Panelists

Attendees (8)

- Hosts (1)
  - Mike Toillion
- Presenters (2)
  - Andy Burnett
  - Lucas Mix
- Participants (5)
  - bob bruner
  - Fred Ciesla
  - Lindsay Hays
  - Matthew Herron
  - Pauli Laine

Open Chat (Everyone)

--------- (10/24/2013 10:57) ---------

Mike Toillion: http://www.youtube.com/playlist?list=PL2vV9BqKn2ze3RuPly6UCkkshnVynpVoY

--------- (10/24/2013 10:59) ---------

Pauli Laine: Andy: Do you know why international telecon numbers don't work like in early webinars?

--------- (10/24/2013 11:00) ---------

bob bruner: If life is in suspended animation (see my Resource Origin of Life on this website) then the only thing that would

--------- (10/24/2013 11:01) ---------

Mike Toillion: mike.toillion@nasa.gov

--------- (10/24/2013 11:03) ---------

Mike Toillion: If you are connecting from outside the US, you can contact me at the above email address for a local toll-free dial in number.

bob bruner, Mike Toillion are typing...

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

Lucas Mix - Common Attributes.pptx

Full Screen

What are the common attributes of extant living systems, and what can they tell us about all living systems?

Laurie Achenbach, Shelley Copley,
Aaron Goldman, Lucas Mix, Matthew Pasek,
Matthew Powell, Frank Rosenzweig, Eric Smith

