BioLaunch: a novel Stanford faculty and student-run program in suborbital and small payloads

Lynn J. Rothschild\textsuperscript{1,2}, James Cutler\textsuperscript{2,3}, Robert Twiggs\textsuperscript{2} & Matthew Maniscalco\textsuperscript{3}

\textsuperscript{1}NASA Ames Research Center
\textsuperscript{2}Stanford University
\textsuperscript{3}AstroDev
The Problem.

Need fast, small missions for astrobiology.
High scientific return on investment.
Train new mission scientists.
The Answer.

High altitude balloons, gliders, rockets and nanosatellites.

These can test equipment, operate science experiments, plus educational participation and public outreach.
High altitude balloon

Long history, even within Agency.

Types of experiments: Atmospheric and equipment testing

Advantages for Astrobiology: quick local access to space, aerobiology of Earth, excellent analog for extraterrestrial environments, good testbed, repeatable.
Introducing

BioLaunch

Conceived by Stanford faculty in 2007 as a novel multidisciplinary educational and scientific project with a focus on astrobiology payloads.
• **Space Systems Development Laboratory (SSDL)**
  – *Established ~ 1994*

• **Missions**
  – *Sapphire, Opal, QuakeSat-1, Genest*
  – *MAST*
  – *PolarBot, Antarctic weather stations*

• **Student demographics:**
  – ~400 students throughout the years
  – *Before 2000, all Stanford students*
  – *Now a mixture of industry and Stanford*
  – *Expansion to SCPD (distance learning)*
BioLaunch
local launches
Radiation on Mars is nasty, and it is cold.
BioLaunch is a Mars Analog

temperature
pressure
UV
cosmic radiation
Early Earth Analog

**Eon**  
**Phan**  
**Precambrian**

**Time (Ma)**

- 0
- 500
- 1000
- 1500
- 2000
- 2500
- 3000
- 3500
- 4000
- 4500

**Formation of the Earth**

<table>
<thead>
<tr>
<th>Plants invade land</th>
<th>Multicellular red algae</th>
<th>Oxygenic photosynthesis</th>
<th>Most BIFs</th>
<th>Dinosaurs &amp; diatoms</th>
<th>Oldest known fossils (Swaziland &amp; Pilbara Supergroups)</th>
<th>Stromatolites w/ cyanobacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambrian Explosion</td>
<td>Origin of eukaryotes</td>
<td>Puntañera</td>
<td>Palaeo</td>
<td>Goiania</td>
<td>Eoan</td>
<td>Proterozoic</td>
</tr>
</tbody>
</table>

**Modern levels (0.212 bars)**

- Rise in atmospheric $O_2$
- $10^{-13}$ bars

**pO$_2$**

**UVC**  
**B**  
**A**  
**Visible**
BioLaunch is a: 
Journey to the past
1. Physical measurements
   (solar & cosmic radiation, temperature, photos)
2. Prebiotic experiments
   (polyaromatic hydrocarbons as sunscreen)
3. Biological measurements
   (DNA damage, microbes, tardigrades)
4. Equipment testbed
   (Stanford Aero/Astro SSDL)
BioLaunch

spectral data

BioLaunch B07A spectra
DNA damage experiments

This includes two types of experiments.

1. Base modification, for example, the production of thymine dimers from adjacent thymines using a dosimeter made of herring sperm DNA.

2. Nicking and breakage of the phosphate backbone using supercoiled plasmid DNA.

<table>
<thead>
<tr>
<th>treatment</th>
<th>mean cpd/mb</th>
<th>st dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSDNA flight dark</td>
<td>1047</td>
<td>100</td>
</tr>
<tr>
<td>HSDNA flight light</td>
<td>3729</td>
<td>679</td>
</tr>
<tr>
<td>HSDNA ground dark</td>
<td>1437</td>
<td>0</td>
</tr>
<tr>
<td>HSDNA ground light</td>
<td>3629</td>
<td>225</td>
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<tr>
<td>pUC flight dark</td>
<td>1300</td>
<td>50</td>
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<tr>
<td>pUC flight light</td>
<td>5365</td>
<td>704</td>
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<tr>
<td>pUC ground dark</td>
<td>986</td>
<td>0</td>
</tr>
<tr>
<td>pUC ground light</td>
<td>5308</td>
<td>682</td>
</tr>
</tbody>
</table>

666 A  
659 T  
675 C  
686 G  

total: 2686 bp

139 TT

so, total potential of 139 dimers in 2686 bp, or 51,749.8 dimers per megabase.
DNA damage experiments

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Results from Kenya, Jan 2007
Kyle Rothschild-Mancinelli
BioLaunch:
Future plans.

• Better temperature and radiation measurements; annual variation
• DNA damage - bases and breakage. Absolute amount. Correlate with both types of radiation.
• Expanded biologicals - survival including genetic basis, air capture, viral induction.
• Testbed for miniaturized flight instrumentation.