Panelists

Attendees (6)

- Hosts (1)
  - Mike Toillion
- Presenters (2)
  - Andy Burnett
  - Greg Springsteen
- Participants (3)
  - Lee
  - Lindsay Hays
  - Melissa

Open Chat (Everyone)

Teleconference Instructions (Parti...

Teleconference Line: 866-692-3158
Passcode: 9109668#
Please use *6 to MUTE your phone's mic when not speaking.
More info: https://astrobiologyfuture.org

2013-11-19 NASA Roadmap - Oligomer Assembly.pdf

Full Screen

Connections to other Roadmap Topics:

- What are the sources of organic monomers relevant to the origin of life?
- What are the common attributes of extant living systems, and what can they tell us about all living systems?
- How did macromolecules gain function?
- What environmental factors are coupled to emergence of life?
- Laboratory models of earliest cellular life.
- How did polypeptide meet polynucleotide?

1
00:00:15,470 --> 00:00:11,360
hello welcome to the next in our webinar

2
00:00:19,460 --> 00:00:15,480
series just a few announcements to start

3
00:00:21,380 --> 00:00:19,470
with there was a slight mix-up on the

4
00:00:23,990 --> 00:00:21,390
email that went out today so just in

5
00:00:26,779 --> 00:00:24,000
case you haven't seen it the email and

6
00:00:28,370 --> 00:00:26,789
the calendar we're out of date we are

7
00:00:31,370 --> 00:00:28,380
starting off with Greg's presentation

8
00:00:34,220 --> 00:00:31,380
today tomorrow is going to be the to

9
00:00:37,520 --> 00:00:34,230
Eric's on stretching time and space

10
00:00:40,220 --> 00:00:37,530
those things are we are now also up to

11
00:00:42,440 --> 00:00:40,230
date with all of our video recordings so

12
00:00:44,990 --> 00:00:42,450
if you want to go back through any of

13
00:00:47,690 --> 00:00:45,000

the presentations using to go to the

14
00:00:50,830 --> 00:00:47,700
astrobiology future website and select

15
00:00:53,950 --> 00:00:50,840
any of the events and the associated

16
00:00:58,430 --> 00:00:53,960
YouTube video will be linked in there

17
00:01:01,970 --> 00:00:58,440
the slides for this event are also on

18
00:01:03,200 --> 00:01:01,980
each of the event entry so if you

19
00:01:04,700 --> 00:01:03,210
connect to this and you're only

20
00:01:07,899 --> 00:01:04,710
listening to the audio you can download

21
00:01:10,820 --> 00:01:07,909
the slides directly from the website and

22
00:01:14,140 --> 00:01:10,830
finally the meeting is being recorded so

23
00:01:18,230 --> 00:01:14,150
at this point let me pass over to Greg

24
00:01:19,789 --> 00:01:18,240
take it away thanks daddy so my name is

25
00:01:22,370 --> 00:01:19,799
Greg Springsteen as one of the

26
00:01:24,560 --> 00:01:22,380
participants in the astrobiology roadmap

27
00:01:26,780 --> 00:01:24,570
meeting and what are they talking about

28
00:01:31,060 --> 00:01:26,790
today is the synthesis and assembly of

29
00:01:33,890 --> 00:01:31,070
populations of stable oligomers now the

30
00:01:35,330 --> 00:01:33,900
text that we plan or at least that is

31
00:01:38,330 --> 00:01:35,340
currently in the paper will be

32
00:01:40,910 --> 00:01:38,340
highlighted in red like this this text

33
00:01:46,069 --> 00:01:40,920
this document will be opened quite soon

34
00:01:49,310 --> 00:01:46,079
maybe right after the presentation okay

35
00:01:50,960 --> 00:01:49,320
so first are justifications for this

36
00:01:53,810 --> 00:01:50,970
topic why are we interested in this is

37
00:01:55,639 --> 00:01:53,820
part of the astrobiology roadmap and so

38
00:01:58,249 --> 00:01:55,649

our group came up with three primary

39
00:02:00,889 --> 00:01:58,259