1
00:00:14,629 --> 00:00:11,830
cool well thank you all for coming

2
00:00:17,109 --> 00:00:14,639
what i want to talk about is the section

3
00:00:19,269 --> 00:00:17,119
uh of our brainstorming around

4
00:00:21,429 --> 00:00:19,279
what are the common attributes of

5
00:00:23,830 --> 00:00:21,439
excellent living systems

6
00:00:25,509 --> 00:00:23,840
and what can they tell us about all

7
00:00:30,710 --> 00:00:25,519
living systems

8
00:00:33,990 --> 00:00:31,910
there we go

9
00:00:35,990 --> 00:00:34,000
our explanation

10
00:00:38,150 --> 00:00:36,000
living systems from cells and

11
00:00:39,910 --> 00:00:38,160
populations of cells to higher order

12
00:00:42,069 --> 00:00:39,920
structures including multicellular

13
00:00:44,150 --> 00:00:42,079

organisms share a set of common

14
00:00:46,069 --> 00:00:44,160
attributes that distinguish them from

15
00:00:48,150 --> 00:00:46,079
non-living systems

16
00:00:49,990 --> 00:00:48,160
an important goal of astrobiology should

17
00:00:52,389 --> 00:00:50,000
be to identify the attributes or

18
00:00:54,389 --> 00:00:52,399
principles of system composition that

19
00:00:56,869 --> 00:00:54,399
collectively would enable us after

20
00:00:58,869 --> 00:00:56,879
taking correct account of the chemistry

21
00:01:00,869 --> 00:00:58,879
upon which a living system might be

22
00:01:03,430 --> 00:01:00,879
based to recognize systems of being

23
00:01:05,189 --> 00:01:03,440
alive a consensus as to the nature of

24
00:01:07,270 --> 00:01:05,199
these attributes and an understanding of

25
00:01:09,190 --> 00:01:07,280
the roles that chance contingency and

26
00:01:11,190 --> 00:01:09,200
necessity play in their origin and

27
00:01:14,149 --> 00:01:11,200
elaboration are essential to being able

28
00:01:17,030 --> 00:01:14,159
to recognize and describe life on other

29
00:01:32,630 --> 00:01:19,190
so

30
00:01:35,830 --> 00:01:34,149
uh yes

31
00:01:37,830 --> 00:01:35,840
interesting question by bob i think

32
00:01:40,550 --> 00:01:37,840
we'll come back to that in the comments

33
00:01:42,950 --> 00:01:40,560
i wanted to say a word about probability

34
00:01:44,789 --> 00:01:42,960
chance and necessity this is not in the

35
00:01:46,710 --> 00:01:44,799
paper itself but

36
00:01:48,550 --> 00:01:46,720
just for some context

37
00:01:51,429 --> 00:01:48,560
chance we're looking at questions of

38
00:01:53,270 --> 00:01:51,439

properties of earth life which

39
00:01:55,350 --> 00:01:53,280
we will which we suspect will have

40
00:01:57,590 --> 00:01:55,360
arisen due to stochastic events in

41
00:01:59,429 --> 00:01:57,600
earth's history for example right-handed

42
00:02:01,429 --> 00:01:59,439
sugars may have been more common in the

43
00:02:03,109 --> 00:02:01,439
original environment so when we're

44
00:02:05,190 --> 00:02:03,119
talking about chants we're talking about

45
00:02:07,510 --> 00:02:05,200
these kinds of things that might have

46
00:02:08,949 --> 00:02:07,520
arisen not because they had to but just

47
00:02:12,390 --> 00:02:08,959
because they happen to in the

48
00:02:14,070 --> 00:02:12,400
environment life found itself

49
00:02:16,550 --> 00:02:14,080
second we have this category of

50
00:02:18,390 --> 00:02:16,560
contingency some properties of earth

51
00:02:20,470 --> 00:02:18,400
life we suspect will have arisen due to

52
00:02:22,869 --> 00:02:20,480
contingent events in earth's history for

53
00:02:25,030 --> 00:02:22,879
example the chick shalom impact which

54
00:02:28,470 --> 00:02:25,040
eliminated larger animals and made way

55
00:02:30,869 --> 00:02:28,480
for the rise of large mammals now both

56
00:02:32,550 --> 00:02:30,879
of these hypotheses have certain aspects

57
00:02:34,150 --> 00:02:32,560
to them which you may or may not agree

58
00:02:35,910 --> 00:02:34,160
with that's not really important here

59
00:02:38,470 --> 00:02:35,920
the question is the types of

60
00:02:42,150 --> 00:02:38,480
explanations we want to invoke and what

61
00:02:45,270 --> 00:02:42,160
they say about our understanding of life

62
00:02:47,190 --> 00:02:45,280
third we have a category of necessity

63
00:02:48,869 --> 00:02:47,200

some properties of earth life we suspect

64
00:02:50,550 --> 00:02:48,879
will have arisen due to necessary

65
00:02:52,790 --> 00:02:50,560
features of the earth necessary

66
00:02:54,710 --> 00:02:52,800
responses to features of the earth's

67
00:02:56,869 --> 00:02:54,720
environment for example terrestrial

68
00:02:58,470 --> 00:02:56,879
organisms need protection terrestrial

69
00:03:00,869 --> 00:02:58,480
that is living on

70
00:03:02,830 --> 00:03:00,879
land organisms need protection from

71
00:03:05,910 --> 00:03:02,840
oxidation and uv

72
00:03:09,750 --> 00:03:05,920
radiation so those are our categories of

73
00:03:11,990 --> 00:03:09,760
chance contingency and necessity

74
00:03:14,710 --> 00:03:12,000
coming back to the language of the white

75
00:03:16,470 --> 00:03:14,720
paper living systems here on earth share

76
00:03:19,750 --> 00:03:16,480
common features that broadly fall into

77
00:03:22,869 --> 00:03:19,760
categories related to their energetics

78
00:03:24,869 --> 00:03:22,879
composition structure function

79
00:03:27,350 --> 00:03:24,879
information in terms of content

80
00:03:28,869 --> 00:03:27,360
retrieval and transmission

81
00:03:31,509 --> 00:03:28,879
living systems self-organize

82
00:03:34,550 --> 00:03:31,519
self-perpetuate and adapt as individuals

83
00:03:36,309 --> 00:03:34,560
but also as populations to spatial and

84
00:03:37,750 --> 00:03:36,319
temporal variability in resource

85
00:03:41,430 --> 00:03:37,760
availability

86
00:03:43,509 --> 00:03:41,440
and physical conditions

87
00:03:45,589 --> 00:03:43,519
adaptations can result from events that

88
00:03:47,589 --> 00:03:45,599

may or may not be repeated if repeated

89
00:03:49,830 --> 00:03:47,599
they will produce

90
00:03:52,470 --> 00:03:49,840
we wonder if repeated will they always

91
00:03:54,390 --> 00:03:52,480
produce the same evolutionary result

92
00:03:56,390 --> 00:03:54,400
examples of this include ubiquitous

93
00:03:57,910 --> 00:03:56,400
traits that arise relatively easily in

94
00:03:59,670 --> 00:03:57,920
independent lineages and then are

95
00:04:02,550 --> 00:03:59,680
conserved as in the case of

96
00:04:04,630 --> 00:04:02,560
multicellularity

97
00:04:06,949 --> 00:04:04,640
also traits that are ubiquitous among

98
00:04:08,949 --> 00:04:06,959
unrelated taxa because they solve common

99
00:04:09,910 --> 00:04:08,959
problems in a similar

100
00:04:11,750 --> 00:04:09,920
way

101
00:04:13,589 --> 00:04:11,760
so here we have

102
00:04:15,030 --> 00:04:13,599
another digression

103
00:04:18,229 --> 00:04:15,040
i'm just going to make distinguish

104
00:04:20,469 --> 00:04:18,239
between shared ancestral traits you can

105
00:04:23,749 --> 00:04:20,479
see on the chart here we have this green

106
00:04:25,270 --> 00:04:23,759
region which is the pisces or fish

107
00:04:27,510 --> 00:04:25,280
and they all

108
00:04:29,270 --> 00:04:27,520
have certain features because the first

109
00:04:31,510 --> 00:04:29,280
organism in the group had certain

110
00:04:33,909 --> 00:04:31,520
features that other groups have emerged

111
00:04:36,950 --> 00:04:33,919
from within our group of fish and you

112
00:04:42,150 --> 00:04:36,960
see here the rise of

113
00:04:46,950 --> 00:04:44,629

likewise we have shared derived traits

114
00:04:49,670 --> 00:04:46,960
synapomorphies um there isn't a

115
00:04:51,270 --> 00:04:49,680
synapomorphy marked on this chart but uh

