2-2*kon*c7*c3-2*kon*c7*c4-2*kon*c7*c5-2*kon*c7*c6-2*kon*c7*c7-2*kon*c7*c8-2*kon*c7*c9-2*kon*c7*c10-2*kon*c7*c11-2*kon*c7*c12-2*kon*c7*c13-2*kon*c7*c14-2*kon*c7*c15-2*kon*c7*c16-2*kon*c7*c17-
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```

Creating kinetic terms with a LabVIEW program

Esoteric? Protein Polymerization by fast cooling

Matsuno: Polymerisation by fast cooling



Polymerization on clay

Needs ion washing: Correct mechanism?

Ferris: Clay-based polymerisation

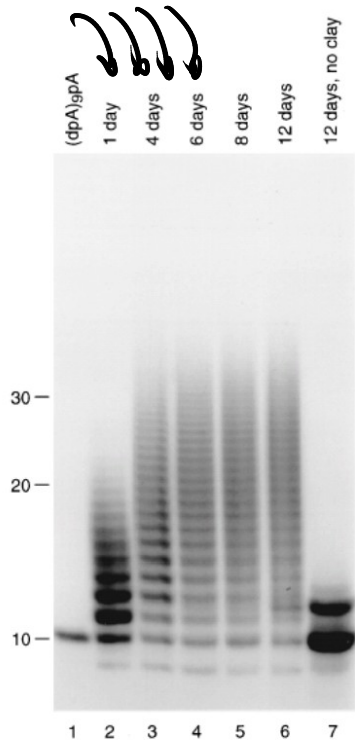
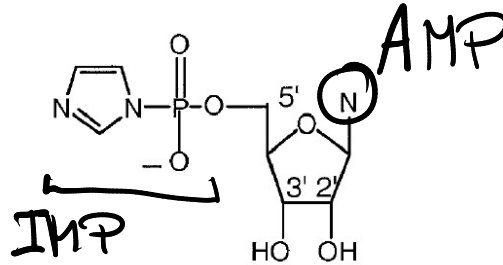
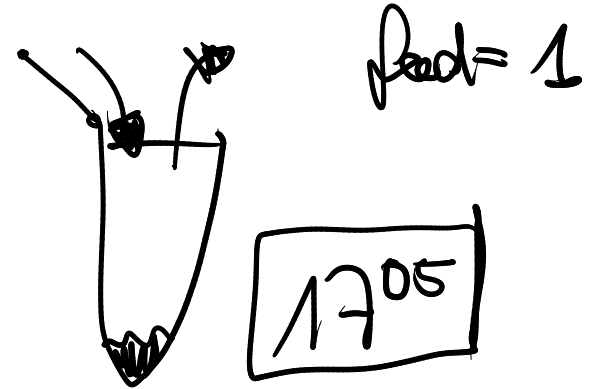
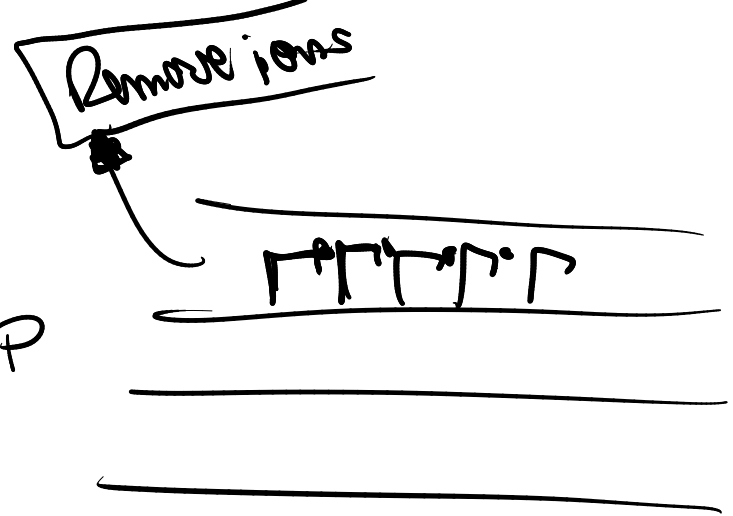


Figure 2. Gel electrophoresis of the elongation of ^{32}P pdA(gpA) with ImpA in microcentrifuge tubes. Lane 1, ^{32}P pdA(gpA); lanes 2-6 elongation in the presence of montmorillonite; lane 7, elongation in the absence of montmorillonite.