justifications one polymers are uniquely

40
00:02:03,139 --> 00:02:00,899
capable of selective catalytic and

41
00:02:06,800 --> 00:02:03,149
janette genetic functions necessary to

42
00:02:09,499 --> 00:02:06,810
life on so we've got the large size of a

43
00:02:12,050 --> 00:02:09,509
polymer incorporating a transition state

44
00:02:13,210 --> 00:02:12,060
and a poly dentate fashion giving some

45
00:02:17,890 --> 00:02:13,220
selectivity

46
00:02:21,580 --> 00:02:17,900
to the catalysis also these polymers or

47
00:02:23,830 --> 00:02:21,590
linear polymers can we can generate

48
00:02:25,450 --> 00:02:23,840
libraries with quite a bit of structural

49
00:02:28,420 --> 00:02:25,460
variability with an extraordinary

50
00:02:30,790 --> 00:02:28,430
limited set of reaction types for

51
00:02:32,740 --> 00:02:30,800
example we could just do the addition of

52
00:02:34,450 --> 00:02:32,750
the monomer if we have multiple monomers

53
00:02:37,450 --> 00:02:34,460
to generate all sorts of structural

54
00:02:40,390 --> 00:02:37,460
variability on in an environment of

55
00:02:43,980 --> 00:02:40,400
which just monomer coupling is the only

56
00:02:46,270 --> 00:02:43,990
available synthetic reaction type

57
00:02:48,640 --> 00:02:46,280
additionally chemical and phylogenetic

58
00:02:51,910 --> 00:02:48,650
evidence suggests that both extant and

59
00:02:53,430 --> 00:02:51,920
ancestral ancestral metabolisms as far

60
00:02:55,900 --> 00:02:53,440
as we are aware at the moment are

61
00:02:58,660 --> 00:02:55,910
dependent on polymers for structural

62
00:03:01,140 --> 00:02:58,670
catalytic and genetic functions it makes

63
00:03:03,400 --> 00:03:01,150

a lot of sense to go after an

64
00:03:10,360 --> 00:03:03,410
understanding of how polymers or

65
00:03:13,270 --> 00:03:10,370
oligomers were generated prebiotic ly so

66
00:03:15,360 --> 00:03:13,280
as a broad overview of the topic topic

67
00:03:18,670 --> 00:03:15,370
explanation we have in most plausible

68
00:03:21,190 --> 00:03:18,680
prebiotic hypotheses abiotic monomers

69
00:03:24,100 --> 00:03:21,200
and we're keeping that very broad amino

70
00:03:26,320 --> 00:03:24,110
acids nucleotides monosaccharides we're

71
00:03:28,590 --> 00:03:26,330
condensed by abiotic dehydration

72
00:03:31,479 --> 00:03:28,600
condensation reactions to form oligomers

73
00:03:34,449 --> 00:03:31,489
life evolved from within this milieu of

74
00:03:37,300 --> 00:03:34,459
reversible polymerization is a plausible

75
00:03:38,920 --> 00:03:37,310
prebiotic hypothesis however

76
00:03:41,320 --> 00:03:38,930
condensation reactions are

77
00:03:42,850 --> 00:03:41,330
thermodynamically problematic in aqueous

78
00:03:44,830 --> 00:03:42,860
media of course because we are

79
00:03:47,620 --> 00:03:44,840
generating water in these condensation

80
00:03:49,780 --> 00:03:47,630
reactions additionally carboxylate and

81
00:03:52,090 --> 00:03:49,790
phosphate astera fication / amidation

82
00:03:53,860 --> 00:03:52,100
reactions suffer from large connect

83
00:03:56,949 --> 00:03:53,870
barriers and near neutral aqueous

84
00:03:59,199 --> 00:03:56,959
environments primarily because of the

85
00:04:01,210 --> 00:03:59,209
poor leaving groups under neutral

86
00:04:06,900 --> 00:04:01,220
conditions from these carboxylic acids

87
00:04:09,220 --> 00:04:06,910
and these phosphate efforts as well so

88
00:04:10,810 --> 00:04:09,230

mechanisms by which dehydration and

89
00:04:13,180 --> 00:04:10,820
condensation reactions may have been

90
00:04:15,910 --> 00:04:13,190