116
00:04:53,590 --> 00:04:51,280
you can see the little node here that i

117
00:04:56,390 --> 00:04:53,600
have marked in red everything from then

118
00:04:58,629 --> 00:04:56,400
on out has a spine so that's the

119
00:05:01,990 --> 00:04:58,639
vertebral group all members of the group

120
00:05:06,310 --> 00:05:04,150
that is a shared derived trait and

121
00:05:09,029 --> 00:05:06,320
finally we have

122
00:05:10,790 --> 00:05:09,039
convergence

123
00:05:13,189 --> 00:05:10,800
you can look at two traits like the

124
00:05:14,150 --> 00:05:13,199
mammals and the birds both of them

125
00:05:15,909 --> 00:05:14,160
have

126
00:05:17,749 --> 00:05:15,919
um

127
00:05:19,510 --> 00:05:17,759
heat regulation

128
00:05:21,510 --> 00:05:19,520
so they're capable of maintaining their

129
00:05:24,150 --> 00:05:21,520
internal temperature separate from the

130
00:05:27,029 --> 00:05:24,160
external temperature but those we

131
00:05:29,029 --> 00:05:27,039
believe arose independently but we also

132
00:05:31,430 --> 00:05:29,039
think they arose as a response to the

133
00:05:33,110 --> 00:05:31,440
same problem so when we're looking at

134
00:05:35,749 --> 00:05:33,120
adaptations we want to know what kind of

135
00:05:37,670 --> 00:05:35,759
problem they're responding to and in

136
00:05:39,830 --> 00:05:37,680
another origin of life would they be

137
00:05:41,590 --> 00:05:39,840
responding to the same problems

138
00:05:44,070 --> 00:05:41,600

so coming back to the original language

139
00:05:46,230 --> 00:05:44,080
again adaptations likely to be repeated

140
00:05:48,469 --> 00:05:46,240
for these reasons are predictable given

141
00:05:49,749 --> 00:05:48,479
a defined set of conditions we would

142
00:05:57,350 --> 00:05:49,759
expect these attributes to be

143
00:06:01,029 --> 00:05:58,870
so once again we've got these shared

144
00:06:03,909 --> 00:06:01,039
ancestral traits we want to know whether

145
00:06:06,150 --> 00:06:03,919
they are adaptations that are necessary

146
00:06:10,230 --> 00:06:06,160
to life necessary to a particular early

147
00:06:12,309 --> 00:06:10,240
environment on earth or just contingent

148
00:06:14,550 --> 00:06:12,319
responses or responses to contingent

149
00:06:16,230 --> 00:06:14,560
events in the external environment like

150
00:06:18,230 --> 00:06:16,240
the chick-fil-a impact

151
00:06:21,029 --> 00:06:18,240
we also have these shared derived and

152
00:06:23,270 --> 00:06:21,039
convergent traits and we want to know to

153
00:06:25,270 --> 00:06:23,280
what they're adapting and is it likely

154
00:06:26,790 --> 00:06:25,280
that extraterrestrial life would also

155
00:06:27,749 --> 00:06:26,800
have to adapt to

156
00:06:31,189 --> 00:06:27,759
such

157
00:06:35,590 --> 00:06:33,270
justification a better understanding of

158
00:06:37,110 --> 00:06:35,600
the common attributes of living systems

159
00:06:39,029 --> 00:06:37,120
and the degree to which they were formed

160
00:06:40,550 --> 00:06:39,039
during contingent or inevitable events

161
00:06:42,629 --> 00:06:40,560
will help us predict the attributes of

162
00:06:44,390 --> 00:06:42,639
life on other planets knowledge of

163
00:06:48,950 --> 00:06:44,400

present consistency can help us

164
00:06:50,950 --> 00:06:48,960
reconstruct historical dates

165
00:06:53,110 --> 00:06:50,960
that brings us to our sub questions the

166
00:06:54,390 --> 00:06:53,120
ones that we have identified are certain

167
00:06:55,270 --> 00:06:54,400
there are more

168
00:06:57,510 --> 00:06:55,280
are

169
00:06:59,510 --> 00:06:57,520
one what would be recognizable on other

170
00:07:01,430 --> 00:06:59,520
worlds in the context of the chemistry

171
00:07:03,830 --> 00:07:01,440
of those worlds that would enable us to

172
00:07:06,550 --> 00:07:03,840
infer the presence of life's attributes

173
00:07:09,749 --> 00:07:06,560
so what are those necessary

174
00:07:11,909 --> 00:07:09,759
adaptations we believe for all life on

175
00:07:13,189 --> 00:07:11,919
any given environment

176
00:07:15,270 --> 00:07:13,199
are there features of life that are

177
00:07:17,189 --> 00:07:15,280
universal and if so how might these be

178
00:07:21,029 --> 00:07:17,199
detected that is are there things that

179
00:07:23,909 --> 00:07:21,039
life necessarily must do wherever it is

180
00:07:26,230 --> 00:07:23,919
this connects with the question of bio

181
00:07:28,070 --> 00:07:26,240
signatures

182
00:07:29,909 --> 00:07:28,080
sub question two

183
00:07:32,230 --> 00:07:29,919
why is the emergence of individuality

184
00:07:33,909 --> 00:07:32,240
such a large factor in driven

185
00:07:35,430 --> 00:07:33,919
non-equilibrium

186
00:07:37,510 --> 00:07:35,440
processes

187
00:07:39,589 --> 00:07:37,520
so again and again in our discussions we

188
00:07:42,469 --> 00:07:39,599

came back to this idea of

189
00:07:47,029 --> 00:07:42,479
uh hierarchical levels of organization

190
00:07:48,870 --> 00:07:47,039
and how they reflect adaptations to the

191
00:07:51,029 --> 00:07:48,880
environment to what extent is

192
00:07:53,350 --> 00:07:51,039
organization into individual units of

193
00:07:55,990 --> 00:07:53,360
ontogeny and selection inevitable in or

194
00:07:58,230 --> 00:07:56,000
entailed by the emergence of persistent

195
00:08:00,950 --> 00:07:58,240
order in driven systems where it often

196
00:08:02,790 --> 00:08:00,960
is not in equilibrium ordered systems

197
00:08:05,110 --> 00:08:02,800
what kinds of major organizational

198
00:08:06,550 --> 00:08:05,120
transitions bring individuality into

199
00:08:09,270 --> 00:08:06,560
existence or change the levels of

200
00:08:11,510 --> 00:08:09,280
hierarchical organization and nesting of

201
00:08:13,189 --> 00:08:11,520
individual forms

202
00:08:17,189 --> 00:08:13,199
you can see there's a little bit of a

203
00:08:18,869 --> 00:08:17,199
definition of life creeping in here

204
00:08:21,350 --> 00:08:18,879
i don't think that's necessary to

205
00:08:24,790 --> 00:08:21,360
subscribe to to understand the general

206
00:08:26,550 --> 00:08:24,800
idea of necessity and contingency in the

207
00:08:28,070 --> 00:08:26,560
history of life

208
00:08:30,070 --> 00:08:28,080
but it shows you somewhat what we were

209
00:08:31,270 --> 00:08:30,080
thinking when we were talking about the

210
00:08:36,149 --> 00:08:31,280
question

211
00:08:39,990 --> 00:08:36,159
and contingency play in the origin and

212
00:08:40,790 --> 00:08:40,000
elaboration of cellular nano machines

213
00:08:42,630 --> 00:08:40,800

um

214
00:08:44,630 --> 00:08:42,640
what is the limited set of modular nano

215
00:08:46,630 --> 00:08:44,640
machines absolutely required to explain

216
00:08:48,470 --> 00:08:46,640
the common attributes of all life but

217
00:08:50,070 --> 00:08:48,480
larger set of nano machines explains the

218
00:08:52,150 --> 00:08:50,080
distinctive attributes of all forms of

219
00:08:53,990 --> 00:08:52,160
life on earth

220
00:08:56,070 --> 00:08:54,000
such machines are recognized more by

221
00:08:57,990 --> 00:08:56,080
their function than by their structure

222
00:08:59,590 --> 00:08:58,000
for example while energy harvesting may

223
00:09:01,190 --> 00:08:59,600
be a characteristic attribute of all

224
00:09:02,870 --> 00:09:01,200
life forms diverse structures realize

225
00:09:04,550 --> 00:09:02,880
this attribute contingent on a

226
00:09:06,550 --> 00:09:04,560
particular lineage's evolutionary

227
00:09:09,030 --> 00:09:06,560
history in the context of environmental

228
00:09:10,710 --> 00:09:09,040
redox and available minerals

229
