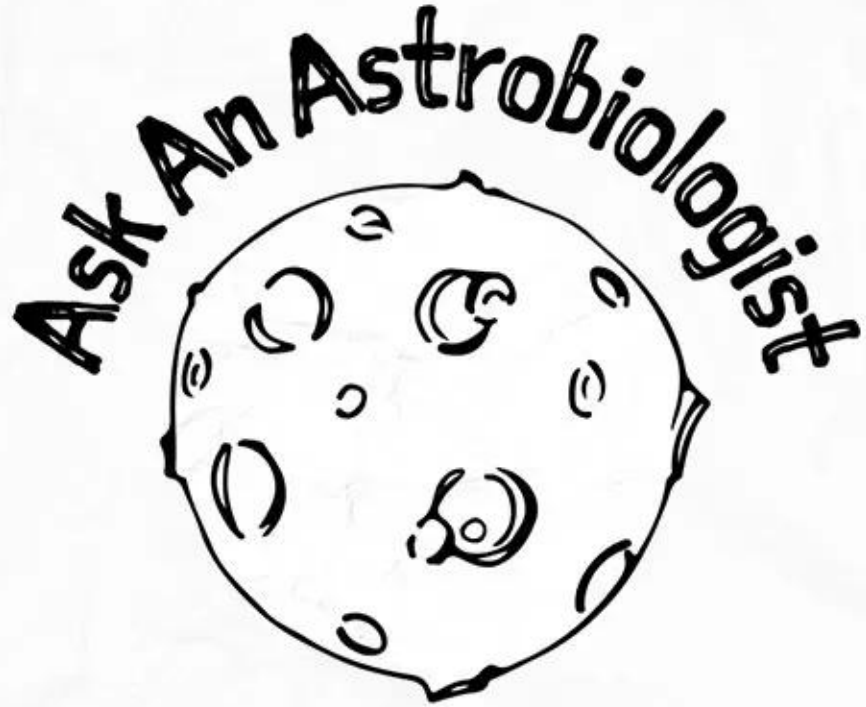

Episode 9: November 2nd, 2017

Dr. Carl Pilcher

NASA Astrobiology Program

1
00:00:00,510 --> 00:00:29,830
[Music]