thermodynamically driven and or kinetic

91
00:04:18,610 --> 00:04:15,920
excel data include incorporation of high

92
00:04:21,219 --> 00:04:18,620
potential energy activating groups to

93
00:04:22,760 --> 00:04:21,229
polymer growth and non-aqueous or dry

94
00:04:24,920 --> 00:04:22,770
down environments

95
00:04:26,749 --> 00:04:24,930
potentially three non-covalent

96
00:04:28,999 --> 00:04:26,759
pre-assembly if monomers either with or

97
00:04:32,180 --> 00:04:29,009
without a template that template being

98
00:04:34,909 --> 00:04:32,190
broadly defined and for some polymer

99
00:04:38,080 --> 00:04:34,919
properties that inhibit degradation of

100
00:04:41,059 --> 00:04:38,090
the polymers of the larger complex are

101
00:04:45,200 --> 00:04:41,069
selectively of one complex over other

102
00:04:47,960 --> 00:04:45,210
complexes and so we've broken up each of

103
00:04:51,890 --> 00:04:47,970
these topics into a number of self

104
00:04:54,409 --> 00:04:51,900
questions so to hit these really one by

105
00:04:55,640 --> 00:04:54,419
one so the first we talked about it on

106
00:04:58,809 --> 00:04:55,650
the previous slide is chemical

107
00:05:00,920 --> 00:04:58,819
activation so what's polymerization

108
00:05:02,629 --> 00:05:00,930
driven in here i'm just going to broadly

109
00:05:05,960 --> 00:05:02,639
speak of thermodynamically or

110
00:05:08,149 --> 00:05:05,970
kinetically by chemical coupling agents

111
00:05:10,040 --> 00:05:08,159
and then what is the source and

112
00:05:11,749 --> 00:05:10,050
persistence of these agents and that is

113
00:05:15,140 --> 00:05:11,759

often a particularly problematic

114
00:05:19,640 --> 00:05:15,150
question now it's not hard to envision

115
00:05:21,350 --> 00:05:19,650
what these agents might have been a look

116
00:05:23,089 --> 00:05:21,360
at carbon diameter carbodiimide

117
00:05:25,700 --> 00:05:23,099
chemistry is very well known for

118
00:05:28,010 --> 00:05:25,710
coupling chemistry diamino maleo nitrile

119
00:05:30,439 --> 00:05:28,020
that not only leads nucleobases but it's

120
00:05:33,350 --> 00:05:30,449
a reasonable dehydrating reagent iron

121
00:05:36,020 --> 00:05:33,360
cyanide is a dehydrating reagent also

122
00:05:38,300 --> 00:05:36,030
the phosphates try meta phosphate is a

123
00:05:42,350 --> 00:05:38,310
dehydrating reagent so we can imagine

124
00:05:44,659 --> 00:05:42,360
all of these catalyzing the coupling of

125
00:05:47,809 --> 00:05:44,669
monomers they are in themselves just

126
00:05:49,519 --> 00:05:47,819
dehydrated reagents so in that sense

127
00:05:51,670 --> 00:05:49,529
we're just pushing the question back to

128
00:05:54,709 --> 00:05:51,680
what was the source of the dehydration

129
00:05:59,209 --> 00:05:54,719
to generate these monomers excuse me

130
00:06:02,170 --> 00:05:59,219
these agents and and why were they not

131
00:06:05,029 --> 00:06:02,180
hydrolyzed in their environments

132
00:06:07,820 --> 00:06:05,039
question 2 what is the role of phosphate

133
00:06:13,370 --> 00:06:07,830
in early dehydration polymerization I

134
00:06:15,879 --> 00:06:13,380
think this is a reasonable separate

135
00:06:21,519 --> 00:06:15,889
question from the first one in that

136
00:06:25,700 --> 00:06:21,529
extent biology is driven by triphosphate

137
00:06:29,570 --> 00:06:25,710
catalysis in terms of a dehydration and

138
00:06:33,529 --> 00:06:29,580

so what was the origin of that that that

139
00:06:35,600 --> 00:06:33,539
phosphate driven dehydration and if it

140
00:06:36,500 --> 00:06:35,610