00:09:13,030 --> 00:09:10,720
there's an interesting use of the word

230
00:09:16,310 --> 00:09:13,040
nano machines that i had not encountered

231
00:09:18,389 --> 00:09:16,320
prior to the meeting

232
00:09:20,550 --> 00:09:18,399
but basically i think here we're trying

233
00:09:23,509 --> 00:09:20,560
to capture the idea that there are

234
00:09:25,509 --> 00:09:23,519
processes running within the cell and we

235
00:09:28,310 --> 00:09:25,519
are looking at how those processes

236
00:09:31,269 --> 00:09:28,320
evolved uh what they're adapting to what

237
00:09:33,269 --> 00:09:31,279
purposes they're serving

238
00:09:35,190 --> 00:09:33,279

question four what roles did chance and

239
00:09:37,509 --> 00:09:35,200
contingency play in determining major

240
00:09:39,990 --> 00:09:37,519
evolutionary transitions in history of

241
00:09:41,430 --> 00:09:40,000
life on earth

242
00:09:42,949 --> 00:09:41,440
a suite of major evolutionary

243
00:09:44,630 --> 00:09:42,959
transitions have been identified

244
00:09:46,550 --> 00:09:44,640
beginning with the origin of life and

245
00:09:48,230 --> 00:09:46,560
metabolism and extending through the

246
00:09:49,829 --> 00:09:48,240
origin of multicellularity to the

247
00:09:52,710 --> 00:09:49,839
evolution of social organisms and

248
00:09:55,509 --> 00:09:52,720
language this approach to mets focuses

249
00:09:57,750 --> 00:09:55,519
on changes in packaging information but

250
00:09:59,350 --> 00:09:57,760
there are alternative approaches to mets

251
00:10:01,190 --> 00:09:59,360
identifying environmental and

252
00:10:03,350 --> 00:10:01,200
developmental factors

253
00:10:04,710 --> 00:10:03,360
there is a great need for identifying

254
00:10:06,470 --> 00:10:04,720
excuse me there's a great need for

255
00:10:07,990 --> 00:10:06,480
connecting these different approaches

256
00:10:10,710 --> 00:10:08,000
and understanding the environmental

257
00:10:12,630 --> 00:10:10,720
context for meps the relative importance

258
00:10:14,389 --> 00:10:12,640
of contingency chance and necessity in

259
00:10:17,269 --> 00:10:14,399
the major mets of interest through

260
00:10:19,350 --> 00:10:17,279
astrobiology remains unresolved progress

261
00:10:21,030 --> 00:10:19,360
has been made in some areas such as

262
00:10:23,509 --> 00:10:21,040
whether the genetic code is a frozen

263
00:10:26,230 --> 00:10:23,519

accident or suggested by crick

264
00:10:27,670 --> 00:10:26,240
or as suggested

265
00:10:29,190 --> 00:10:27,680
excuse me

266
00:10:31,110 --> 00:10:29,200
weather genetic code is a frozen

267
00:10:33,190 --> 00:10:31,120
accident as suggested by crick and in

268
00:10:34,949 --> 00:10:33,200
aspects of cellularity

269
00:10:37,030 --> 00:10:34,959
yet the issue has hardly been addressed

270
00:10:38,630 --> 00:10:37,040
for other nats resolving this issue is

271
00:10:40,870 --> 00:10:38,640
critical for understanding the extent to

272
00:10:42,790 --> 00:10:40,880
which we can generalize from mets on

273
00:10:47,030 --> 00:10:42,800
earth to complex life

274
00:10:50,069 --> 00:10:48,710
uh similar to what i was talking about

275
00:10:52,630 --> 00:10:50,079
for the nano machines but here we're

276
00:10:55,350 --> 00:10:52,640
asking questions of how necessary is it

277
00:10:58,230 --> 00:10:55,360
to make transitions perhaps to higher

278
00:11:01,910 --> 00:10:58,240
levels of organization or

279
00:11:06,389 --> 00:11:03,990
five what is the correct understanding

280
00:11:07,509 --> 00:11:06,399
of earth life in context that would lead

281
00:11:09,829 --> 00:11:07,519
us to look for the correct

282
00:11:12,389 --> 00:11:09,839
characteristics of life in non-earth

283
00:11:14,949 --> 00:11:12,399
context so this is trying to separate

284
00:11:17,269 --> 00:11:14,959
out the differential differences between

285
00:11:20,870 --> 00:11:17,279
contingent life properties on earth and

286
00:11:21,750 --> 00:11:20,880
necessary life properties everywhere

287
00:11:23,910 --> 00:11:21,760
six

288
00:11:25,990 --> 00:11:23,920

if earth organisms exist that represent

289
00:11:28,550 --> 00:11:26,000
a second origin of life how would we

290
00:11:30,550 --> 00:11:28,560
recognize and differentiate them

291
00:11:32,470 --> 00:11:30,560
certainly this question of shadow life

292
00:11:35,750 --> 00:11:32,480
on earth begs the question

293
00:11:37,269 --> 00:11:35,760
of is there in fact some other

294
00:11:39,590 --> 00:11:37,279
type of earth

295
00:11:43,110 --> 00:11:39,600
some other type of life on earth other

296
00:11:44,870 --> 00:11:43,120
than the type we see in humans and c

297
00:11:47,350 --> 00:11:44,880
elegans and all the other things we

298
00:11:49,350 --> 00:11:47,360
normally associate with the tree of life

299
00:11:54,230 --> 00:11:49,360
if there is a type of life other than

300
00:11:58,310 --> 00:11:56,470
seven are there regimes or eras of

301
00:12:00,150 --> 00:11:58,320
evolutionary history that were

302
00:12:02,310 --> 00:12:00,160
constrained by different evolutionary

303
00:12:03,990 --> 00:12:02,320
rules or environmental processes

304
00:12:05,910 --> 00:12:04,000
for example following catastrophic

305
00:12:08,389 --> 00:12:05,920
extinctions were certain ecological

306
00:12:10,790 --> 00:12:08,399
rules suspended or altered are they

307
00:12:13,030 --> 00:12:10,800
capitulated at are they recapitulated at

308
00:12:14,550 --> 00:12:13,040
smaller spatial scales

309
00:12:16,310 --> 00:12:14,560
so here we're looking at this question

310
00:12:17,509 --> 00:12:16,320
of whether

311
00:12:19,430 --> 00:12:17,519
really we're looking at the question of

312
00:12:22,829 --> 00:12:19,440
how we want to characterize

313
00:12:25,350 --> 00:12:22,839

periods of time on earth when the

314
00:12:27,829 --> 00:12:25,360
adaptive constraints were

315
00:12:29,590 --> 00:12:27,839
different perhaps than they are now

316
00:12:32,069 --> 00:12:29,600
certainly the

317
00:12:33,509 --> 00:12:32,079
reducing atmosphere of early earth and

318
00:12:35,030 --> 00:12:33,519
the oxygenetic

319
00:12:37,430 --> 00:12:35,040
arm

320
00:12:40,150 --> 00:12:37,440
and the oxygenized atmosphere we

321
00:12:42,150 --> 00:12:40,160
currently have represent two different

322
00:12:44,389 --> 00:12:42,160
regimes so we're interested in the

323
00:12:46,389 --> 00:12:44,399
question of whether adaptations will be

324
00:12:48,870 --> 00:12:46,399
different at different times and whether

325
00:12:50,790 --> 00:12:48,880
we can expect similar adaptations for

326
00:12:52,710 --> 00:12:50,800
other planets one of the things that

327
00:12:55,350 --> 00:12:52,720
we're particularly looking at is this

328
00:12:56,470 --> 00:12:55,360
question of

329
00:12:58,629 --> 00:12:56,480
oxygen

330
00:13:03,670 --> 00:12:58,639
on other planets we usually consider an

331
00:13:05,430 --> 00:13:03,680
oxygen signature to be a good way of

332
00:13:07,750 --> 00:13:05,440
convincing ourselves that there might be

333
00:13:09,590 --> 00:13:07,760
life on another planet if that's the

334
00:13:11,110 --> 00:13:09,600
case then we can say an oxygenated

335
00:13:13,590 --> 00:13:11,120
atmosphere might be one of the

336
00:13:17,430 --> 00:13:13,600
conditions that life we're looking for

337
00:13:19,509 --> 00:13:17,440
elsewhere would have to adapt to

338
00:13:21,590 --> 00:13:19,519

eight what are the specific attributes

339
00:13:22,949 --> 00:13:21,600
of life at the base of the evolutionary

340
00:13:25,430 --> 00:13:22,959
tree so

341
00:13:26,550 --> 00:13:25,440
we're thinking if we can reconstruct the

342