2
00:00:34,130 --> 00:00:31,939
greetings friends of astrobiology

3
00:00:36,260 --> 00:00:34,140
welcome to a brand-new episode of ask

4
00:00:37,970 --> 00:00:36,270
and astrobiologist a show where we

5
00:00:40,160 --> 00:00:37,980
celebrate science and celebrate

6
00:00:41,720 --> 00:00:40,170
scientists my name is Sandra salmon this

7
00:00:44,060 --> 00:00:41,730
program is made possible by

8
00:00:46,490 --> 00:00:44,070
contributions from Elsie the Earth Life

9
00:00:48,470 --> 00:00:46,500
Science Institute at Tokyo Tech the NASA

10
00:00:50,630 --> 00:00:48,480
Astrobiology program and a non-profit

11
00:00:52,130 --> 00:00:50,640
bloom rabu space today we have the

12
00:00:54,860 --> 00:00:52,140
immense privilege or welcome to the show

13
00:00:57,049 --> 00:00:54,870

dr. Carl Pilcher but before we start

14
00:00:59,959 --> 00:00:57,059
talking to him it is time for our

15
00:01:02,029 --> 00:00:59,969
monthly background quiz so Mike if you

16
00:01:06,230 --> 00:01:02,039
could pop up the background from last

17
00:01:09,350 --> 00:01:06,240
time it was of course the stromatolites

18
00:01:11,330 --> 00:01:09,360
from Shark Bay Australia evidence of

19
00:01:13,370 --> 00:01:11,340
ancient life that has managed to eke out

20
00:01:15,740 --> 00:01:13,380
a living even into this modern day and

21
00:01:17,480 --> 00:01:15,750
they are likely the source of the oxygen

22
00:01:18,859 --> 00:01:17,490
that started accumulating on our planet

23
00:01:21,289 --> 00:01:18,869
about two and a half billion years ago

24
00:01:25,820 --> 00:01:21,299
and the first person who got it right

25
00:01:27,460 --> 00:01:25,830
big shout out - JA - Jason major who got

26
00:01:30,880 --> 00:01:27,470
it right so congratulations to you and

27
00:01:34,340 --> 00:01:30,890
and the background this month is

28
00:01:35,990 --> 00:01:34,350
probably a tad easier it is a moon in

29
00:01:38,480 --> 00:01:36,000
the outer solar system I think you all

30
00:01:40,010 --> 00:01:38,490
know it but if you know it make sure you

31
00:01:41,929 --> 00:01:40,020
use hashtag ask

32
00:01:43,819 --> 00:01:41,939
Astro bio to tell your answer and if any

33
00:01:46,219 --> 00:01:43,829
points during this program you have a

34
00:01:48,469 --> 00:01:46,229
question for dr. Pilcher make sure you

35
00:01:50,030 --> 00:01:48,479
use hashtag ask Esther bio on Twitter or

36
00:01:54,020 --> 00:01:50,040
ask your questions directly on the

37
00:01:55,370 --> 00:01:54,030
Signet org chat Carl it is immensely

38
00:01:57,920 --> 00:01:55,380

wonderful to have you on a program

39
00:02:00,410 --> 00:01:57,930
welcome Thank You San Joey it's great to

40
00:02:02,060 --> 00:02:00,420
be here with everybody you know what I

41
00:02:03,889 --> 00:02:02,070
when I was coming to the studio this

42
00:02:05,749 --> 00:02:03,899
morning I was going over the questions I

43
00:02:07,819 --> 00:02:05,759
was gonna ask you about how you youth

44
00:02:10,490 --> 00:02:07,829
contributed to your choices in your

45
00:02:12,260 --> 00:02:10,500
professional career and so on but as I

46
00:02:12,920 --> 00:02:12,270
came over I decided to throw all out of

47
00:02:14,869 --> 00:02:12,930
the window

48
00:02:17,660 --> 00:02:14,879
just begin this program but just saying

49
00:02:19,490 --> 00:02:17,670
thank you thank you for all that you

50
00:02:21,020 --> 00:02:19,500
have done for the astrobiology as a

51
00:02:23,780 --> 00:02:21,030
discipline all that you've done for

52
00:02:25,819 --> 00:02:23,790
astrobiology as a community many of us

53
00:02:29,360 --> 00:02:25,829
who are early carriers or almost early

54
00:02:31,250 --> 00:02:29,370
careers owe you the ability to do

55
00:02:33,080 --> 00:02:31,260
astrobiology as a profession you are

56
00:02:34,699 --> 00:02:33,090
influential when we were students and I

57
00:02:36,860 --> 00:02:34,709
know you were influential also for

58
00:02:40,910 --> 00:02:36,870
professional scientists who are actively

59
00:02:43,490 --> 00:02:40,920
involved in astrobiology as a research

60
00:02:46,030 --> 00:02:43,500
topic so I can't speak on behalf of

61
00:02:48,679 --> 00:02:46,040
anyone but I know from the incredible

62
00:02:50,300 --> 00:02:48,689
session we had for you at the

63
00:02:52,970 --> 00:02:50,310

astrobiology science conference that

64
00:02:54,710 --> 00:02:52,980
everybody would agree to just thank you

65
00:02:57,349 --> 00:02:54,720
for the amazing contributions you've

66
00:02:59,089 --> 00:02:57,359
done to our discipline well Sandra I

67
00:03:01,399 --> 00:02:59,099
thank you and and thanks to the

68
00:03:04,009 --> 00:03:01,409
community and and particularly the the

69
00:03:06,890 --> 00:03:04,019
early career community this has been the

70
00:03:10,879 --> 00:03:06,900
most rewarding thing I think I have ever

71
00:03:13,940 --> 00:03:10,889
done in my career when the opportunity

72
00:03:16,039 --> 00:03:13,950
to become director at the NAIA opened up

73
00:03:21,289 --> 00:03:16,049
there was not a job on earth that I

74
00:03:23,930 --> 00:03:21,299
wanted more than that job and the I I

75
00:03:26,149 --> 00:03:23,940
have to give a lot of credit to the

76
00:03:29,599 --> 00:03:26,159
principal investigators in the NAI too

77
00:03:32,500 --> 00:03:29,609
because as soon as I came into the job

78
00:03:35,089 --> 00:03:32,510
we were in a financial crisis the

79
00:03:38,780 --> 00:03:35,099
astrobiology program had just got cut

80
00:03:43,399 --> 00:03:38,790
and cut in half in terms of its budget

81
00:03:46,280 --> 00:03:43,409
and the principal investigators took a

82
00:03:48,349 --> 00:03:46,290
voluntary cut in their budgets that had

83
00:03:50,809 --> 00:03:48,359
already been agreed to and negotiated in

84
00:03:53,059 --> 00:03:50,819
one of the conditions was that we

85
00:03:54,710 --> 00:03:53,069
support the early career community and

86
00:03:58,550 --> 00:03:54,720
that of course was something that I

87
00:04:01,039 --> 00:03:58,560
could endorse wholeheartedly and we went

88
00:04:02,929 --> 00:04:01,049

forward but it was very very much with

89
00:04:04,789 --> 00:04:02,939
the support of the principal

90
00:04:07,999 --> 00:04:04,799
investigators and that support continued

91
00:04:09,890 --> 00:04:08,009
as long as I was Nai director and I'm

92
00:04:13,670 --> 00:04:09,900
sure that support I know that support

93
00:04:15,770 --> 00:04:13,680
continues today so it wasn't just me it

94
00:04:19,759 --> 00:04:15,780
was really a team of people and we were

95
00:04:21,379 --> 00:04:19,769
all very very supportive of the early

96
00:04:24,830 --> 00:04:21,389
career community and look what it's

97
00:04:26,090 --> 00:04:24,840
produced it's crazy saying things like

98
00:04:28,340 --> 00:04:26,100
saving it

99
00:04:30,440 --> 00:04:28,350
and all the things that you're doing

100
00:04:32,630 --> 00:04:30,450
today so it's very very gratifying to

101
00:04:35,210 --> 00:04:32,640
see the community is definitely I think

102
00:04:37,310 --> 00:04:35,220
what makes astrobiology special some of

103
00:04:39,740 --> 00:04:37,320
my best friends and best colleagues stem

104
00:04:42,850 --> 00:04:39,750
from the community you all supported

105
00:04:46,790 --> 00:04:42,860
when we were younger so thank you

106
00:04:49,790 --> 00:04:46,800
astrobiology is something you have seen

107
00:04:52,640 --> 00:04:49,800
grow from a tiny little seed into a

108
00:04:55,400 --> 00:04:52,650
full-fledged NASA program and I was

109
00:04:57,350 --> 00:04:55,410
wondering if we could go through us with

110
00:04:59,810 --> 00:04:57,360
us through this these steps because they

111
00:05:02,060 --> 00:04:59,820
the events that also shaped your career

112
00:05:04,640 --> 00:05:02,070
and we've also have done everything in

113
00:05:06,740 --> 00:05:04,650

astrobiology you were a grad student

114
00:05:08,900 --> 00:05:06,750
working on on outer planets you are a

115
00:05:11,270 --> 00:05:08,910
professor at a university you were held

116
00:05:12,710 --> 00:05:11,280
management positions at NASA you've done

117
00:05:14,930 --> 00:05:12,720
it all and it's and we would love to

118
00:05:17,720 --> 00:05:14,940
hear about how you have gone through all

119
00:05:19,690 --> 00:05:17,730
these steps and what events in in the

120
00:05:22,910 --> 00:05:19,700
sciences over the past several decades

121
00:05:24,200 --> 00:05:22,920
led to these choices so perhaps we can

122
00:05:26,150 --> 00:05:24,210
start at the beginning like how did you

123
00:05:28,910 --> 00:05:26,160
get involved with astrobiology and what

124
00:05:30,820 --> 00:05:28,920
was it like back then when you were when

125
00:05:32,600 --> 00:05:30,830
you had a fierce beard I have to admit

126
00:05:34,220 --> 00:05:32,610
unfortunately going on how anymore I

127
00:05:37,160 --> 00:05:34,230
didn't shave today try it to try to be

128
00:05:40,390 --> 00:05:37,170
as cool as you but but anything case

129