wasn't the first dehydrating reagents

141
00:06:40,070 --> 00:06:36,510
what were the Meccan

142
00:06:43,180 --> 00:06:40,080
ism's to move from a say car mode I

143
00:06:46,400 --> 00:06:43,190
timid based dehydration environment to a

144
00:06:53,300 --> 00:06:46,410
nucleotide triphosphate on driven

145
00:06:55,910 --> 00:06:53,310
environment additionally so or what say

146
00:06:58,940 --> 00:06:55,920
alternatively if we don't have these

147
00:07:01,970 --> 00:06:58,950
high potential energy dehydrating

148
00:07:04,810 --> 00:07:01,980
reactions we're we potentially doing

149
00:07:08,290 --> 00:07:04,820
these condensation polymerization in

150
00:07:11,630 --> 00:07:08,300
alternative solvents or environments so

151
00:07:13,370 --> 00:07:11,640
what are potential non aqueous

152
00:07:16,730 --> 00:07:13,380
environments we can think of things like

153
00:07:18,820 --> 00:07:16,740
a form of my which will be seen in the

154
00:07:20,990 --> 00:07:18,830
literature hydrocarbons deep eutectic

155
00:07:24,110 --> 00:07:21,000
environments potentially in the

156
00:07:26,360 --> 00:07:24,120
membranes of myself if the legalization

157
00:07:29,450 --> 00:07:26,370
reactions occurred within these solvents

158
00:07:31,430 --> 00:07:29,460
flash environments of this dehydration

159
00:07:34,520 --> 00:07:31,440
Stefan may have been thermodynamically

160
00:07:38,090 --> 00:07:34,530
favorable and kinetically feasible one

161
00:07:39,680 --> 00:07:38,100
of the other or more um so investigation

162
00:07:41,900 --> 00:07:39,690
of alternative solvent systems with

163
00:07:44,810 --> 00:07:41,910

respect to accumulation in geochemical

164
00:07:47,510 --> 00:07:44,820
and cost melodica context may justify

165
00:07:50,540 --> 00:07:47,520
these environments as prebiotic ly

166
00:07:53,440 --> 00:07:50,550
plausible and additionally what's

167
00:07:55,880 --> 00:07:53,450
polymerization driven by water activity

168
00:08:00,260 --> 00:07:55,890
cycling so are we talking about

169
00:08:01,910 --> 00:08:00,270
conditions that are a dry um whether

170
00:08:06,530 --> 00:08:01,920
we're talking about dry down conditions

171
00:08:08,810 --> 00:08:06,540
or just our solvents becoming dry in in

172
00:08:14,390 --> 00:08:08,820
cycling conditions weather temperature

173
00:08:17,180 --> 00:08:14,400
day night title and on um so below we

174
00:08:18,680 --> 00:08:17,190
just have just some structures to

175
00:08:21,380 --> 00:08:18,690
exemplify kind of things that we're

176
00:08:25,580 --> 00:08:21,390
thinking of they become in urea based

177
00:08:28,040 --> 00:08:25,590
deep eutectics the formatted for my

178
00:08:34,870 --> 00:08:28,050
excuse me ammonium formate non-aqueous

179
00:08:39,680 --> 00:08:37,040
alright a third question what about

180
00:08:43,750 --> 00:08:39,690
polymer sustainability so were these

181
00:08:47,570 --> 00:08:43,760
early polymers that gave rise to

182
00:08:48,800 --> 00:08:47,580
biopolymers a thermodynamically

183
00:08:51,500 --> 00:08:48,810
advantage door

184
00:08:53,510 --> 00:08:51,510
ethically trapped what polymer

185
00:08:55,970 --> 00:08:53,520
properties could potentially confer

186
00:08:57,860 --> 00:08:55,980
resistance to hydrolysis or other

187
00:09:01,130 --> 00:08:57,870
degradation leading to a kinetic

188
00:09:04,100 --> 00:09:01,140

trapping and what roles do polymer

189
00:09:06,680 --> 00:09:04,110
solubility salvation and hydrophobicity

190
00:09:09,650 --> 00:09:06,690
play in the evolution of functional

191
00:09:12,620 --> 00:09:09,660