00:13:28,710 --> 00:13:26,560
traits at the beginning of the

343
00:13:31,509 --> 00:13:28,720
evolutionary tree we can

344
00:13:33,670 --> 00:13:31,519
compare that to the environment on early

345
00:13:36,230 --> 00:13:33,680
earth when we expect the

346
00:13:39,430 --> 00:13:36,240
earliest organisms to have existed and

347
00:13:41,110 --> 00:13:39,440
use those to constrain the necessary and

348
00:13:43,590 --> 00:13:41,120
contingent

349
00:13:49,829 --> 00:13:47,829
and adaptations at that period of time

350
00:13:51,910 --> 00:13:49,839
what attributes of organisms species

351
00:13:53,910 --> 00:13:51,920
ecosystems etc have repeatedly

352
00:13:55,829 --> 00:13:53,920
originated by convergent evolution and

353
00:13:58,790 --> 00:13:55,839
under what circumstances would they be

354
00:14:01,990 --> 00:13:58,800
likely to appear or not on other planets

355
00:14:06,150 --> 00:14:04,470
been proposed for example that once you

356
00:14:07,269 --> 00:14:06,160
have a lot of life you will expect to

357
00:14:10,069 --> 00:14:07,279
find life

358
00:14:12,069 --> 00:14:10,079
somewhere in the atmosphere uh above the

359
00:14:14,790 --> 00:14:12,079
surface does that

360
00:14:17,269 --> 00:14:14,800
because there is space there does that

361
00:14:18,389 --> 00:14:17,279
mean that there is necessarily

362
00:14:19,829 --> 00:14:18,399
uh

363
00:14:21,910 --> 00:14:19,839

going to be some organism that has

364
00:14:23,829 --> 00:14:21,920
adapted to fill that space are there

365
00:14:26,069 --> 00:14:23,839
niches that we would expect to appear on

366
00:14:28,150 --> 00:14:26,079
any um

367
00:14:33,110 --> 00:14:28,160
on any planet uh that we expect

368
00:14:36,710 --> 00:14:34,710
10 is it inevitable that units of

369
00:14:40,310 --> 00:14:36,720
selection cluster into forms that act as

370
00:14:44,550 --> 00:14:40,320
higher level units of selection

371
00:14:46,470 --> 00:14:44,560
we can ask questions of whether the

372
00:14:48,069 --> 00:14:46,480
structure of cells

373
00:14:51,430 --> 00:14:48,079
is something that we think would be

374
00:14:52,870 --> 00:14:51,440
repeated whether the

375
00:14:58,710 --> 00:14:52,880
symbioses

376
00:15:01,990 --> 00:14:58,720
mitochondria and chloroplast

377
00:15:03,590 --> 00:15:02,000
might be such an advantageous adaptation

378
00:15:05,590 --> 00:15:03,600
to the environment we would expect it

379
00:15:07,350 --> 00:15:05,600
everywhere or whether we think that's

380
00:15:08,710 --> 00:15:07,360
just a rare event

381
00:15:10,710 --> 00:15:08,720
in that case

382
00:15:13,030 --> 00:15:10,720
we've actually seen endosymbiosis

383
00:15:15,990 --> 00:15:13,040
several times so maybe it is something

384
00:15:20,790 --> 00:15:19,110
11. how does modularity influence

385
00:15:22,870 --> 00:15:20,800
organization at multiple levels of

386
00:15:24,829 --> 00:15:22,880
biology and should we expect a similar

387
00:15:27,829 --> 00:15:24,839
modular structure in

388
00:15:32,389 --> 00:15:27,839

non-terrestrial life i think that's

389
00:15:38,069 --> 00:15:33,590
and that just brings us to our

390
00:15:40,870 --> 00:15:39,269
so you can

391
00:15:43,189 --> 00:15:40,880
plug into those

392
00:15:44,150 --> 00:15:43,199
discussions those webinars if you would

393
00:15:46,310 --> 00:15:44,160
like

394
00:15:54,710 --> 00:15:46,320
and that is my summary of what we came

395
00:16:00,069 --> 00:15:56,629
i just wanted to make sure my mic was

396
00:16:02,629 --> 00:16:00,079
open f uh thank you lucas um

397
00:16:05,110 --> 00:16:02,639
all right so uh looks do you want to

398
00:16:08,310 --> 00:16:05,120
come back to the question that bob

399
00:16:24,949 --> 00:16:08,320
raised just at the start only thoughts

400
00:16:29,590 --> 00:16:27,110
yes i think we definitely want to

401
00:16:30,389 --> 00:16:29,600
consider this question of

402
00:16:33,990 --> 00:16:30,399
um

403
00:16:36,550 --> 00:16:34,000
information storage of some kind and

404
00:16:39,509 --> 00:16:36,560
whether that information is necessarily

405
00:16:41,990 --> 00:16:39,519
going to be stored in dna or a similar

406
00:16:43,350 --> 00:16:42,000
molecule or contingently

407
00:16:45,030 --> 00:16:43,360
i know

408
00:16:47,430 --> 00:16:45,040
steve banner has

409
00:16:50,230 --> 00:16:47,440
published some things on

410
00:16:52,310 --> 00:16:50,240
the use of carbon whether we necessarily

411
00:16:55,030 --> 00:16:52,320
are looking for carbon molecules because

412
00:16:58,470 --> 00:16:55,040
they seem to be able to

413
00:16:59,590 --> 00:16:58,480

operate in more ways uh for more complex

414
00:17:01,269 --> 00:16:59,600
structures

415
00:17:03,509 --> 00:17:01,279
than other things

416
00:17:05,669 --> 00:17:03,519
uh bob is there anything else you'd like

417
00:17:07,990 --> 00:17:05,679
to anywhere else you'd like to run with

418
00:17:10,390 --> 00:17:08,000
that question

419
00:17:12,470 --> 00:17:10,400
yes can you hear me

420
00:17:13,350 --> 00:17:12,480
yes we can

421
00:17:15,270 --> 00:17:13,360
um

422
00:17:18,870 --> 00:17:15,280
basically uh

423
00:17:20,789 --> 00:17:18,880
my point is that if

424
00:17:23,829 --> 00:17:20,799
say mars life

425
00:17:27,270 --> 00:17:23,839
had gone into suspended animation

426
00:17:29,909 --> 00:17:27,280
because of the conditions deteriorating

427
00:17:30,870 --> 00:17:29,919
on the surface of the planet

428
00:17:33,669 --> 00:17:30,880
then

429
00:17:35,990 --> 00:17:33,679
there would be no activity other than

430
00:17:38,710 --> 00:17:36,000
the fact that these

431
00:17:39,669 --> 00:17:38,720
creatures have some kind of memory

432
00:17:44,830 --> 00:17:39,679
now

433
00:17:47,510 --> 00:17:44,840
mit and harvard are developing this dna

434
00:17:50,150 --> 00:17:47,520
detector that they hope will fly on a

435
00:17:52,950 --> 00:17:50,160
future mars mission

436
00:17:56,230 --> 00:17:52,960
but if these aliens

437
00:17:58,070 --> 00:17:56,240
have a different memory storage

438
00:18:01,029 --> 00:17:58,080

than dna

439
00:18:03,590 --> 00:18:01,039
then how would we detect

440
00:18:09,110 --> 00:18:03,600
these aliens that are in suspended

441
00:18:14,150 --> 00:18:11,750
i think that has to be uh

442
00:18:16,470 --> 00:18:14,160
necessary i think that has to be an

443
00:18:18,630 --> 00:18:16,480
important part of research

444
00:18:20,870 --> 00:18:18,640
for the future uh

445
00:18:23,350 --> 00:18:20,880
for me that's one of the big take-home

446
00:18:24,310 --> 00:18:23,360
messages uh from this question

447
00:18:26,150 --> 00:18:24,320
is

448
00:18:27,830 --> 00:18:26,160
what sorts of things are we looking for

449
00:18:29,430 --> 00:18:27,840
and why do we think that they will be

450
00:18:31,510 --> 00:18:29,440
necessary

451
00:18:33,909 --> 00:18:31,520
personally i find

452
00:18:35,990 --> 00:18:33,919
the quest the idea that dna is necessary

453
00:18:38,710 --> 00:18:36,000
for all life in the universe

454
00:18:40,549 --> 00:18:38,720
uh highly problematic i would expect

455
00:18:41,669 --> 00:18:40,559
some other kind of information storage

456
00:18:43,430 --> 00:18:41,679
molecule

457
00:18:44,950 --> 00:18:43,440
but i do think that the information

458
00:18:47,270 --> 00:18:44,960
storage molecule is going to have to

459
00:18:49,510 --> 00:18:47,280
have some

460
00:18:50,870 --> 00:18:49,520
property of organization

461
00:18:53,029 --> 00:18:50,880
uh some

462
00:18:56,710 --> 00:18:53,039
information content

463
00:18:59,110 --> 00:18:56,720

that might be discernible i'm still

464
00:19:02,789 --> 00:18:59,120