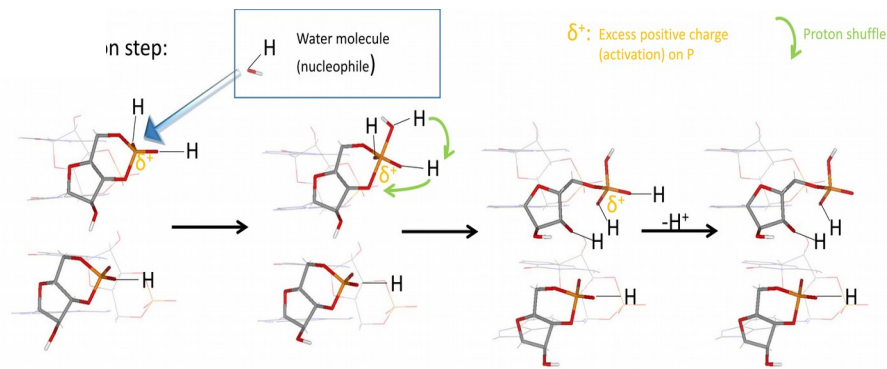
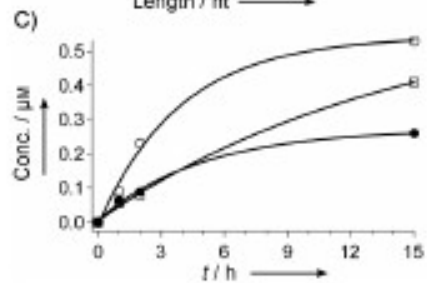
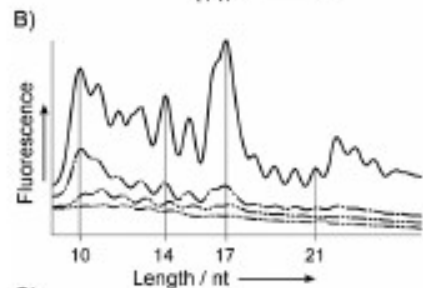
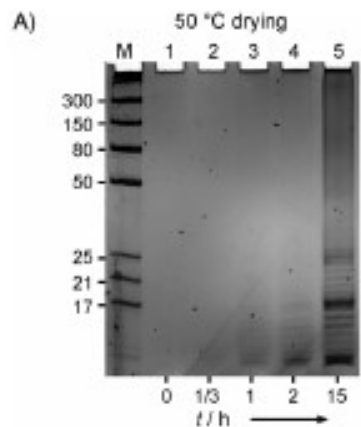
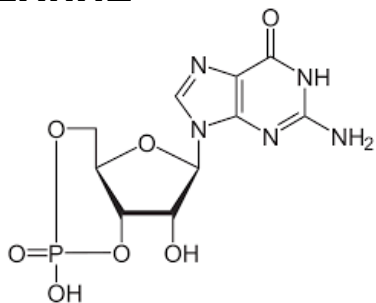
On the **surface of negative charged montmorillonite** clay, energy rich nucleotide-primers can undergo efficient polymerization. One can reach **30-50-mers within some days**. Surfaces are therefore interesting places for catalysis of prebiotic reactions since they can enhance the concentration of the molecules. Problem is the removal of the polymerized species from the surface and replication priming.