polymers so we imagine that polymer

192
00:09:15,890 --> 00:09:12,630
folding polymer solubility are going to

193
00:09:19,630 --> 00:09:15,900
be on important questions in our

194
00:09:24,800 --> 00:09:19,640
understanding of how these first

195
00:09:31,040 --> 00:09:24,810
oligomers / polymers arose on an evolved

196
00:09:35,329 --> 00:09:31,050
function all right next up reassembly of

197
00:09:38,920 --> 00:09:35,339
monomers so if we look at biopolymers

198
00:09:41,780 --> 00:09:38,930
right there's a strong sense of

199
00:09:43,820 --> 00:09:41,790
non-covalent interactions whether we're

200
00:09:46,250 --> 00:09:43,830
looking at the beta sheets of peptides

201
00:09:48,680 --> 00:09:46,260
which I got in the upper left or we're

202
00:09:50,720 --> 00:09:48,690
looking at the hydrogen bonding patterns

203
00:09:53,230 --> 00:09:50,730
of nucleic acids which I got in the top

204
00:09:56,329 --> 00:09:53,240
right there's this non covalent

205
00:10:00,170 --> 00:09:56,339
association so one could ask did this

206
00:10:04,190 --> 00:10:00,180
non covalent association precede the

207
00:10:07,370 --> 00:10:04,200
covalent polymerization and so that's

208
00:10:10,490 --> 00:10:07,380
the first question we have down below so

209
00:10:14,090 --> 00:10:10,500
was this polymerization dynamic or

210
00:10:16,820 --> 00:10:14,100
templated before that the covalent bonds

211
00:10:19,460 --> 00:10:16,830
formed we can also ask one other

212
00:10:22,820 --> 00:10:19,470
mechanisms promote high effective

213
00:10:25,460 --> 00:10:22,830

concentrations of monomers preceding

214
00:10:27,200 --> 00:10:25,470
covalent bond formation thermal

215
00:10:30,560 --> 00:10:27,210
convection service absorption

216
00:10:34,970 --> 00:10:30,570
permeability lots of other potential

217
00:10:38,980 --> 00:10:34,980
ideas and if we are imagining scenarios

218
00:10:41,300 --> 00:10:38,990
at which these monomers were laid down

219
00:10:44,720 --> 00:10:41,310
noncovalently before non covalent bond

220
00:10:47,510 --> 00:10:44,730
formation can we imagine scenarios in

221
00:10:50,480 --> 00:10:47,520
which this homo chirality arose not

222
00:10:53,269 --> 00:10:50,490
because of a preference of monomers but

223
00:10:56,540 --> 00:10:53,279
because of a preference of how these

224
00:11:00,860 --> 00:10:56,550
monomers interacted in their local

225
00:11:06,800 --> 00:11:04,350
a big part of this question is also what

226
00:11:10,530 --> 00:11:06,810
what can we infer from extant

227
00:11:15,170 --> 00:11:10,540
biopolymers since our X and biology is

228
00:11:17,970 --> 00:11:15,180
so polymer based so what does the

229
00:11:21,110 --> 00:11:17,980
mechanisms of polymerization in extant

230
00:11:23,790 --> 00:11:21,120
biology so besides lipids primarily

231
00:11:25,949 --> 00:11:23,800
dehydrated polymerization tell us about

232
00:11:27,689 --> 00:11:25,959
the early biotic environment as far as

233
00:11:31,079 --> 00:11:27,699
the early biotic environment may

234
00:11:34,730 --> 00:11:31,089
potentially dehydrated are irregular or

235
00:11:38,180 --> 00:11:34,740
branched polymers horrible precursors to

236
00:11:41,490 --> 00:11:38,190
functional biopolymers so we see

237
00:11:44,220 --> 00:11:41,500
primarily linear polymers now besides

238
00:11:47,850 --> 00:11:44,230

some notable exceptions with disulfide

239
00:11:50,460 --> 00:11:47,860
bonds for example um but in a prebiotic

240
00:11:53,550 --> 00:11:50,470
sense it's very hard to limit polymers

241
00:11:56,550 --> 00:11:53,560