fuzzy on what that would be

465
00:19:04,310 --> 00:19:02,799
um if there's perhaps some an entropic

466
00:19:07,430 --> 00:19:04,320
there we go repeating sequence of

467
00:19:08,390 --> 00:19:07,440
certain molecules from kelly lane

468
00:19:11,750 --> 00:19:08,400
yes

469
00:19:14,310 --> 00:19:11,760
some level of repetition which is

470
00:19:15,669 --> 00:19:14,320
higher than we would expect from abiotic

471
00:19:18,549 --> 00:19:15,679
sources

472
00:19:22,230 --> 00:19:18,559
and yet not completely random

473
00:19:26,310 --> 00:19:23,990
presumably the ultimate answer will be

474
00:19:29,669 --> 00:19:26,320
graphene because the unfortunate

475
00:19:32,470 --> 00:19:29,679
everything is graphene at the moment um

476
00:19:35,270 --> 00:19:32,480
other other questions you're welcome to

477
00:19:37,830 --> 00:19:35,280
type them in uh the phone lines are

478
00:19:39,669 --> 00:19:37,840
actually open so if you just take

479
00:19:41,510 --> 00:19:39,679
yourself off mute

480
00:19:43,110 --> 00:19:41,520
we're only a small group so i'm not

481
00:19:44,789 --> 00:19:43,120
going to suggest that you have to raise

482
00:19:47,110 --> 00:19:44,799
your hands but

483
00:19:50,310 --> 00:19:47,120
other thoughts or questions particularly

484
00:19:52,070 --> 00:19:50,320
because anything that you add here

485
00:19:54,470 --> 00:19:52,080
and in the document afterwards can help

486
00:19:58,150 --> 00:19:54,480
the group uh improve their documents as

487
00:20:00,870 --> 00:19:58,160
we're moving them towards uh a more uh a

488
00:20:02,630 --> 00:20:00,880

broader publication on that so

489
00:20:22,150 --> 00:20:02,640
other thoughts or questions that people

490
00:20:25,669 --> 00:20:23,750
for a moment this takes me back to when

491
00:20:29,510 --> 00:20:25,679
i used to teach nba classes when you

492
00:20:33,590 --> 00:20:31,430
but i shan't

493
00:20:35,830 --> 00:20:33,600
i'm going to throw a question out there

494
00:20:38,630 --> 00:20:35,840
that's maybe a little bit more specific

495
00:20:40,870 --> 00:20:38,640
uh hopefully it will get things rolling

496
00:20:43,990 --> 00:20:40,880
what do you think are

497
00:20:45,430 --> 00:20:44,000
perhaps universal traits of life on

498
00:20:46,390 --> 00:20:45,440
earth

499
00:20:49,510 --> 00:20:46,400
that we

500
00:20:50,789 --> 00:20:49,520
might consider dna is certainly one

501
00:20:52,710 --> 00:20:50,799
that's been

502
00:20:54,230 --> 00:20:52,720
thrown out there already are there

503
00:21:15,590 --> 00:20:54,240
others

504
00:21:15,600 --> 00:21:18,390
hello

505
00:21:22,950 --> 00:21:20,789
yep go right ahead

506
00:21:25,190 --> 00:21:22,960
hi i i

507
00:21:26,789 --> 00:21:25,200
my hands got faster than my brain on

508
00:21:28,950 --> 00:21:26,799
what i typed

509
00:21:30,630 --> 00:21:28,960
basically

510
00:21:33,029 --> 00:21:30,640
may be other mechanisms

511
00:21:34,870 --> 00:21:33,039
for uh memory storage or information

512
00:21:35,830 --> 00:21:34,880
storage out there that we don't know

513
00:21:36,789 --> 00:21:35,840

about

514
00:21:39,270 --> 00:21:36,799
uh

515
00:21:41,909 --> 00:21:39,280
but we do know about dna here on earth

516
00:21:43,990 --> 00:21:41,919
uh but what we don't know about mars is

517
00:21:46,549 --> 00:21:44,000
whether there's any organic material in

518
00:21:48,710 --> 00:21:46,559
the sediments at all

519
00:21:50,390 --> 00:21:48,720
that has not been established as yet

520
00:21:51,990 --> 00:21:50,400
and that would be a big discovery if it

521
00:21:53,270 --> 00:21:52,000
happens

522
00:21:55,430 --> 00:21:53,280
and

523
00:21:57,909 --> 00:21:55,440
to characterize the organics if they are

524
00:21:59,750 --> 00:21:57,919
found would be the next step and to see

525
00:22:02,630 --> 00:21:59,760
if there are any structures that are

526
00:22:04,149 --> 00:22:02,640
reminiscent of life such as in organic

527
00:22:08,270 --> 00:22:04,159
geochemistry

528
00:22:11,270 --> 00:22:08,280
and you know dna would be wonderful but

529
00:22:12,950 --> 00:22:11,280
i think it's reasonable that

530
00:22:14,710 --> 00:22:12,960
other other things might be out there

531
00:22:16,470 --> 00:22:14,720
but i have no clue as to

532
00:22:22,549 --> 00:22:16,480
what we should look for beyond dna at

533
00:22:22,559 --> 00:24:10,470
i will go mute thank you

534
00:24:12,230 --> 00:24:11,350
system

535
00:24:14,789 --> 00:24:12,240
um

536
00:24:16,950 --> 00:24:14,799
and i think both of those uh once again

537
00:24:18,710 --> 00:24:16,960
return us to this dna question

538
00:24:21,830 --> 00:24:18,720

uh it would be

539
00:24:23,830 --> 00:24:21,840
lovely to find dna because it is

540
00:24:25,190 --> 00:24:23,840
unambiguously

541
00:24:27,269 --> 00:24:25,200
uh

542
00:24:29,029 --> 00:24:27,279
informative

543
00:24:30,830 --> 00:24:29,039
but it's sort of unclear what else would

544
00:24:32,549 --> 00:24:30,840
be unambiguously

545
00:24:33,909 --> 00:24:32,559
informative

546
00:24:36,390 --> 00:24:33,919
and i think

547
00:24:39,029 --> 00:24:36,400
a real benefit of the line of research

548
00:24:41,909 --> 00:24:39,039
uh presented under this head is rather

549
00:24:44,070 --> 00:24:41,919
than ask the open-ended question what is

550
00:24:45,830 --> 00:24:44,080
there out there that we might find

551
00:24:47,990 --> 00:24:45,840
it's asking the question what's common

552
00:24:49,510 --> 00:24:48,000
to all life on earth and is there some

553
00:24:53,430 --> 00:24:49,520
reason we should expect it would be

554
00:24:58,310 --> 00:24:55,590
um

555
00:25:00,149 --> 00:24:58,320
so perhaps there is some aspect of

556
00:25:01,430 --> 00:25:00,159
metabolism that we expect to be

557
00:25:03,269 --> 00:25:01,440
universal

558
00:25:05,269 --> 00:25:03,279
information storage is there but hard to

559
00:25:08,789 --> 00:25:05,279
detect

560
00:25:12,070 --> 00:25:08,799
scavenging perhaps scavenging of

561
00:25:18,230 --> 00:25:15,510
radicals uh electrons protons

562
00:25:19,830 --> 00:25:18,240
can we think of some way we might

563
00:25:22,070 --> 00:25:19,840

characterize

564
00:25:43,269 --> 00:25:22,080
removing those from the environment that

565
00:25:47,350 --> 00:25:45,350
bob if it's easier for you to speak

566
00:25:49,190 --> 00:25:47,360
rather than type you're welcome to do

567
00:26:24,710 --> 00:25:49,200
that as applies to everyone else of

568
00:26:24,720 --> 00:26:29,510
it's ron again hi

569
00:26:33,590 --> 00:26:31,510
i'm getting a delay on i'm hearing back

570
00:26:36,230 --> 00:26:33,600
from you guys on my system

571
00:26:41,350 --> 00:26:39,830
detecting that macromolecules uh such as

572
00:26:43,430 --> 00:26:41,360
dna

573
00:26:45,990 --> 00:26:43,440
would be wonderful but

574
00:26:47,669 --> 00:26:46,000
that's an a priori assumption that

575
00:26:49,590 --> 00:26:47,679
whatever is out there is going to be our

576
00:26:52,390 --> 00:26:49,600
model system

577
00:26:54,630 --> 00:26:52,400
uh detection of metabolic activity would

578
00:26:56,950 --> 00:26:54,640
be wonderful

579
00:26:58,630 --> 00:26:56,960
but that's hard the viking experiments

580
00:27:01,190 --> 00:26:58,640
were

581
00:27:04,390 --> 00:27:01,200
not so easy to interpret and they all

582
00:27:06,390 --> 00:27:04,400
leaned in the negative area

583
00:27:07,909 --> 00:27:06,400
that you have to make an assumption that

584
00:27:09,990 --> 00:27:07,919
what you're giving them to eat will be

585
00:27:11,269 --> 00:27:10,000
metabolized that's hard enough to do

586
00:27:12,149 --> 00:27:11,279
here on earth

587