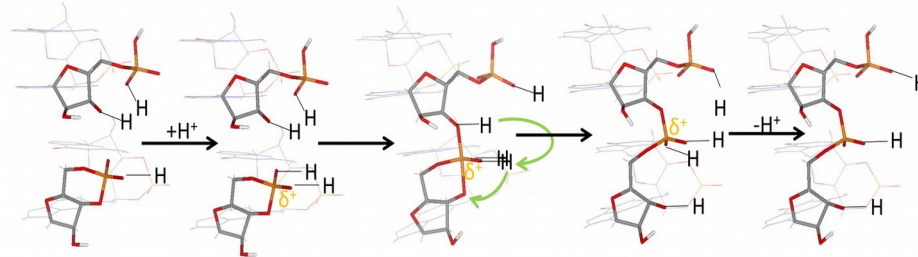
Polymerization by drying of 3'-5' cyclic G-Nucleotide

Dry Polymerization of 3',5'-Cyclic GMP to Long Strands of RNA

Matthias Morasch,^[a] Christof B. Mast,^[a] Johannes K. Langer,^[a] Pierre Schilcher,^[b] and Dieter Braun^{*[a]}



Chain-extension step:



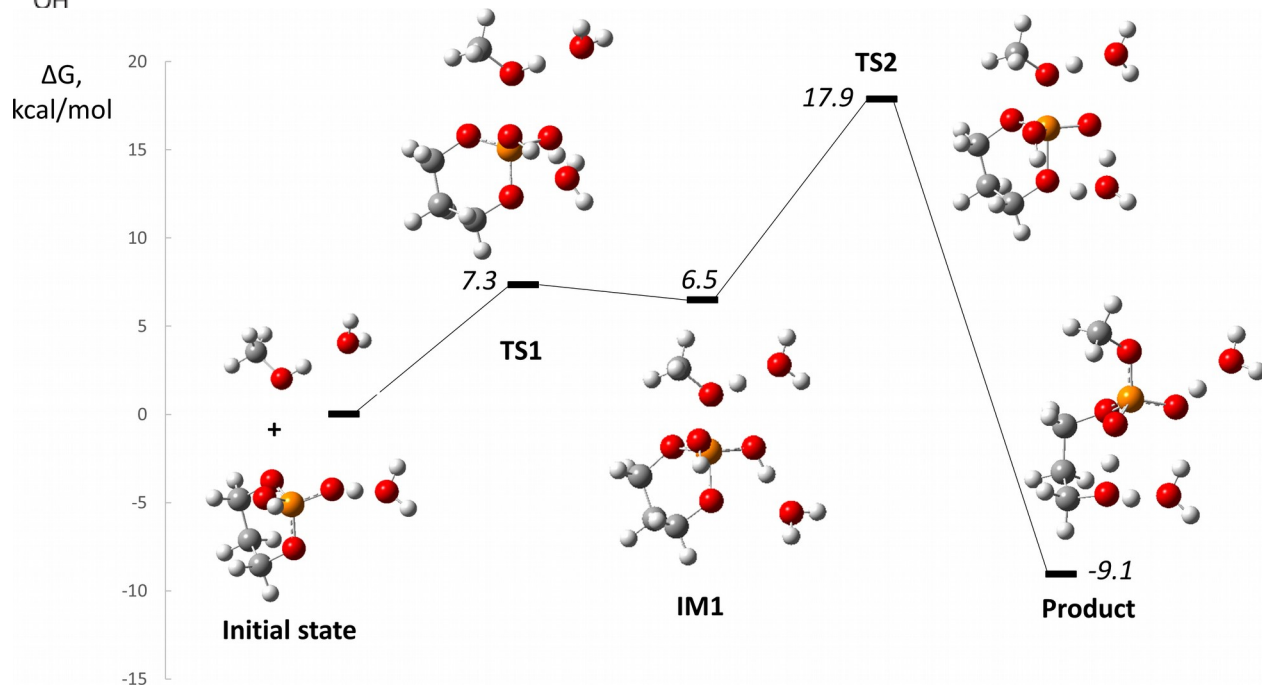
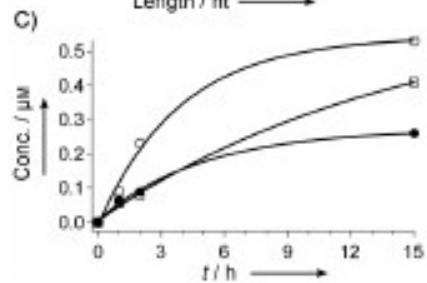
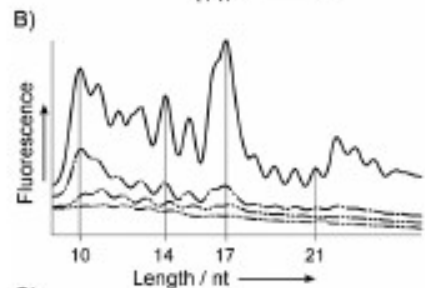
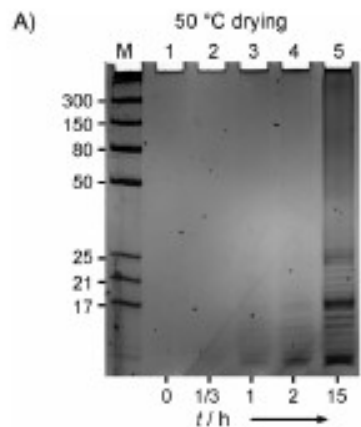
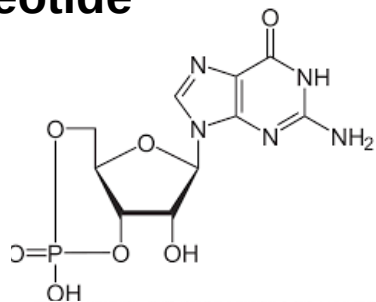
Atom coloring: P, O, H, C, N