to just linear right there if we look at

242
00:11:58,499 --> 00:11:56,560
peptides for example or the two prime

243
00:12:01,889 --> 00:11:58,509
three prime ribose right there are lots

244
00:12:07,769 --> 00:12:01,899
of opportunities to branch out in our

245
00:12:10,860 --> 00:12:07,779
pre bio polymeric systems and uh when

246
00:12:13,439 --> 00:12:10,870
did the primacy of polyphosphate driven

247
00:12:15,470 --> 00:12:13,449
condensation arise and if it wasn't the

248
00:12:18,749 --> 00:12:15,480
first what were the mechanisms of

249
00:12:25,379 --> 00:12:18,759
transferring that dehydrated potential

250
00:12:28,650 --> 00:12:25,389
from earlier precursors and then our

251
00:12:31,199 --> 00:12:28,660
last light is connections to other Road

252
00:12:33,840 --> 00:12:31,209
mech topics and there are a lot what

253
00:12:37,259 --> 00:12:33,850
what is our library of potential

254
00:12:39,569 --> 00:12:37,269
monomers and what was the synthesis of

255
00:12:41,939 --> 00:12:39,579
these monomers that might give us some

256
00:12:44,220 --> 00:12:41,949
clues as to what the environment was on

257
00:12:46,650 --> 00:12:44,230
that led to the dehydration of these

258
00:12:49,199 --> 00:12:46,660
monomers once generated what are the

259
00:12:50,819 --> 00:12:49,209
common attributes of X living systems

260
00:12:54,840 --> 00:12:50,829
and what can they tell us about all

261
00:12:57,600 --> 00:12:54,850
living systems so what was the driver

262
00:13:01,650 --> 00:12:57,610
was with their redox driver for example

263
00:13:04,110 --> 00:13:01,660

of these dehydrated conditions how did

264
00:13:07,050 --> 00:13:04,120
my bro molecules gain functions of

265
00:13:09,960 --> 00:13:07,060
course how do we link the folding of

266
00:13:12,480 --> 00:13:09,970
macromolecules into some functional

267
00:13:14,460 --> 00:13:12,490
catalyst genetic polymer what does that

268
00:13:18,840 --> 00:13:14,470
tell us about the environment at which

269
00:13:21,990 --> 00:13:18,850
the covalent bond formation of those

270
00:13:23,790 --> 00:13:22,000
macromolecules happened what

271
00:13:26,160 --> 00:13:23,800
environmental factors are coupled to the

272
00:13:28,379 --> 00:13:26,170
emergence of life so there's got to be a

273
00:13:30,470 --> 00:13:28,389
non-equilibrium driving here

274
00:13:33,269 --> 00:13:30,480
particularly if we're reading to aqueous

275
00:13:36,360 --> 00:13:33,279
conditions again it brings us back to

276
00:13:38,730 --> 00:13:36,370
redox and dehydrated conditions or what

277
00:13:42,139 --> 00:13:38,740
environment where we end laboratory

278
00:13:45,720 --> 00:13:42,149
models of earliest cellular life again

279
00:13:49,920 --> 00:13:45,730
if we are imagining that we are arising

280
00:13:53,460 --> 00:13:49,930
in aqueous conditions how do we justify

281
00:13:55,259 --> 00:13:53,470
that in terms of the the thermodynamics

282
00:13:58,319 --> 00:13:55,269
and the kinetics of this polymerization

283
00:14:00,689 --> 00:13:58,329
and how the polypeptide meet Polly

284
00:14:02,819 --> 00:14:00,699
nucleotide there's anything that we

285
00:14:05,490 --> 00:14:02,829
learn about the polymerization of one

286
00:14:06,900 --> 00:14:05,500
system our polypeptide system is likely

287
00:14:08,759 --> 00:14:06,910
going to play a large role in our

288
00:14:11,639 --> 00:14:08,769

understanding of the condensation

289
00:14:13,619 --> 00:14:11,649
polymerization in the other system so

290
00:14:17,549 --> 00:14:13,629
there's going to be a lot of cross talk

291