00:05:43,580 --> 00:05:40,400
take us back through these decades well

130
00:05:46,010 --> 00:05:43,590
perhaps one place to start is how little

131
00:05:49,010 --> 00:05:46,020
I knew about biology before I got

132
00:05:50,720 --> 00:05:49,020
involved in astrobiology I got

133
00:05:52,700 --> 00:05:50,730
interested in chemistry while I was in

134
00:05:54,680 --> 00:05:52,710
high school and went to a high school

135
00:05:56,900 --> 00:05:54,690
where you could actually major in

136
00:05:58,520 --> 00:05:56,910
chemistry and so I took this was

137
00:06:01,340 --> 00:05:58,530
Brooklyn Technical High School in New

138
00:06:03,560 --> 00:06:01,350

York City and so I took chemistry 15

139
00:06:05,000 --> 00:06:03,570
hours a week for my last two years of

140
00:06:06,740 --> 00:06:05,010
high school but something had to get

141
00:06:08,600 --> 00:06:06,750
sacrificed in order for that to happen

142
00:06:11,270 --> 00:06:08,610
and one of the things that got

143
00:06:13,490 --> 00:06:11,280
sacrificed was biology and as it turned

144
00:06:16,070 --> 00:06:13,500
out I went to an urban high school at an

145
00:06:18,290 --> 00:06:16,080
urban college Polytechnic Institute of

146
00:06:21,200 --> 00:06:18,300
Brooklyn as it was then called it's now

147
00:06:24,290 --> 00:06:21,210
part of NYU and it turned out in this

148
00:06:26,420 --> 00:06:24,300
urban university the biology labs were

149
00:06:29,690 --> 00:06:26,430
about a mile away from the main building

150
00:06:31,550 --> 00:06:29,700
and one thing led to another and I

151
00:06:33,590 --> 00:06:31,560
didn't take biology in college either

152
00:06:37,529 --> 00:06:33,600
and then of course I get into a graduate

153
00:06:41,300 --> 00:06:37,539
program in chemistry and there was

154
00:06:45,059 --> 00:06:41,310
any requirement that I take biology so I

155
00:06:48,870 --> 00:06:45,069
reached a rather late stage of my career

156
00:06:51,870 --> 00:06:48,880
without ever having taken biology well

157
00:06:54,540 --> 00:06:51,880
what happened was in graduate school I

158
00:06:56,430 --> 00:06:54,550
made a transition to space science and

159
00:07:00,540 --> 00:06:56,440
that turned out to be planetary

160
00:07:03,420 --> 00:07:00,550
astronomy I didn't go to graduate school

161
00:07:05,939 --> 00:07:03,430
quite with that intent I had applied to

162
00:07:07,980 --> 00:07:05,949
chemistry departments since after all I

163
00:07:10,620 --> 00:07:07,990

had gotten a bachelor's degree in

164
00:07:13,080 --> 00:07:10,630
chemistry but just about the time I was

165
00:07:15,060 --> 00:07:13,090
applying to schools I was thinking that

166
00:07:16,980 --> 00:07:15,070
I'd really like to figure out how to go

167
00:07:18,810 --> 00:07:16,990
into space science and without any

168
00:07:22,439 --> 00:07:18,820
formal training in astronomy or

169
00:07:24,810 --> 00:07:22,449
planetary science to speak of I decided

170
00:07:28,649 --> 00:07:24,820
that that really wasn't the best way to

171
00:07:30,689 --> 00:07:28,659
continue making field transitions so I

172
00:07:32,460 --> 00:07:30,699
felt that going back to school was the

173
00:07:34,230 --> 00:07:32,470
right way to do it and I had a great

174
00:07:35,909 --> 00:07:34,240
opportunity to go to Princeton at a

175
00:07:38,279 --> 00:07:35,919
great education in international

176
00:07:41,129 --> 00:07:38,289
relations and then wound up going to

177
00:07:43,020 --> 00:07:41,139
work for NASA not that I expected to I

178
00:07:47,310 --> 00:07:43,030
was thinking I might go to work for the

179
00:07:48,570 --> 00:07:47,320
State Department or perhaps a the

180
00:07:50,790 --> 00:07:48,580
Brookings Institution

181
00:07:52,560 --> 00:07:50,800
but NASA made me an offer that I

182
00:07:55,140 --> 00:07:52,570
couldn't refuse which was to be the

183
00:07:57,629 --> 00:07:55,150
science director in Sally ride's office

184
00:07:59,730 --> 00:07:57,639
of exploration the one that she set up

185
00:08:04,350 --> 00:07:59,740
after the loss of space shuttle

186
00:08:06,540 --> 00:08:04,360
Challenger and when I arrived in

187
00:08:09,240 --> 00:08:06,550
government when I arrived at my NASA

188
00:08:13,649 --> 00:08:09,250

office on the first day I had no idea

189
00:08:16,439 --> 00:08:13,659
what my job was and it took me about a

190
00:08:18,330 --> 00:08:16,449
year to figure it out and what I

191
00:08:20,399 --> 00:08:18,340
realized after about a year is that all

192
00:08:21,659 --> 00:08:20,409
these meetings that were on my calendar

193
00:08:24,899 --> 00:08:21,669
and that I had to keep going to that

194
00:08:27,240 --> 00:08:24,909
that was the actual work because while I

195
00:08:31,379 --> 00:08:27,250
had been a professor meetings were the

196
00:08:33,510 --> 00:08:31,389
things that interfered with my work my

197
00:08:35,730 --> 00:08:33,520
work was at the telescope my work was

198
00:08:38,819 --> 00:08:35,740
writing papers my work was in the

199
00:08:42,120 --> 00:08:38,829
laboratory my work was with my graduate

200
00:08:43,529 --> 00:08:42,130
students and the meetings were the

201
00:08:44,310 --> 00:08:43,539
things that interfered with getting

202
00:08:45,840 --> 00:08:44,320
stuff done

203
00:08:47,760 --> 00:08:45,850
and it took me about a year to figure

204
00:08:50,350 --> 00:08:47,770
out that in government the meetings

205
00:08:52,629 --> 00:08:50,360
actually are the work and

206
00:08:54,609 --> 00:08:52,639
in government it is not so much about

207
00:08:56,289 --> 00:08:54,619
the government official getting things

208
00:08:58,539 --> 00:08:56,299
done it's about the government official

209
00:09:02,340 --> 00:08:58,549
enabling other people to get things done

210
00:09:06,400 --> 00:09:02,350
and that's what we do in government and

211
00:09:09,970 --> 00:09:06,410
so I just went from position to position

212
00:09:17,259 --> 00:09:09,980
at NASA for another row 15 years or so

213
00:09:20,829 --> 00:09:17,269

214
00:09:23,289 --> 00:09:20,839
the meteorite from Mars that people

215
00:09:25,569 --> 00:09:23,299
suspected had evidence of life and at

216
00:09:29,499 --> 00:09:25,579
this point I have not taken a biology

217
00:09:32,410 --> 00:09:29,509
course and I thought these questions

218
00:09:34,689 --> 00:09:32,420
that these people are raising are just

219
00:09:39,669 --> 00:09:34,699
going to be too much fun weren't too

220
00:09:42,329 --> 00:09:39,679
much fun not to be a part of and so I

221
00:09:44,350 --> 00:09:42,339
decided it was time to learn biology

222
00:09:46,900 --> 00:09:44,360
unfortunately by that time I knew

223
00:09:50,249 --> 00:09:46,910
wonderful people like Ken Nealson and

224
00:09:52,329 --> 00:09:50,259
Mitch Sojin and norm pace who were all

225
00:09:54,549 --> 00:09:52,339
microbiologists who had become involved

226
00:09:56,949 --> 00:09:54,559
in NASA's programs and I had gotten to

227
00:10:00,549 --> 00:09:56,959
know them from my various positions at

228
00:10:03,909 --> 00:10:00,559
NASA and they in different ways took me

229
00:10:06,159 --> 00:10:03,919
under their wings and helped me figure

230
00:10:08,350 --> 00:10:06,169
out how to learn some biology

231
00:10:10,479 --> 00:10:08,360
particularly some microbiology and I

232
00:10:12,999 --> 00:10:10,489
discovered the courses up at the Marine

233
00:10:16,569 --> 00:10:13,009
Biological lab that Mitch Dogen had a

234
00:10:18,819 --> 00:10:16,579
lot to do with and between one thing and

235
00:10:22,569 --> 00:10:18,829
another I managed to learn enough

236
00:10:24,850 --> 00:10:22,579
biology to start having a place in the

237
00:10:27,929 --> 00:10:24,860
astrobiology program at headquarters and

238
00:10:31,689 --> 00:10:27,939

then a few years later the opportunity

239
00:10:35,979 --> 00:10:31,699
to move out and be director of the

240
00:10:40,479 --> 00:10:35,989
Institute in California came up and that

241
00:10:43,389 --> 00:10:40,489
was as I mentioned my dream job and you

242
00:10:45,569 --> 00:10:43,399
know it's it's the most wonderful move

243
00:10:48,189 --> 00:10:45,579
that I think I ever made in my career

244
00:10:51,689 --> 00:10:48,199
how did NASA get interested in

245
00:10:55,299 --> 00:10:51,699
astrobiology enough to form a official

246
00:10:57,129 --> 00:10:55,309
program well NASA was interested in

247
00:10:59,859 --> 00:10:57,139
these questions from the very outset of

248
00:11:04,000 --> 00:10:59,869
NASA the exobiology program dates back

249
00:11:06,340 --> 00:11:04,010
to NASA's earliest days I think 1959

250
00:11:09,520 --> 00:11:06,350
was the first grant in a program that

251
00:11:11,500 --> 00:11:09,530
was not then called Astro exobiology but

252
00:11:15,310 --> 00:11:11,510
became known a few years later as

253
00:11:18,490 --> 00:11:15,320
exobiology and so NASA was supporting

254
00:11:23,490 --> 00:11:18,500
this work Carl was for example in the

255
00:11:27,220 --> 00:11:23,500
70s and early 80s could not get support