00:27:15,269 --> 00:27:12,159
uh

588
00:27:16,549 --> 00:27:15,279

let alone a system that we

589
00:27:19,510 --> 00:27:16,559
are dubious with if there is

590
00:27:21,110 --> 00:27:19,520
microorganisms in the soil

591
00:27:23,669 --> 00:27:21,120
one thing i don't think has been

592
00:27:26,310 --> 00:27:23,679
particularly well explored is the use of

593
00:27:27,190 --> 00:27:26,320
stable isotope fractionation

594
00:27:29,110 --> 00:27:27,200
uh

595
00:27:31,909 --> 00:27:29,120
to detect products

596
00:27:33,990 --> 00:27:31,919
that have been formed by reactants

597
00:27:35,669 --> 00:27:34,000
that already exist in the system we are

598
00:27:36,710 --> 00:27:35,679
going to study

599
00:27:41,190 --> 00:27:36,720
so

600
00:27:42,789 --> 00:27:41,200
is very well known on earth the best

601
00:27:47,110 --> 00:27:42,799
example being

602
00:27:52,870 --> 00:27:50,390
behind methane that's enriched to nc13

603
00:27:54,070 --> 00:27:52,880
and co2 that's well enriched in carbon

604
00:27:56,630 --> 00:27:54,080
12

605
00:27:58,149 --> 00:27:56,640
as very very clear signals for

606
00:28:00,070 --> 00:27:58,159
biological

607
00:28:03,029 --> 00:28:00,080
methane oxidation as well as methane

608
00:28:05,909 --> 00:28:03,039
production

609
00:28:07,669 --> 00:28:05,919
the advantage of something like that

610
00:28:09,990 --> 00:28:07,679
is

611
00:28:12,470 --> 00:28:10,000
in easily measure

612
00:28:13,350 --> 00:28:12,480
the stable isotopes that are that are

613
00:28:15,590 --> 00:28:13,360

given

614
00:28:17,110 --> 00:28:15,600
for say a hydrocarbon in the system once

615
00:28:18,549 --> 00:28:17,120
you know they are there

616
00:28:20,149 --> 00:28:18,559
and to look at

617
00:28:21,669 --> 00:28:20,159
potential products

618
00:28:23,029 --> 00:28:21,679
uh to see if they are enriched in the

619
00:28:25,990 --> 00:28:23,039
lighter isotope that would be a

620
00:28:28,149 --> 00:28:26,000
signature for the presence of life

621
00:28:31,029 --> 00:28:28,159
uh on an uh

622
00:28:33,269 --> 00:28:31,039
an extraterrestrial body

623
00:28:35,909 --> 00:28:33,279
i'm thinking specifically of perhaps

624
00:28:38,230 --> 00:28:35,919
titan or enceladus

625
00:28:40,789 --> 00:28:38,240
and maybe the metabolism of

626
00:28:43,909 --> 00:28:40,799
acetylene

627
00:28:45,190 --> 00:28:43,919
to acetate my biological systems could

628
00:28:47,750 --> 00:28:45,200
enrich

629
00:28:49,909 --> 00:28:47,760
uh acetate and carbon-12 relative to the

630
00:28:51,990 --> 00:28:49,919
starting acetylene

631
00:28:54,310 --> 00:28:52,000
and that would allow you to say yes

632
00:28:56,389 --> 00:28:54,320
there's life there based on what we know

633
00:28:59,750 --> 00:28:56,399
occurs in in terrestrial anaerobic

634
00:29:00,789 --> 00:28:59,760
systems for that metabolize acetylene

635
00:29:02,310 --> 00:29:00,799
and we wouldn't have to do any

636
00:29:03,750 --> 00:29:02,320
incubation experiments we can just

637
00:29:04,950 --> 00:29:03,760
collect the stuff

638
00:29:06,389 --> 00:29:04,960

anyway

639
00:29:08,310 --> 00:29:06,399
that's just an example i'm sure there

640
00:29:09,990 --> 00:29:08,320
are better ones than what i came up with

641
00:29:12,070 --> 00:29:10,000
but

642
00:29:13,110 --> 00:29:12,080
it eliminates

643
00:29:15,510 --> 00:29:13,120
the

644
00:29:17,430 --> 00:29:15,520
difficulty of conducting a metabolic

645
00:29:19,990 --> 00:29:17,440
experiment ella viking

646
00:29:22,230 --> 00:29:20,000
as well as a priori looking for

647
00:29:24,029 --> 00:29:22,240
something like dna

648
00:29:25,430 --> 00:29:24,039
and then having to rule out

649
00:29:27,750 --> 00:29:25,440
unequivocally that it's not

650
00:29:31,269 --> 00:29:27,760
contamination by one of the guys at jpl

651
00:29:33,909 --> 00:29:31,279
who sneezed into the collectivism anyway

652
00:29:38,789 --> 00:29:33,919
that's all i have to say

653
00:29:43,669 --> 00:29:41,029
lucas do you want to pick up bob's

654
00:29:51,590 --> 00:29:43,679
question as well that he's just typed

655
00:29:57,430 --> 00:29:54,070
so bob is asking this question of uh

656
00:29:59,510 --> 00:29:57,440
organic carbon deposition and whether

657
00:30:00,870 --> 00:29:59,520
carbon is going to survive in certain

658
00:30:03,350 --> 00:30:00,880
environments

659
00:30:05,350 --> 00:30:03,360
uh again i think one of the central

660
00:30:07,350 --> 00:30:05,360
questions we have to deal with i would

661
00:30:08,470 --> 00:30:07,360
perhaps take a step back and ask the

662
00:30:11,990 --> 00:30:08,480
people here

663
00:30:13,750 --> 00:30:12,000

do you think carbon is necessarily

664
00:30:16,149 --> 00:30:13,760
what we're looking for so when i say

665
00:30:17,430 --> 00:30:16,159
organic chemistry i mean carbon-based

666
00:30:20,870 --> 00:30:17,440
chemistry

667
00:30:22,389 --> 00:30:20,880
we always looking for carbon-based

668
00:30:23,750 --> 00:30:22,399
chemistry or

669
00:30:25,750 --> 00:30:23,760
um

670
00:30:27,269 --> 00:30:25,760
are we imagining something like silicon

671
00:30:29,269 --> 00:30:27,279
deep in the

672
00:30:31,029 --> 00:30:29,279
clouds of jupiter where the pressure is

673
00:30:33,669 --> 00:30:31,039
high enough perhaps to make a

674
00:30:35,350 --> 00:30:33,679
silicon-based uh information storage

675
00:30:52,389 --> 00:30:35,360
molecule possible

676
00:31:12,310 --> 00:30:54,310
and the sound of deep thinking could be

677
00:31:17,029 --> 00:31:14,789
mike how hard it would be to just uh

678
00:31:18,870 --> 00:31:17,039
pull up a quick survey

679
00:31:21,269 --> 00:31:18,880
uh that way we can

680
00:31:23,510 --> 00:31:21,279
poke people a little bit to commit to

681
00:31:24,950 --> 00:31:23,520
whether they think carbon is a good

682
00:31:29,029 --> 00:31:24,960
foundation

683
00:31:30,710 --> 00:31:29,039
not

684
00:31:35,029 --> 00:31:30,720
we could do that so just a yes no

685
00:31:40,310 --> 00:31:38,149
is the question is is carbon

686
00:31:42,549 --> 00:31:40,320
is carbon a necessary

687
00:31:46,549 --> 00:31:42,559
feature of life

688
00:31:53,350 --> 00:31:49,990

how about a yes uh no and uh

689
00:31:55,350 --> 00:31:53,360
you wanna possibly or not sure option

690
00:32:17,350 --> 00:31:55,360
uh no i wanna make people commit to yes

691
00:32:20,389 --> 00:32:18,630
okay and uh just so you know all you

692
00:32:31,990 --> 00:32:20,399
have to do is select an option to cast

693
00:32:32,000 --> 00:32:54,830
so andy and mike you guys

694
00:32:59,590 --> 00:32:57,909
six mike i saw your lips moving and i

695
00:33:00,789 --> 00:32:59,600
heard something but i didn't get words

696
00:33:20,549 --> 00:33:00,799
out of that

697
00:33:20,559 --> 00:33:31,190
okay

698
00:33:35,509 --> 00:33:34,310
i love it when we get uh 50 50 results

699
00:33:38,710 --> 00:33:35,519
here

700
00:33:41,350 --> 00:33:38,720
had

701
00:33:43,830 --> 00:33:41,360
perhaps someone who thinks that uh

702
00:33:46,950 --> 00:33:43,840
there is no non-carbon-based life would

703
00:34:13,430 --> 00:33:46,960
like to speak up on why they think

704
00:34:13,440 --> 00:34:58,150
uh

705
00:35:02,630 --> 00:35:00,069
i think paulie sums it up pretty nicely

706
00:35:05,910 --> 00:35:02,640
he says we know only one kind of life

707
00:35:08,150 --> 00:35:05,920
can we make conclusions uh certainly

708
00:35:09,270 --> 00:35:08,160
i would say from a philosophical

709
00:35:11,589 --> 00:35:09,280
standpoint

710
00:35:13,349 --> 00:35:11,599
uh going from n equals one your

711
00:35:15,430 --> 00:35:13,359
confidence in your conclusions is going