00:14:20,670 --> 00:14:17,559
between these two worlds at least the

292
00:14:23,720 --> 00:14:20,680
study of these two systems once we

293
00:14:26,400 --> 00:14:23,730
understand in one or the other how this

294
00:14:31,410 --> 00:14:26,410
dehydrated condensation polymerization

295
00:14:34,199 --> 00:14:31,420
may have arisen um so I would happily

296
00:14:37,199 --> 00:14:34,209
take any questions and you can certainly

297
00:14:39,689 --> 00:14:37,209
look at the road map document and I

298
00:14:42,689 --> 00:14:39,699
would love to see anybody suggestions on

299
00:14:45,530 --> 00:14:42,699
that document as well of how we're going

300
00:14:48,210 --> 00:14:45,540
to potentially take this paper forward

301
00:14:51,720 --> 00:14:48,220
thanks for your time and attention and I

302
00:14:56,040 --> 00:14:51,730
look forward to hearing from you okay so

303
00:14:59,009 --> 00:14:56,050
we have a select group that appears in

304
00:15:00,840 --> 00:14:59,019
the in the participant list here I'm not

305
00:15:05,340 --> 00:15:00,850
sure if we have other people who are

306
00:15:07,740 --> 00:15:05,350
also dialed in just to say to our

307
00:15:09,720 --> 00:15:07,750
participants were right partway through

308
00:15:11,549 --> 00:15:09,730
obviously this is being recorded so you

309
00:15:14,879 --> 00:15:11,559
can run back and see the beginning of it

310
00:15:17,809 --> 00:15:14,889
as well but let me just throw it open

311
00:15:19,590 --> 00:15:17,819
because our our audio lines are now open

312
00:15:22,350 --> 00:15:19,600
legal Alyssa

313
00:15:24,930 --> 00:15:22,360

or even Lindsey because you there do you

314
00:15:28,230 --> 00:15:24,940
have any questions that observations

315
00:15:29,759 --> 00:15:28,240
that you want to make now and actually

316
00:15:32,329 --> 00:15:29,769
just before you do that let me just

317
00:15:35,699 --> 00:15:32,339
respond to gregs point the document is

318
00:15:37,590 --> 00:15:35,709
currently in read-only mode that in a

319
00:15:39,809 --> 00:15:37,600
few minutes it will be flipped over so

320
00:15:42,059 --> 00:15:39,819
that you'll be able to add comments to

321
00:15:44,550 --> 00:15:42,069
it so by all means and your thoughts

322
00:15:46,590 --> 00:15:44,560
directly in the document as well but

323
00:15:48,509 --> 00:15:46,600
come back to our participants or any

324
00:15:59,610 --> 00:15:48,519
questions or observations that you'd

325
00:16:01,530 --> 00:15:59,620
like to make at this one hello this is

326
00:16:13,920 --> 00:16:01,540
Melissa no comments from me but thank

327
00:16:18,120 --> 00:16:13,930
you Greg hey this is Lindsay um can you

328
00:16:22,439 --> 00:16:18,130
all hear me hey yes okay I apologize

329
00:16:24,360 --> 00:16:22,449
that I came in a bit late but I actually

330
00:16:27,600 --> 00:16:24,370
would actually sort of like to direct

331
00:16:30,329 --> 00:16:27,610
the same question to you that I directed

332
00:16:32,009 --> 00:16:30,339
to the last group which was you know for

333
00:16:33,929 --> 00:16:32,019
if we're looking at things that we can

334
00:16:35,910 --> 00:16:33,939
think about working on in the next 10

335
00:16:37,939 --> 00:16:35,920
years etc I mean that's sort of the

336
00:16:41,309 --> 00:16:37,949
general concept of this whole program

337
00:16:43,019 --> 00:16:41,319
this whole astrobiology strategy but is

338
00:16:44,429 --> 00:16:43,029

there anything specific that you would

339
00:16:48,780 --> 00:16:44,439
want to point to about that you know

340
00:16:51,059 --> 00:16:48,790