256
00:11:30,040 --> 00:11:27,230
for his work readily and NASA was one of

257
00:11:32,530 --> 00:11:30,050
his principal sources of support and so

258
00:11:35,110 --> 00:11:32,540
much of what we understand today about

259
00:11:37,720 --> 00:11:35,120
the three domains of life was originally

260
00:11:41,230 --> 00:11:37,730
supported by NASA through the exobiology

261
00:11:46,450 --> 00:11:41,240
program so NASA was always interested in

262
00:11:49,920 --> 00:11:46,460
these questions of life beyond Earth but

263
00:11:53,800 --> 00:11:49,930

what happened in 1996 and subsequently

264
00:11:58,990 --> 00:11:53,810
was I think a real integration of the

265
00:12:02,980 --> 00:11:59,000
fields exobiology existed on its own and

266
00:12:05,590 --> 00:12:02,990
the the it was interdisciplinary but it

267
00:12:10,150 --> 00:12:05,600
was not as interdisciplinary as we

268
00:12:16,390 --> 00:12:10,160
realized we needed to be host alh84001

269
00:12:19,660 --> 00:12:16,400
and so the astrobiology program I think

270
00:12:22,900 --> 00:12:19,670
the big difference between astrobiology

271
00:12:25,060 --> 00:12:22,910
and exobiology as a NASA program is that

272
00:12:27,990 --> 00:12:25,070
the astrobiology program was charged

273
00:12:31,330 --> 00:12:28,000
with proactively bringing together

274
00:12:36,070 --> 00:12:31,340
scientists from disciplines which would

275
00:12:40,090 --> 00:12:36,080
not generally be interacting and to to

276
00:12:42,190 --> 00:12:40,100
do so in a very proactive way and to

277
00:12:44,050 --> 00:12:42,200
forge collaborations that would not

278
00:12:45,310 --> 00:12:44,060
otherwise have occurred and that of

279
00:12:49,450 --> 00:12:45,320
course is what the NASA Astrobiology

280
00:12:51,940 --> 00:12:49,460
Institute has been all about you know of

281
00:12:54,940 --> 00:12:51,950
questions through say Gannett and by

282
00:12:57,130 --> 00:12:54,950
email about students asking me how to

283
00:12:59,230 --> 00:12:57,140
become an astrobiologist and I always

284
00:13:00,970 --> 00:12:59,240
tell them there's there's no single tap

285
00:13:03,640 --> 00:13:00,980
because no single astrobiologists is the

286
00:13:05,200 --> 00:13:03,650
same as the other but what is your take

287
00:13:06,640 --> 00:13:05,210
on this how do you feel astrobiology

288
00:13:10,510 --> 00:13:06,650

integrates in the modern scientific

289
00:13:12,420 --> 00:13:10,520
endeavor well I think astrobiology

290
00:13:15,160 --> 00:13:12,430
provides an example of how science

291
00:13:17,590 --> 00:13:15,170
increasingly has to be done that is it

292
00:13:21,340 --> 00:13:17,600
has to be done across disciplinary

293
00:13:24,069 --> 00:13:21,350
Therese now a student who wants to work

294
00:13:27,249 --> 00:13:24,079
in astrobiology is faced with that

295
00:13:29,379 --> 00:13:27,259
standard problem that you really have to

296
00:13:31,840 --> 00:13:29,389
have expertise in a particular

297
00:13:35,860 --> 00:13:31,850
discipline frequently that's essential

298
00:13:37,930 --> 00:13:35,870
for getting a job so if you're going to

299
00:13:41,710 --> 00:13:37,940
if you're seeking a job as a faculty

300
00:13:44,199 --> 00:13:41,720
member whatever Department is going to

301
00:13:47,110 --> 00:13:44,209
hire you is going to want you to be able

302
00:13:48,579 --> 00:13:47,120
to teach the introductory courses and

303
00:13:50,590 --> 00:13:48,589
that departments discipline whether

304
00:13:54,129 --> 00:13:50,600
that's geology or biology or chemistry

305
00:13:56,050 --> 00:13:54,139
or physics or astronomy so you have to

306
00:13:57,970 --> 00:13:56,060
demonstrate some depth but on the other

307
00:14:01,600 --> 00:13:57,980
hand in order to be an astrobiologist

308
00:14:06,160 --> 00:14:01,610
you really have to develop breaths as

309
00:14:09,129 --> 00:14:06,170
well and this tension between depths and

310
00:14:11,710 --> 00:14:09,139
breaths is a tension that I think every

311
00:14:14,650 --> 00:14:11,720
scientist has to deal with in his or her

312
00:14:16,569 --> 00:14:14,660
career and I think an astrobiology you

313
00:14:18,970 --> 00:14:16,579

have to deal with it particularly and

314
00:14:22,840 --> 00:14:18,980
you have to find your own path through

315
00:14:25,929 --> 00:14:22,850
that really I think in my career I have

316
00:14:28,540 --> 00:14:25,939
really gone for breath and I recognize

317
00:14:31,900 --> 00:14:28,550
that in some ways I have sacrificed

318
00:14:34,660 --> 00:14:31,910
steps I would not call myself an expert

319
00:14:39,850 --> 00:14:34,670
in any particular of the component

320
00:14:43,420 --> 00:14:39,860
fields of astrobiology but I do think

321
00:14:45,579 --> 00:14:43,430
that my skill is in connecting the dots

322
00:14:48,309 --> 00:14:45,589
in putting all of the pieces together

323
00:14:50,980 --> 00:14:48,319
and knowing who are the experts who can

324
00:14:53,559 --> 00:14:50,990
provide the in-depth knowledge that's

325
00:14:56,889 --> 00:14:53,569
required but everybody has to find their

326
00:14:59,350 --> 00:14:56,899
their own way through that thicket but

327
00:15:01,449 --> 00:14:59,360
you need the right balance of breadth

328
00:15:04,620 --> 00:15:01,459
and depth for you as a person and as a

329
00:15:08,220 --> 00:15:04,630
scientist and for your career goals

330
00:15:10,590 --> 00:15:08,230
great advice thanks Carl how has your

331
00:15:15,639 --> 00:15:10,600
education and international affairs

332
00:15:17,800 --> 00:15:15,649
shaped the way you you shaped who you

333
00:15:20,590 --> 00:15:17,810
are as a scientist but also as a leader

334
00:15:22,540 --> 00:15:20,600
of scientists you know I almost can't

335
00:15:24,730 --> 00:15:22,550
answer that question because it so

336
00:15:27,429 --> 00:15:24,740
profoundly changed the way I think that

337
00:15:30,639 --> 00:15:27,439
it's very hard for me to go back to

338
00:15:33,609 --> 00:15:30,649

before that experience and

339
00:15:36,519 --> 00:15:33,619
remember what I was like and and how I

340
00:15:38,079 --> 00:15:36,529
might have functioned later on had I not

341
00:15:41,559 --> 00:15:38,089
had that experience so it's a hard

342
00:15:44,379 --> 00:15:41,569
question for me to answer okay being

343
00:15:46,030 --> 00:15:44,389
being immersed in social science for

344
00:15:47,799 --> 00:15:46,040
three years I was at Princeton for three

345
00:15:50,139 --> 00:15:47,809
years to to get the degree and then I

346
00:15:53,590 --> 00:15:50,149
had support as a visiting fellow furrier

347
00:15:55,629 --> 00:15:53,600
and being immersed in social science for

348
00:16:00,280 --> 00:15:55,639
three years was such a different

349
00:16:05,650 --> 00:16:00,290
experience from my life in the physical

350
00:16:07,540 --> 00:16:05,660
sciences that it it really has

351
00:16:10,179 --> 00:16:07,550
completely changed the way I thought I

352
00:16:12,850 --> 00:16:10,189
thought things were very reductionist we

353
00:16:14,919 --> 00:16:12,860
had gone to the moon because Kennedy was

354
00:16:18,699 --> 00:16:14,929
a visionary and that was a great thing

355
00:16:23,160 --> 00:16:18,709
to do for science and for technology and

356
00:16:26,410 --> 00:16:23,170
lo and behold it was all part of the

357
00:16:28,150 --> 00:16:26,420
Cold War in our competition with the

358
00:16:33,460 --> 00:16:28,160
Soviet Union and I don't think I knew

359
00:16:35,489 --> 00:16:33,470
that before I went off and got into a

360
00:16:37,900 --> 00:16:35,499
social science world now I think many

361
00:16:39,669 --> 00:16:37,910
people who were scientists did

362
00:16:43,869 --> 00:16:39,679
understand that at the time but I know

363
00:16:46,059 --> 00:16:43,879

that I didn't until I arrived on the

364
00:16:47,860 --> 00:16:46,069
East Coast in in Princeton and then

365
00:16:50,259 --> 00:16:47,870
particularly spent a summer working at

366
00:16:53,350 --> 00:16:50,269
the United Nations and suddenly realized

367
00:16:57,009 --> 00:16:53,360
that international relations and

368
00:16:59,169 --> 00:16:57,019
politics had been drivers of so many

369
00:17:01,360 --> 00:16:59,179
things that I thought oh this is all

370
00:17:04,090 --> 00:17:01,370
just rational stuff and you know

371
00:17:06,159 --> 00:17:04,100
decisions being made on the scientific

372
00:17:08,230 --> 00:17:06,169
merits or the technical merits and lo

373
00:17:10,419 --> 00:17:08,240
and behold there were all kinds of

374
00:17:13,590 --> 00:17:10,429
economic historical and political

375
00:17:16,659 --> 00:17:13,600
considerations that had gone on and

376
00:17:19,059 --> 00:17:16,669
another part of my education in social

377
00:17:21,809 --> 00:17:19,069
science was organizational dynamics and

378
00:17:24,490 --> 00:17:21,819
how organizations function and why

379
00:17:27,909 --> 00:17:24,500
decisions get made by organizations be

380
00:17:30,190 --> 00:17:27,919