See papers by di Mauro and Judith Sporer

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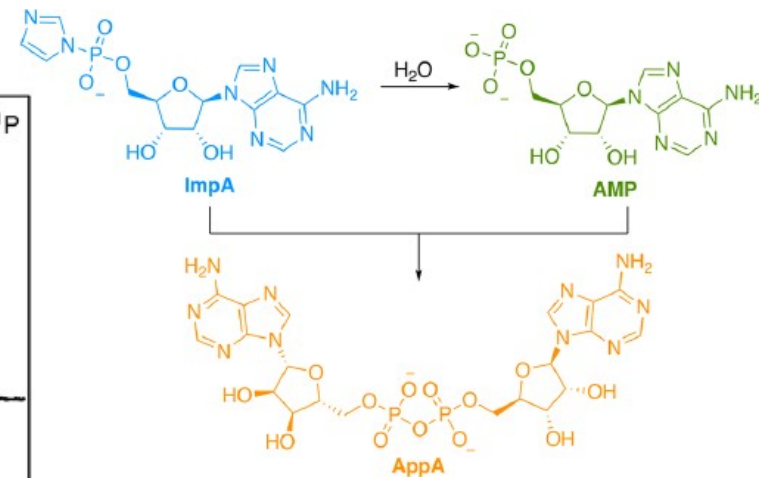
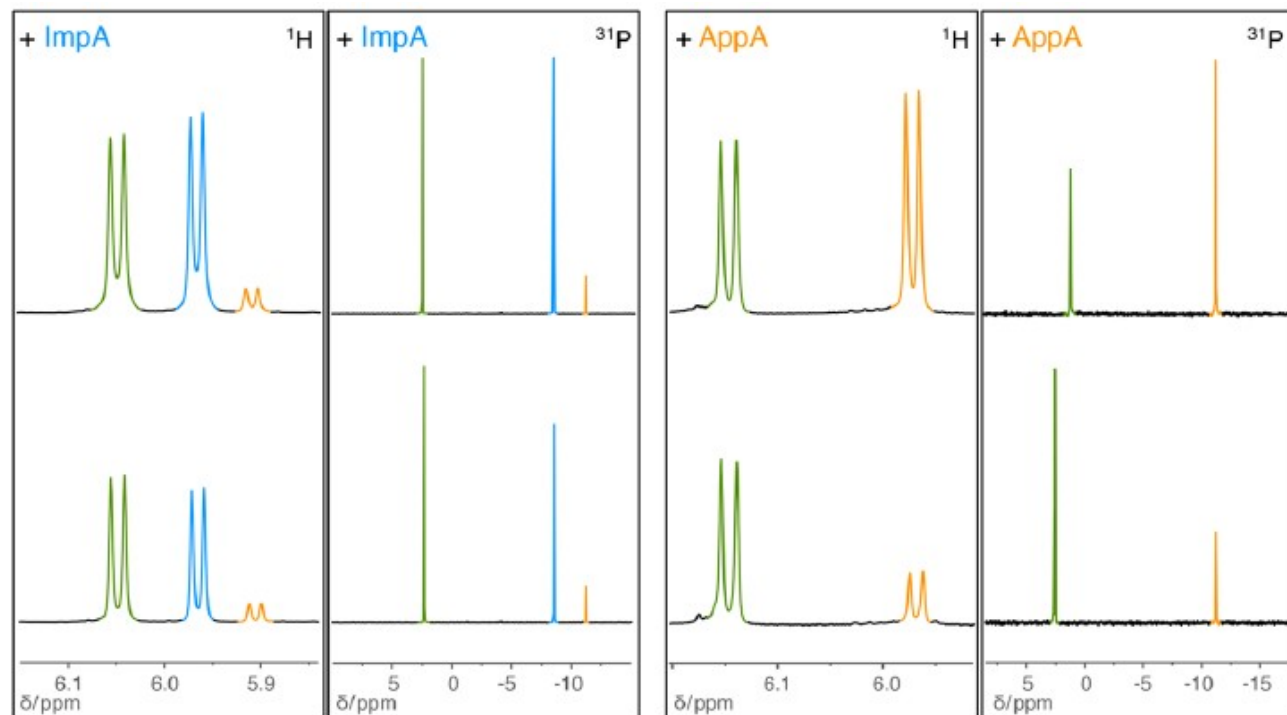
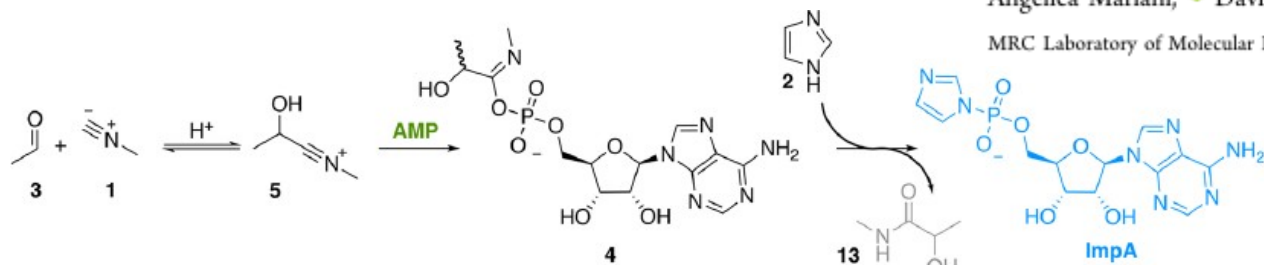
See papers by di Mauro and Judith Sponer

Activation group: in situ possible?

A Light-Releasable Potentially Prebiotic Nucleotide Activating Agent

Angelica Mariani,[†] David A. Russell,[†] Thomas Javelle, and John D. Sutherland^{*†}

MRC Laboratory of Molecular Biology, Francis Crick Avenue, Cambridge Biomedical Campus, Cambridge CB2 0QH, U.K.



Polymerization boost by Thermophoretic Trap