712
00:35:17,670 --> 00:35:15,440
to be fairly weak

713
00:35:19,510 --> 00:35:17,680

nonetheless we have a task that

714
00:35:21,670 --> 00:35:19,520
theoretically we wish to complete which

715
00:35:23,670 --> 00:35:21,680
is the search for life elsewhere

716
00:35:26,870 --> 00:35:23,680
uh well complete might not be the right

717
00:35:28,069 --> 00:35:26,880
word an endeavor we pursue

718
00:35:29,510 --> 00:35:28,079
uh

719
00:35:32,310 --> 00:35:29,520
so i would maintain that some

720
00:35:33,829 --> 00:35:32,320
operational definition of life for

721
00:35:35,750 --> 00:35:33,839
um

722
00:35:39,430 --> 00:35:35,760
trying to think of the exact words that

723
00:35:41,750 --> 00:35:39,440
uh cleland and shaiba use in the article

724
00:35:43,910 --> 00:35:41,760
in planets and life but we need a

725
00:36:29,990 --> 00:35:43,920
testable

726
00:36:34,630 --> 00:36:32,630
i agree with with ron's comment uh

727
00:36:36,310 --> 00:36:34,640
i'm having trouble imagining anything

728
00:36:38,630 --> 00:36:36,320
other than carbon working and since i

729
00:36:41,270 --> 00:36:38,640
know carbon works at least once

730
00:36:43,589 --> 00:36:41,280
that seems a strong case for it possibly

731
00:36:46,870 --> 00:36:43,599
working somewhere else uh it's hard to

732
00:36:49,910 --> 00:36:46,880
imagine a strong case for something else

733
00:36:52,310 --> 00:36:49,920
uh i flirt with nitrogen on occasion

734
00:37:09,270 --> 00:36:52,320
but uh

735
00:37:13,109 --> 00:37:11,349
yay we have a universal feature of life

736
00:37:14,310 --> 00:37:13,119
or at least one that no one's willing to

737
00:37:15,910 --> 00:37:14,320
uh

738
00:37:18,069 --> 00:37:15,920

argue against at the moment so we're

739
00:37:20,710 --> 00:37:18,079
looking for carbon

740
00:37:23,829 --> 00:37:20,720
uh what else

741
00:37:25,589 --> 00:37:23,839
how about liquid water

742
00:37:28,230 --> 00:37:25,599
let's uh

743
00:37:29,990 --> 00:37:28,240
mike let's go for another poll here

744
00:38:17,109 --> 00:37:30,000
about the liquid water unnecessary

745
00:38:19,990 --> 00:38:18,470
okay

746
00:38:22,470 --> 00:38:20,000
it looks like

747
00:38:24,550 --> 00:38:22,480
we have one person who's claiming

748
00:38:27,510 --> 00:38:24,560
that uh liquid water is a necessary

749
00:38:28,710 --> 00:38:27,520
condition of life i think that's the

750
00:38:32,390 --> 00:38:28,720
um

751
00:38:34,710 --> 00:38:32,400
carbon

752
00:38:38,310 --> 00:38:34,720
so who would like to defend

753
00:38:40,230 --> 00:38:38,320
another uh presumably another solvent

754
00:38:41,349 --> 00:38:40,240
for life

755
00:38:44,790 --> 00:38:41,359
yep

756
00:38:51,589 --> 00:38:46,550
who wants to propose an alternative

757
00:38:54,630 --> 00:38:52,790
uh

758
00:38:56,710 --> 00:38:54,640
can you hear me

759
00:38:59,589 --> 00:38:56,720
yes

760
00:39:01,349 --> 00:38:59,599
it's been proposed on titan that

761
00:39:03,750 --> 00:39:01,359
methane uh

762
00:39:05,829 --> 00:39:03,760
and ethane might serve as uh

763
00:39:06,790 --> 00:39:05,839

solvents for life

764
00:39:08,710 --> 00:39:06,800
but

765
00:39:12,069 --> 00:39:08,720
since there there's a hydrologic cycle

766
00:39:13,510 --> 00:39:12,079
on on titan based on those hydrocarbons

767
00:39:16,150 --> 00:39:13,520
and there's a lot of good things that

768
00:39:19,670 --> 00:39:16,160
could dissolve into it and uh

769
00:39:23,430 --> 00:39:19,680
sustain an analog of life as we know it

770
00:39:25,270 --> 00:39:23,440
albeit at extremely low temperatures

771
00:39:26,390 --> 00:39:25,280
whether it's true or not is is another

772
00:39:28,790 --> 00:39:26,400
story but

773
00:39:31,829 --> 00:39:28,800
uh hypothetically speaking yeah it could

774
00:39:37,910 --> 00:39:31,839
probably work chris mckay is uh

775
00:39:42,630 --> 00:39:40,710
do we know what range of temperature

776
00:39:43,670 --> 00:39:42,640
uh and pressure

777
00:39:45,589 --> 00:39:43,680
uh

778
00:39:49,589 --> 00:39:45,599
me saying methane and combinations

779
00:39:51,750 --> 00:39:49,599
thereof would be liquid under

780
00:39:54,310 --> 00:39:51,760
it's what about uh

781
00:39:56,550 --> 00:39:54,320
90 degrees kelvin and it's roughly about

782
00:40:00,470 --> 00:39:56,560
twice the atmosphere of

783
00:40:03,030 --> 00:40:00,480
the atmospheric pressure of uh earth

784
00:40:05,190 --> 00:40:03,040
very cold and and some high pressure but

785
00:40:06,310 --> 00:40:05,200
not not excessive

786
00:40:08,630 --> 00:40:06,320
right now i'm

787
00:40:12,150 --> 00:40:08,640
not just um

788
00:40:14,470 --> 00:40:12,160

tighten the question is um

789
00:40:17,430 --> 00:40:14,480
the question is how broad the range of

790
00:40:19,829 --> 00:40:17,440
temperatures it stays liquid under one

791
00:40:21,349 --> 00:40:19,839
of the benefits of water is we have this

792
00:40:24,630 --> 00:40:21,359
large range

793
00:40:26,630 --> 00:40:24,640
of 100 kelvin

794
00:40:29,030 --> 00:40:26,640
through which it stays liquid

795
00:40:30,950 --> 00:40:29,040
and the question is whether our

796
00:40:35,589 --> 00:40:30,960
methane ethane mix

797
00:40:35,599 --> 00:40:45,030
good point i don't know of hand

798
00:40:50,069 --> 00:40:47,030
that's definitely a great option anyone

799
00:41:24,870 --> 00:40:50,079
want to propose another option

800
00:41:28,150 --> 00:41:26,309
all right well we

801
00:41:29,990 --> 00:41:28,160
was there a comment there

802
00:41:33,109 --> 00:41:30,000
no actually lucas i was just i was just

803
00:41:34,470 --> 00:41:33,119
going to suggest that uh at this point

804
00:41:37,510 --> 00:41:34,480
unless there are

805
00:41:39,990 --> 00:41:37,520
any other questions or ideas that people

806
00:41:42,390 --> 00:41:40,000
want to chip in we might draw it to a

807
00:41:45,190 --> 00:41:42,400
close on the understanding but uh what

808
00:41:46,870 --> 00:41:45,200
the team really need is for you to dig

809
00:41:49,589 --> 00:41:46,880
into the document so if you just give us

810
00:41:52,069 --> 00:41:49,599
a few minutes just to flip the switch

811
00:41:53,910 --> 00:41:52,079
and start putting in your comments just

812
00:41:56,710 --> 00:41:53,920
in case anyone hasn't done this or

813
00:41:58,309 --> 00:41:56,720

anyone's watching uh this later and

814
00:42:01,190 --> 00:41:58,319
hasn't done it

815
00:42:04,069 --> 00:42:01,200
we're asking you to log into your google

816
00:42:06,230 --> 00:42:04,079
account just so we can see who is

817
00:42:08,069 --> 00:42:06,240
writing which comments in case the

818
00:42:09,190 --> 00:42:08,079
authors need to follow it up with you

819
00:42:11,109 --> 00:42:09,200
afterwards

820
00:42:13,190 --> 00:42:11,119
and the commenting process is terribly

821
00:42:15,670 --> 00:42:13,200
simple you highlight a block of text you

822
00:42:17,750 --> 00:42:15,680
right click and choose add comment and

823
00:42:19,109 --> 00:42:17,760
you get a little post-it note pop-up at

824
00:42:21,349 --> 00:42:19,119
the side

825
00:42:22,630 --> 00:42:21,359
and that's how we're collecting people's

826
00:42:23,430 --> 00:42:22,640
thoughts on that

827
00:42:25,430 --> 00:42:23,440
so

828
00:42:27,430 --> 00:42:25,440
having said that lucas thank you very

829
00:42:31,030 --> 00:42:27,440
much appreciate that we appreciate all

830
00:42:33,750 --> 00:42:31,040
the input from uh everyone out there and

831
00:42:35,750 --> 00:42:33,760
we will now go and change the status of

832
00:42:37,990 --> 00:42:35,760
the document and see you all in a

833
00:42:39,829 --> 00:42:38,000
different format um