it a corporation or a government and so

381
00:17:32,649 --> 00:17:30,200
that experience just really profoundly

382
00:17:36,490 --> 00:17:32,659
changed the way I thought it turned out

383
00:17:39,310 --> 00:17:36,500
to be my entry card into government the

384
00:17:41,830 --> 00:17:39,320
person who hired me told me that he

385
00:17:45,279 --> 00:17:41,840
hired me because I had this combination

386
00:17:48,460 --> 00:17:45,289
of this policy credential combined with

387
00:17:51,370 --> 00:17:48,470
my scientific background and experience

388
00:17:53,260 --> 00:17:51,380

and I don't think I could have

389
00:17:55,830 --> 00:17:53,270
functioned in government the way I did

390
00:17:58,480 --> 00:17:55,840
without the perspectives that I gained

391
00:18:03,010 --> 00:17:58,490
at Princeton during those three years of

392
00:18:05,590 --> 00:18:03,020
being with social scientists so Ken

393
00:18:07,360 --> 00:18:05,600
astrobiology influenced social science

394
00:18:10,000 --> 00:18:07,370
as well you mentioned some very

395
00:18:11,980 --> 00:18:10,010
interesting things when you're

396
00:18:13,480 --> 00:18:11,990
discussing what motivated you to join

397
00:18:16,269 --> 00:18:13,490
International Affairs was the desire to

398
00:18:18,310 --> 00:18:16,279
understand the world but humanity tends

399
00:18:19,720 --> 00:18:18,320
to have a very short historical memory

400
00:18:22,240 --> 00:18:19,730
and some of the mistakes that happen in

401
00:18:24,760 --> 00:18:22,250
the past hopefully are not but seem to

402
00:18:27,010 --> 00:18:24,770
be happening again today I'm does

403
00:18:30,130 --> 00:18:27,020
astrobiology have us have a way to

404
00:18:33,250 --> 00:18:30,140
contribute to the conversation of in the

405
00:18:35,760 --> 00:18:33,260
social sciences well you know I think I

406
00:18:38,680 --> 00:18:35,770
think of say Gannett as a way that

407
00:18:42,549 --> 00:18:38,690
astrobiology is contributing to society

408
00:18:48,220 --> 00:18:42,559
and implicitly if not explicitly to the

409
00:18:50,710 --> 00:18:48,230
social sciences using science as say

410
00:18:53,740 --> 00:18:50,720
Gannett does and as so many of us do in

411
00:18:56,649 --> 00:18:53,750
astrobiology using science as a means to

412
00:18:59,700 --> 00:18:56,659
reach out to the public and get the the

413
00:19:01,419 --> 00:18:59,710

public engaged in a dialogue about

414
00:19:03,580 --> 00:19:01,429
societal problems

415
00:19:06,490 --> 00:19:03,590
I just gave a lecture a couple of days

416
00:19:10,570 --> 00:19:06,500
ago on astrobiology and climate change

417
00:19:12,970 --> 00:19:10,580
and that's just one example where an

418
00:19:18,399 --> 00:19:12,980
astrobiological perspective can be

419
00:19:21,549 --> 00:19:18,409
brought to bear and people can begin to

420
00:19:24,880 --> 00:19:21,559
see the climate change that is occurring

421
00:19:27,190 --> 00:19:24,890
on earth today in a historical light of

422
00:19:29,320 --> 00:19:27,200
four billion years of climate change and

423
00:19:31,960 --> 00:19:29,330
see what we are doing to the planet

424
00:19:35,590 --> 00:19:31,970
today and how we are returning it to a

425
00:19:37,990 --> 00:19:35,600
state that it hasn't been in in at least

426
00:19:42,940 --> 00:19:38,000
a couple of million years and looking

427
00:19:45,100 --> 00:19:42,950
back at earlier examples like the paleo

428
00:19:50,049 --> 00:19:45,110
scene Eocene thermal maximum for example

429
00:19:52,080 --> 00:19:50,059
as a metaphor and a an analog to what

430
00:19:54,549 --> 00:19:52,090
we're doing today so I think

431
00:19:55,480 --> 00:19:54,559
astrobiology has a lot to contribute and

432
00:19:58,570 --> 00:19:55,490
the nice

433
00:20:00,370 --> 00:19:58,580
thing of course is that it is attractive

434
00:20:04,990 --> 00:20:00,380
to people and so people want to hear

435
00:20:07,810 --> 00:20:05,000
about it and as we share astrobiology

436
00:20:11,010 --> 00:20:07,820
with people we can get them engaged in

437
00:20:12,850 --> 00:20:11,020
discussions of larger issues I

438
00:20:14,860 --> 00:20:12,860

definitely had a great deal of success

439
00:20:16,470 --> 00:20:14,870
personally using astrobiology to

440
00:20:18,580 --> 00:20:16,480
communicate science to especially the

441
00:20:19,810 --> 00:20:18,590
young kids at the elementary school

442
00:20:21,520 --> 00:20:19,820
level because if they don't realize

443
00:20:23,380 --> 00:20:21,530
they're talking about science but you

444
00:20:25,150 --> 00:20:23,390
can grab them with the the thoughts of

445
00:20:28,870 --> 00:20:25,160
aliens and what does it take for life to

446
00:20:30,100 --> 00:20:28,880
be beyond Earth so there's this I don't

447
00:20:32,410 --> 00:20:30,110
know if the roar frustration is the

448
00:20:35,880 --> 00:20:32,420
right one but so space exploration and

449
00:20:38,410 --> 00:20:35,890
astrobiology our long-term goals are

450
00:20:40,780 --> 00:20:38,420
sometimes multi-generational partically

451
00:20:42,580 --> 00:20:40,790
when talking about Humanity on Mars and

452
00:20:46,600 --> 00:20:42,590
elsewhere which is part of astrobiology

453
00:20:48,520 --> 00:20:46,610
but the way the agency is led is from a

454
00:20:51,310 --> 00:20:48,530
political standpoint the goals tend to

455
00:20:52,630 --> 00:20:51,320
be reset every administration you've

456
00:20:54,700 --> 00:20:52,640
been in government that has there must

457
00:20:56,500 --> 00:20:54,710
have been quite frustrating how does one

458
00:20:58,960 --> 00:20:56,510
navigate that to try and keep the ship

459
00:21:03,299 --> 00:20:58,970
steered in one direction and not like

460
00:21:06,580 --> 00:21:03,309
vacillates well I think NASA has had a

461
00:21:09,310 --> 00:21:06,590
steady course in many ways you look at

462
00:21:11,140 --> 00:21:09,320
the robotic science program the program

463
00:21:13,810 --> 00:21:11,150

that's been run by the science office

464
00:21:17,560 --> 00:21:13,820
and the program that's been run by the

465
00:21:22,210 --> 00:21:17,570
Science Office has not been subject that

466
00:21:26,500 --> 00:21:22,220
much to the every four year changes our

467
00:21:30,610 --> 00:21:26,510
missions that have run by that office

468
00:21:33,760 --> 00:21:30,620
take more than four years generally to

469
00:21:36,130 --> 00:21:33,770
develop and they've had bipartisan

470
00:21:40,000 --> 00:21:36,140
support in Congress Congress tends to be

471
00:21:42,580 --> 00:21:40,010
generally supportive of NASA science the

472
00:21:45,250 --> 00:21:42,590
human spaceflight program in contrast

473
00:21:47,620 --> 00:21:45,260
has gone through a lot of back-and-forth

474
00:21:51,100 --> 00:21:47,630
but even there the human spaceflight

475
00:21:52,960 --> 00:21:51,110
program has had long term projects the

476
00:21:57,100 --> 00:21:52,970
space station and the shuttle being the

477
00:22:01,419 --> 00:21:57,110
two most obvious ones and those projects

478
00:22:04,659 --> 00:22:01,429
once they get support have been brought

479
00:22:06,790 --> 00:22:04,669
to completion so there is uncertainty

480
00:22:09,220 --> 00:22:06,800
but for the most part I think nASA has

481
00:22:12,120 --> 00:22:09,230
actually

482
00:22:15,549 --> 00:22:12,130
run a a pretty steady course

483
00:22:18,370 --> 00:22:15,559
particularly in the science area that's

484
00:22:19,960 --> 00:22:18,380
good to hear so where do you see the

485
00:22:22,360 --> 00:22:19,970
signs going in the future what are the

486
00:22:25,720 --> 00:22:22,370
discoveries you would love to see in the

487
00:22:27,610 --> 00:22:25,730
coming decade in astrobiology well you

488
00:22:29,200 --> 00:22:27,620

know of course there's a Holy Grail of N

489
00:22:32,350 --> 00:22:29,210
equals 2

490
00:22:34,090 --> 00:22:32,360
as everybody you know participating in

491
00:22:37,390 --> 00:22:34,100
this particular broadcast right now

492
00:22:40,450 --> 00:22:37,400
knows I'm sure we only have an example

493
00:22:43,750 --> 00:22:40,460
of life on Earth and therefore we don't

494
00:22:45,700 --> 00:22:43,760
know what is necessary for life and what

495
00:22:48,970 --> 00:22:45,710
is contingent what just happened to work

496
00:22:52,570 --> 00:22:48,980
out that for this way for life on Earth

497
00:22:56,430 --> 00:22:52,580
so certainly finding a second example of

498
00:23:02,710 --> 00:22:56,440
life is is certainly the holy grail of

499
00:23:04,900 --> 00:23:02,720
astrobiology and if you know if they if

500
00:23:06,640 --> 00:23:04,910
I had my choice of discoveries that

501
00:23:09,330 --> 00:23:06,650
would that would be the discovery that

502
00:23:15,460 --> 00:23:09,340
for me would be just most astonishing

503
00:23:16,960 --> 00:23:15,470
but even finding life elsewhere in this

504
00:23:19,060 --> 00:23:16,970
solar system even if it didn't have a

505
00:23:21,549 --> 00:23:19,070
separate origin from life on Earth even