sort of specific questions you know in a

341
00:16:54,030 --> 00:16:51,069
in a more in a less general sense in a

342
00:16:57,480 --> 00:16:54,040
more directed sense that you think we're

343
00:17:00,629 --> 00:16:57,490
going to we're going to get you yeah you

344
00:17:03,929 --> 00:17:00,639
know you said not general and then I'm

345
00:17:07,789 --> 00:17:03,939
going to answer generally but I the idea

346
00:17:10,679 --> 00:17:07,799
of drivers of non-equilibrium

347
00:17:13,919 --> 00:17:10,689
environments and how they were coupled

348
00:17:16,409 --> 00:17:13,929
to polymer synthesis I think it's very

349
00:17:18,510 --> 00:17:16,419
fascinating and I think whether the

350
00:17:20,250 --> 00:17:18,520
answer comes directly from this question

351
00:17:21,659 --> 00:17:20,260
or from others that we pertained to hear

352
00:17:24,659 --> 00:17:21,669
this tremendous amount of crosstalk

353
00:17:27,600 --> 00:17:24,669
right if we're talking about a redox

354
00:17:30,480 --> 00:17:27,610
driver for example of polymerization um

355
00:17:33,930 --> 00:17:30,490
you know as we see now it's quite calm

356
00:17:38,600 --> 00:17:33,940
next in biology how we couple redox

357
00:17:41,549 --> 00:17:38,610
energy to ATP synthesis and then to this

358
00:17:44,160 --> 00:17:41,559
dehydrate of polymerization and so which

359
00:17:46,290 --> 00:17:44,170
way did that occur if prebiotic lee was

360
00:17:49,950 --> 00:17:46,300
it with a dehydration first or redox

361
00:17:54,180 --> 00:17:49,960
coupling first so i think what is

362
00:17:56,669 --> 00:17:54,190
fascinating about this concept is we are

363
00:18:04,080 --> 00:17:56,679

either going to teach or learn from a

364
00:18:06,180 --> 00:18:04,090
great deal of other questions ok any

365
00:18:09,890 --> 00:18:06,190
other hopes of the vendors that answer i

366
00:18:15,990 --> 00:18:09,900
think your question specifically enough

367
00:18:19,710 --> 00:18:16,000
we'll go with that you're very

368
00:18:21,690 --> 00:18:19,720
interested specifically on in realistic

369
00:18:25,410 --> 00:18:21,700
coupling reagent sorry we see a lot of

370
00:18:27,840 --> 00:18:25,420
those in the literature can we imagine

371
00:18:30,750 --> 00:18:27,850
environments at which they persist and

372
00:18:32,850 --> 00:18:30,760
our effective generators of polymers and

373
00:18:41,100 --> 00:18:32,860
you know I would like to see that

374
00:18:43,440 --> 00:18:41,110
explored in the very near term great any

375
00:18:53,400 --> 00:18:43,450
other thoughts questions that people

376
00:18:55,260 --> 00:18:53,410
want to pose this point okay uh we will

377
00:18:57,450 --> 00:18:55,270
go and flip the switch on your document

378
00:19:00,180 --> 00:18:57,460
great thank you very much for doing this

379
00:19:02,810 --> 00:19:00,190
appreciate that and if I can encourage

380
00:19:05,160 --> 00:19:02,820
everyone whether you are live now or

381
00:19:06,780 --> 00:19:05,170
catching missin and at the recording

382
00:19:09,180 --> 00:19:06,790
please go and put your thoughts and

383
00:19:11,490 --> 00:19:09,190
comments directly in the document the

384
00:19:14,160 --> 00:19:11,500
documents link strength from the front

385
00:19:16,700 --> 00:19:14,170
page of the site and it will help the

386
00:19:19,650 --> 00:19:16,710
team enormously if you can just add

387
00:19:21,540 --> 00:19:19,660
anything to help them strengthen the

388
00:19:25,760 --> 00:19:21,550

paper that will be wonderful thank you

389
00:19:27,890 --> 00:19:25,770
very much okay I'm document thanks dear