506
00:23:24,669 --> 00:23:21,559
if it was microbes on Mars that are

507
00:23:27,039 --> 00:23:24,679
producing methane and and discharging it

508
00:23:30,190 --> 00:23:27,049
into the atmosphere today and even if

509
00:23:34,060 --> 00:23:30,200
those microbes had a common origin with

510
00:23:36,460 --> 00:23:34,070
life on Earth we would still learn a

511
00:23:40,330 --> 00:23:36,470
tremendous amount about evolution

512
00:23:42,240 --> 00:23:40,340
because presumably those two on place of

513
00:23:46,510 --> 00:23:42,250

life would have been separated for

514
00:23:49,330 --> 00:23:46,520
billions of years and we would get to

515
00:23:52,990 --> 00:23:49,340
see what happens at least it's microbial

516
00:23:56,650 --> 00:23:53,000
level if we took the same initial

517
00:24:01,680 --> 00:23:56,660
conditions and then let things run in a

518
00:24:03,940 --> 00:24:01,690
completely different way so certainly

519
00:24:07,900 --> 00:24:03,950
another discovery that would be very

520
00:24:10,270 --> 00:24:07,910
exciting would be to find very strange

521
00:24:14,880 --> 00:24:10,280
things going on on an extrasolar planet

522
00:24:18,850 --> 00:24:14,890
and to begin to have some suspicion that

523
00:24:22,360 --> 00:24:18,860
there might be some kind of non-physical

524
00:24:23,170 --> 00:24:22,370
potentially biological process going on

525
00:24:24,970 --> 00:24:23,180
on

526
00:24:27,730 --> 00:24:24,980
extrasolar planet because it just had

527
00:24:30,000 --> 00:24:27,740
weird atmosphere of course we know that

528
00:24:32,530 --> 00:24:30,010
you can get weird atmospheres by

529
00:24:35,020 --> 00:24:32,540
physical and chemical processes too so

530
00:24:37,360 --> 00:24:35,030
that would be both an interesting

531
00:24:39,520 --> 00:24:37,370
discovery but also an interesting

532
00:24:42,340 --> 00:24:39,530
challenge to people to try to figure out

533
00:24:45,640 --> 00:24:42,350
what are the very many ways that strange

534
00:24:47,350 --> 00:24:45,650
things can happen in the universe so

535
00:24:49,320 --> 00:24:47,360
from your experience of the social

536
00:24:51,280 --> 00:24:49,330
scientists and working in government

537
00:24:56,230 --> 00:24:51,290
what do you think would be the

538
00:25:02,380 --> 00:24:56,240

implications not on a science side if n

539
00:25:05,500 --> 00:25:02,390
equals 2 or when N equals 2 well you

540
00:25:08,770 --> 00:25:05,510
know we've already kind of seen this a

541
00:25:11,320 --> 00:25:08,780
little bit so for example let's go back

542
00:25:14,200 --> 00:25:11,330
to 1996 so there's a press conference

543
00:25:17,800 --> 00:25:14,210
that doesn't say we found N equals 2 it

544
00:25:20,140 --> 00:25:17,810
just says that we have found evidence of

545
00:25:23,350 --> 00:25:20,150
life on Mars in a meteorite that came

546
00:25:26,440 --> 00:25:23,360
from Mars well what happened is it led

547
00:25:29,140 --> 00:25:26,450
to a billion dollar per year increase in

548
00:25:32,200 --> 00:25:29,150
NASA's budget and there's a dirty little

549
00:25:33,850 --> 00:25:32,210
secret that I will reveal that is it

550
00:25:37,090 --> 00:25:33,860
could have been a two billion dollar a

551
00:25:40,960 --> 00:25:37,100
year increase in NASA's budget but NASA

552
00:25:43,720 --> 00:25:40,970
just didn't want to have that much of an

553
00:25:49,510 --> 00:25:43,730
increase at that time in one particular

554
00:25:53,980 --> 00:25:49,520
area so the political system responded

555
00:25:58,780 --> 00:25:53,990
in a tremendously positive way to this

556
00:26:01,780 --> 00:25:58,790
amazing discovery and I think that that

557
00:26:06,120 --> 00:26:01,790
is is the way I think the political

558
00:26:11,740 --> 00:26:06,130
system is most likely to respond to

559
00:26:18,700 --> 00:26:11,750
really substantive new information that

560
00:26:20,350 --> 00:26:18,710
isn't so much a subject of political

561
00:26:23,280 --> 00:26:20,360
concern that the kinds of information

562
00:26:26,890 --> 00:26:23,290
that's a subject of political concern is

563
00:26:28,990 --> 00:26:26,900

information that some people fear would

564
00:26:31,810 --> 00:26:29,000
cause government to take greater control

565
00:26:34,680 --> 00:26:31,820
of their lives and that's why climate

566
00:26:38,460 --> 00:26:34,690
change is such a problem

567
00:26:40,110 --> 00:26:38,470
for so many people they I believe that

568
00:26:43,110 --> 00:26:40,120
they feel that they have to deny the

569
00:26:46,140 --> 00:26:43,120
science because if they acknowledge the

570
00:26:49,890 --> 00:26:46,150
science then they are then led to

571
00:26:53,100 --> 00:26:49,900
acknowledge that governments are the

572
00:26:56,580 --> 00:26:53,110
only entities large enough to have an

573
00:26:59,070 --> 00:26:56,590
impact on these areas and therefore

574
00:27:01,020 --> 00:26:59,080
government has to play a larger role and

575
00:27:03,930 --> 00:27:01,030
if you believe deep down in your soul

576
00:27:07,470 --> 00:27:03,940
that government should not be

577
00:27:10,830 --> 00:27:07,480
controlling your life then you have to

578
00:27:13,020 --> 00:27:10,840
back up and say that well that science

579
00:27:15,710 --> 00:27:13,030
must not be right because if it's right

580
00:27:21,450 --> 00:27:15,720
it just leads in a direction that I just

581
00:27:24,660 --> 00:27:21,460
can't can't handle I don't think things

582
00:27:26,490 --> 00:27:24,670
about life in the universe are going to

583
00:27:30,380 --> 00:27:26,500
do that so much of course there is

584
00:27:35,880 --> 00:27:30,390
always the question about religion and

585
00:27:37,860 --> 00:27:35,890
fundamentalism but the many of the

586
00:27:40,140 --> 00:27:37,870
religions certainly in the United States

587
00:27:43,380 --> 00:27:40,150
and I think around the world are very

588
00:27:47,880 --> 00:27:43,390

accepting of the potential for there to

589
00:27:51,540 --> 00:27:47,890
be life beyond Earth just for example if

590
00:27:53,700 --> 00:27:51,550
you believe that God has all power then

591
00:27:58,380 --> 00:27:53,710
God has the power to create life

592
00:28:01,170 --> 00:27:58,390
elsewhere just as God created life on

593
00:28:04,820 --> 00:28:01,180
Earth if that happens to be your your

594
00:28:08,370 --> 00:28:04,830
religious belief so I I don't think that

595
00:28:10,800 --> 00:28:08,380
the reaction would be problematic and

596
00:28:12,720 --> 00:28:10,810
negative except perhaps in certain areas

597
00:28:14,670 --> 00:28:12,730
I think in general government would

598
00:28:18,530 --> 00:28:14,680
respond in a very positive way as it

599
00:28:21,090 --> 00:28:18,540
already has yeah I think that's true you

600
00:28:23,130 --> 00:28:21,100
force us to think about what does it

601
00:28:25,260 --> 00:28:23,140
mean to be humans and hopefully an

602
00:28:27,240 --> 00:28:25,270
equals who will make us realize that we

603
00:28:33,330 --> 00:28:27,250
are humans first and then American

604
00:28:36,090 --> 00:28:33,340
Chinese Muslims or Christians but for a

605
00:28:37,920 --> 00:28:36,100
positive effect indeed I could talk with

606
00:28:39,780 --> 00:28:37,930
you forever about these topics but we

607
00:28:41,700 --> 00:28:39,790
have an audience an international

608
00:28:43,650 --> 00:28:41,710
audience so my last question for you

609
00:28:46,920 --> 00:28:43,660
before I'm moving to the to our to our

610
00:28:48,270 --> 00:28:46,930
audience is is everybody is growing No

611
00:28:50,760 --> 00:28:48,280
United States but all over the world

612
00:28:53,430 --> 00:28:50,770
what would be kind of your vision of

613
00:28:55,740 --> 00:28:53,440

this international groups sprouting

614
00:28:58,860 --> 00:28:55,750
everywhere and starting slowly to work

615
00:29:01,860 --> 00:28:58,870
together oh well this is of course one

616
00:29:05,540 --> 00:29:01,870
of the things that I pursued very

617
00:29:08,130 --> 00:29:05,550
strongly as director of the NAI the

618
00:29:10,230 --> 00:29:08,140
astrobiology expertise is of course

619
00:29:12,510 --> 00:29:10,240
distributed all around the world and

620
00:29:15,330 --> 00:29:12,520
this tremendous interest in astrobiology

621
00:29:17,660 --> 00:29:15,340
all around the world my vision has

622
00:29:20,990 --> 00:29:17,670
always been of an integrated

623
00:29:24,090 --> 00:29:21,000
international community pursuing

624
00:29:26,280 --> 00:29:24,100
astrobiology working together working

625
00:29:29,520 --> 00:29:26,290
not only across disciplinary boundaries

626
00:29:31,740 --> 00:29:29,530
boundaries but across the boundaries

627
00:29:34,530 --> 00:29:31,750
between international organizations and

628
00:29:37,230 --> 00:29:34,540
between governments and I think we have

629
00:29:40,860 --> 00:29:37,240
realized this to some degree but there's

630
00:29:44,220 --> 00:29:40,870
a lot more can be done the international

631
00:29:46,680 --> 00:29:44,230
partner program of the NAI I think has

632
00:29:49,950 --> 00:29:46,690
been a real contributor to this but

633
00:29:53,580 --> 00:29:49,960
there's there are many more synergies

634
00:29:57,270 --> 00:29:53,590
that can be realized and I think that's

635
00:29:59,430 --> 00:29:57,280
one of the challenges and the

636
00:30:03,960 --> 00:29:59,440
opportunities for example for the new

637
00:30:07,050 --> 00:30:03,970
nei director for any Boston indeed they

638
00:30:09,750 --> 00:30:07,060

were excited about you if any all right

639
00:30:12,030 --> 00:30:09,760
so Karl thanks again I'm gonna move the

640
00:30:13,890 --> 00:30:12,040
the questions to the audience so again

641
00:30:16,530 --> 00:30:13,900
if you're listening and watching this

642
00:30:19,290 --> 00:30:16,540
this series live you can use hashtag ask

643
00:30:21,240 --> 00:30:19,300
Esther bio on Twitter or you can ask

644
00:30:23,850 --> 00:30:21,250
questions directly on the Signet org

645
00:30:26,700 --> 00:30:23,860
main chat room so let's begin

646
00:30:28,680 --> 00:30:26,710
so landon stiver thank you for your

647
00:30:31,520 --> 00:30:28,690
question asks dr. Pilcher how did

648
00:30:33,440 --> 00:30:31,530
degrees in chemistry translates to

649
00:30:38,640 --> 00:30:33,450
astrobiology

650
00:30:41,070 --> 00:30:38,650
well well landed when I decided that I

651
00:30:44,280 --> 00:30:41,080
needed to start learning biology and and

652
00:30:46,920 --> 00:30:44,290
this was in the mid to late 1990s the

653
00:30:49,560 --> 00:30:46,930
one of the first things I did was I

654
00:30:51,740 --> 00:30:49,570
picked up a biology textbook and in fact

655
00:30:55,290 --> 00:30:51,750
I picked up a molecular cell biology

656
00:30:57,420 --> 00:30:55,300
textbook I had actually seen one on the

657
00:31:00,360 --> 00:30:57,430
coffee table of Mike Carr who was a

658
00:31:03,390 --> 00:31:00,370
planetary scientist at the USGS

659
00:31:05,370 --> 00:31:03,400
in Menlo Park at the time and I was

660
00:31:09,240 --> 00:31:05,380
visiting his home and I saw this big

661
00:31:11,940 --> 00:31:09,250
sick 2-inch thick cell biology textbook

662
00:31:13,320 --> 00:31:11,950
on his coffee table and he said yeah he

663
00:31:16,440 --> 00:31:13,330

was reading it and trying to learn some

664
00:31:18,180 --> 00:31:16,450
biology and I picked it up and I flipped

665
00:31:22,350 --> 00:31:18,190
through it and I realized this was just

666
00:31:24,960 --> 00:31:22,360
bizarrely complex chemistry that the

667
00:31:26,940 --> 00:31:24,970
chemical principles that were in that

668
00:31:28,380 --> 00:31:26,950
book core principles I understood it was

669
00:31:31,230 --> 00:31:28,390
best that they were being applied to

670
00:31:32,760 --> 00:31:31,240
bizarrely complex molecules but I

671
00:31:35,340 --> 00:31:32,770
thought I can read this and I can

672
00:31:38,700 --> 00:31:35,350
understand this so I started reading

673
00:31:46,010 --> 00:31:38,710
that and then then found other courses

674
00:31:53,639 --> 00:31:49,460
biologists microbiologists in particular

675
00:31:59,269 --> 00:31:53,649
and so that was really how chemistry was

676
00:32:03,389 --> 00:31:59,279
for me a and opening into biology a

677
00:32:05,730 --> 00:32:03,399
wonderful Sebastian asks dr. Pilcher I'm

678
00:32:08,789 --> 00:32:05,740
starting a PhD in microbiology next fall

679
00:32:13,590 --> 00:32:08,799
what steps should I make to make an

680
00:32:18,779 --> 00:32:13,600
impact in astrobiology well think

681
00:32:21,930 --> 00:32:18,789
broadly think about microbiology which

682
00:32:24,510 --> 00:32:21,940
of course can and and will get very very

683
00:32:26,310 --> 00:32:24,520
specialized you'll be looking at you

684
00:32:28,380 --> 00:32:26,320
know particular phenomena or particular

685
00:32:30,269 --> 00:32:28,390
organisms but think about it in the

686
00:32:35,940 --> 00:32:30,279
context think about it in the broader

687
00:32:37,769 --> 00:32:35,950
context of the evolution of microbes the

688
00:32:40,500 --> 00:32:37,779

the four and a half billion year history

689
00:32:45,269 --> 00:32:40,510
of four billion year history of life on

690
00:32:48,299 --> 00:32:45,279
Earth and in the context of the

691
00:32:51,630 --> 00:32:48,309
potential for microbial habitats

692
00:32:55,440 --> 00:32:51,640
elsewhere the context of extremophiles

693
00:32:59,549 --> 00:32:55,450
here on earth so while you are getting

694
00:33:02,370 --> 00:32:59,559
very very specific in your studies make

695
00:33:06,409 --> 00:33:02,380
sure that you you maintain a broad view

696
00:33:10,080 --> 00:33:06,419
of the context that your work fits into

697
00:33:13,200 --> 00:33:10,090
thanks Sebastian so your planet is next

698
00:33:15,629 --> 00:33:13,210
he's asking a question about the

699
00:33:19,229 --> 00:33:15,639
solvent for life whether you think water

700
00:33:22,560 --> 00:33:19,239
is that is uniquely be solvent for

701
00:33:25,229 --> 00:33:22,570
biology and the conversation continues

702
00:33:27,180 --> 00:33:25,239
on Twitter who is who is asking and Ben

703
00:33:28,979 --> 00:33:27,190
Pierce continues to ask about what do

704
00:33:31,109 --> 00:33:28,989
you think the instruments should be on

705
00:33:35,190 --> 00:33:31,119
the Europa subsurface ocean in the

706
00:33:38,339 --> 00:33:35,200
submarine well limit let's let's go do

707
00:33:42,389 --> 00:33:38,349
water first water is certainly a great

708
00:33:45,719 --> 00:33:42,399
song for life and if water is your

709
00:33:50,779 --> 00:33:45,729
solvent then carbon chain molecules are

710
00:33:54,269 --> 00:33:50,789
the only molecules that really form very

711
00:33:58,950 --> 00:33:54,279
long complex molecules in water so if

712
00:34:02,310 --> 00:33:58,960
you believe that that water is a solvent

713
00:34:04,200 --> 00:34:02,320

and then you have a carbon water

714
00:34:05,849 --> 00:34:04,210
chemistry although of course it doesn't

715
00:34:08,669 --> 00:34:05,859
have to be the carbon water chemistry we

716
00:34:10,019 --> 00:34:08,679
have on earth water of course is also

717
00:34:12,059 --> 00:34:10,029
made from the first and third most

718
00:34:14,579 --> 00:34:12,069
abundant elements in the universe and so

719
00:34:16,680 --> 00:34:14,589
the universe really is a case of water

720
00:34:18,419 --> 00:34:16,690
water everywhere and that's why follow

721
00:34:20,159 --> 00:34:18,429
the water and looking for water is

722
00:34:24,839 --> 00:34:20,169
really a pretty good starting place but

723
00:34:28,409 --> 00:34:24,849
it's not the only possibility people ask

724
00:34:33,149 --> 00:34:28,419
whether there could be life for example

725
00:34:35,579 --> 00:34:33,159
in the methane ethane seas of Titan and

726
00:34:38,190 --> 00:34:35,589
and lakes

727
00:34:40,919 --> 00:34:38,200
you know that's kind of fanciful of one

728
00:34:42,899 --> 00:34:40,929
of the issues is does a solvent for life

729
00:34:46,829 --> 00:34:42,909
have to be polar or not water of course

730
00:34:51,869 --> 00:34:46,839
is polar methane isn't so there's that

731
00:34:54,899 --> 00:34:51,879
issue but one can be fanciful and think

732
00:34:58,049 --> 00:34:54,909
about liquid nitrogen we have liquid

733
00:35:00,510 --> 00:34:58,059
nitrogen and the outer solar system it's

734
00:35:03,809 --> 00:35:00,520
probably powering the geysers on Triton

735
00:35:06,569 --> 00:35:03,819
the moon of Neptune and it turns out

736
00:35:08,370 --> 00:35:06,579
that silicon chain molecules are stable

737
00:35:10,740 --> 00:35:08,380
in liquid nitrogen they're not stable in

738
00:35:13,769 --> 00:35:10,750

water might you have a silicon-based

739
00:35:16,920 --> 00:35:13,779
life on Triton with silicon chain

740
00:35:18,720 --> 00:35:16,930
molecules in a liquid nitrogen solvent

741
00:35:21,900 --> 00:35:18,730
of course reaction rates would be rather

742
00:35:25,490 --> 00:35:21,910
slow at those kinds of temperatures but

743
00:35:29,960 --> 00:35:25,500
they're certainly things that

744
00:35:31,520 --> 00:35:29,970
and couldn't can imagine in in terms of

745
00:35:34,780 --> 00:35:31,530
alternative solvent so I think we have

746
00:35:39,440 --> 00:35:34,790
to keep our minds open about all of that

747
00:35:41,720 --> 00:35:39,450
instruments in in a Europa surface ocean

748
00:35:44,750 --> 00:35:41,730
Explorer well I am reminded of Carl

749
00:35:47,240 --> 00:35:44,760
Sagan's argument about putting a camera

750
00:35:49,099 --> 00:35:47,250
on the Viking Lander because in the

751
00:35:51,260 --> 00:35:49,109
early days of the space program cameras

752
00:35:53,000 --> 00:35:51,270
were not thought of as scientific

753
00:35:56,240 --> 00:35:53,010
instruments the early days of the space

754
00:35:58,430 --> 00:35:56,250
program were largely involved in

755
00:36:02,030 --> 00:35:58,440
studying particles and fields and the

756
00:36:05,359 --> 00:36:02,040
the very first missions were missions to

757
00:36:08,050 --> 00:36:05,369
study Earth's Van Allen belts named

758
00:36:12,070 --> 00:36:08,060
after Jim Van Allen who was a leader of

759
00:36:15,349 --> 00:36:12,080
of that era the space program and

760
00:36:17,960 --> 00:36:15,359
cameras were were really not seen as

761
00:36:20,210 --> 00:36:17,970
scientific instruments and there were

762
00:36:22,580 --> 00:36:20,220
initially not plans to include a camera

763
00:36:24,920 --> 00:36:22,590

on the Viking landers and Karl's

764
00:36:29,900 --> 00:36:24,930
argument as I have heard described to me

765
00:36:36,579 --> 00:36:29,910
was look if a giraffe walks by the

766
00:36:39,829 --> 00:36:36,589
Lander I want to know about it and and

767
00:36:43,490 --> 00:36:39,839
Karl's arguments for putting Amazon the

768
00:36:45,290 --> 00:36:43,500
Landers succeeded so I have to say the

769
00:36:47,240 --> 00:36:45,300
very first thing I'd want to see on

770
00:36:49,310 --> 00:36:47,250
something going down into the rope ocean

771
00:36:53,390 --> 00:36:49,320
was a camera if something swims by I

772
00:36:55,190 --> 00:36:53,400
want to know about it and beyond that or

773
00:36:57,980 --> 00:36:55,200
if you want you want to know about the

774
00:37:01,339 --> 00:36:57,990
chemistry you want to know are there is

775
00:37:04,160 --> 00:37:01,349
there a redox gradient in that ocean are

776
00:37:08,030 --> 00:37:04,170
there both reduced species and oxidized

777
00:37:10,930 --> 00:37:08,040
species and if there are then you've got

778
00:37:13,160 --> 00:37:10,940
something that can power metabolism

779
00:37:14,450 --> 00:37:13,170
giraffes on Europa and that's something

780
00:37:16,000 --> 00:37:14,460
I'll take home today following this

781
00:37:18,440 --> 00:37:16,010
conversation

782
00:37:18,980 --> 00:37:18,450
swimming giraffes know that we need your

783
00:37:24,650 --> 00:37:18,990
eyes

784
00:37:26,720 --> 00:37:24,660
know that Kitty shady asks what is it in

785
00:37:29,839 --> 00:37:26,730
astrobiology that keeps you motivated

786
00:37:32,570 --> 00:37:29,849
and passionate all those years and until

787
00:37:35,359 --> 00:37:32,580
now great questions kitty Oh

788
00:37:38,809 --> 00:37:35,369

astrobiology just ask

789
00:37:41,480 --> 00:37:38,819
the most exciting questions and requires

790
00:37:43,299 --> 00:37:41,490
you to bring together so many areas of

791
00:37:48,170 --> 00:37:43,309
knowledge I think the thing that really

792
00:37:51,019 --> 00:37:48,180
motivates me is seeing the connections

793
00:37:54,589 --> 00:37:51,029
between various areas of biology and

794
00:37:58,450 --> 00:37:54,599
chemistry and astronomy and planetary

795
00:38:02,120 --> 00:37:58,460
science and history and philosophy and

796
00:38:05,359 --> 00:38:02,130
just making those connections for me is

797
00:38:08,450 --> 00:38:05,369
is just glorious and I love doing that

798
00:38:12,079 --> 00:38:08,460
and I continue to do it

799
00:38:14,599 --> 00:38:12,089
just seeing the connections between

800
00:38:17,450 --> 00:38:14,609
things and then working with other

801
00:38:20,509 --> 00:38:17,460
people who are similarly motivated by

802
00:38:23,120 --> 00:38:20,519
these profound questions we ask and by

803
00:38:26,059 --> 00:38:23,130
the connections between everything else

804
00:38:28,789 --> 00:38:26,069
so I think this community is such a

805
00:38:32,809 --> 00:38:28,799
wonderful community because astrobiology

806
00:38:37,670 --> 00:38:32,819
attracts in people who really are turned

807
00:38:41,289 --> 00:38:37,680
on by the depths of the questions that

808
00:38:43,640 --> 00:38:41,299
we ask their decks and breaths and by

809
00:38:46,130 --> 00:38:43,650
the excitement of making these

810
00:38:49,759 --> 00:38:46,140
connections between different fields so

811
00:38:52,099 --> 00:38:49,769
well I I think it's just glorious it

812
00:38:55,220 --> 00:38:52,109
what's it's what motivates me and I will

813
00:38:58,609 --> 00:38:55,230

probably continue to be motivated by it

814
00:38:59,839 --> 00:38:58,619
as long as I'm on this earth that's like

815
00:39:02,299 --> 00:38:59,849
almost that the intersection was

816
00:39:04,460 --> 00:39:02,309
philosophy too because the questions are

817
00:39:05,749 --> 00:39:04,470
so big that they very much line at a

818
00:39:07,960 --> 00:39:05,759
realm of philosophy and makes for very

819
00:39:13,009 --> 00:39:07,970
interesting conversations at conferences

820
00:39:14,479 --> 00:39:13,019
very much Jakub misra asks when

821
00:39:17,599 --> 00:39:14,489
discussing science who's government

822
00:39:20,210 --> 00:39:17,609
officials how can we as scientists best

823
00:39:23,059 --> 00:39:20,220
communicate the value of our work seems

824
00:39:25,220 --> 00:39:23,069
a very pertinent in today's world you

825
00:39:27,049 --> 00:39:25,230
know well it depends upon which science

826
00:39:29,299 --> 00:39:27,059
officials you're talking to if you're

827
00:39:32,690 --> 00:39:29,309
talking to your program manager at NASA

828
00:39:34,870 --> 00:39:32,700
or the NSF you would approach that

829
00:39:40,640 --> 00:39:34,880
conversation I think in a different way

830
00:39:43,069 --> 00:39:40,650
than if you got a an opportunity to

831
00:39:47,630 --> 00:39:43,079
speak with a person in government who is

832
00:39:48,259 --> 00:39:47,640
not a scientist so for people in

833
00:39:50,779 --> 00:39:48,269
government

834
00:39:53,779 --> 00:39:50,789
were not scientists you have to be able

835
00:39:56,119 --> 00:39:53,789
to communicate the importance of what

836
00:39:58,549 --> 00:39:56,129
you do the significance of what you do

837
00:40:00,919 --> 00:39:58,559
and that's where I come back to

838
00:40:04,179 --> 00:40:00,929

understanding the context of your work

839
00:40:09,289 --> 00:40:04,189
you have to be able to put your work

840
00:40:12,349 --> 00:40:09,299
into a broader context of society or a

841
00:40:15,979 --> 00:40:12,359
broad context of science and be able to

842
00:40:18,309 --> 00:40:15,989
describe how the knowledge that you are

843
00:40:22,879 --> 00:40:18,319
gaining which may be in a very narrow

844
00:40:26,269 --> 00:40:22,889
specialized area the how that knowledge

845
00:40:29,299 --> 00:40:26,279
fits together into a larger picture of

846
00:40:32,379 --> 00:40:29,309
our understanding our place in the

847
00:40:36,229 --> 00:40:32,389
universe or our understanding how some

848
00:40:37,459 --> 00:40:36,239
aspect of the earth works etc so I think

849
00:40:39,469 --> 00:40:37,469
you have to take a different approach

850
00:40:42,649 --> 00:40:39,479
depending upon who you're talking to

851
00:40:46,129 --> 00:40:42,659
their background is and what their

852
00:40:48,699 --> 00:40:46,139
motivations are you have to remember to

853
00:40:51,379 --> 00:40:48,709
try to put yourself in their shoes and

854
00:40:53,329 --> 00:40:51,389
have an idea of what their job is and

855
00:40:56,299 --> 00:40:53,339
what they're trying to accomplish and

856
00:40:59,989 --> 00:40:56,309
basically think about how can you help

857
00:41:01,969 --> 00:40:59,999
them accomplish their job because if you

858
00:41:04,519 --> 00:41:01,979
help them accomplish their job they will

859
00:41:09,519 --> 00:41:04,529
really appreciate what you have done and

860
00:41:12,559 --> 00:41:09,529
they'll remember you concept

861
00:41:15,439 --> 00:41:12,569
Marco Antonio day although at sintra I

862
00:41:17,389 --> 00:41:15,449
hope I pronounce that properly asks is

863
00:41:19,699 --> 00:41:17,399

there hope that in the short or medium

864
00:41:21,379 --> 00:41:19,709
term we will know the path of prebiotic

865
00:41:24,279 --> 00:41:21,389
chemistry which has led to the emergence

866
00:41:27,019 --> 00:41:24,289
of life Wow

867
00:41:29,149 --> 00:41:27,029
well the the exciting thing is that

868
00:41:31,999 --> 00:41:29,159
people are trying to close in on this

869
00:41:33,559 --> 00:41:32,009
from both directions that is there is

870
00:41:36,559 --> 00:41:33,569
the bottom-up approach in the top-down

871
00:41:38,449 --> 00:41:36,569
approach and the bottom-up approach of

872
00:41:42,169 --> 00:41:38,459
course starts with chemistry and and

873
00:41:44,239 --> 00:41:42,179
looks at how chemistry can build up to

874
00:41:46,429 --> 00:41:44,249
more and more complex molecules the

875
00:41:51,399 --> 00:41:46,439
top-down approach looks at what we know

876
00:41:55,189 --> 00:41:51,409
about life on Earth today and how can we

877
00:41:58,549 --> 00:41:55,199
pick the processes of life apart to try

878
00:42:01,910 --> 00:41:58,559
to understand their their chemical

879
00:42:04,670 --> 00:42:01,920
origins and there are groups

880
00:42:06,320 --> 00:42:04,680
coming together just happened to read a

881
00:42:09,620 --> 00:42:06,330
press release that was put out by

882
00:42:12,290 --> 00:42:09,630
Georgia Tech which has folks working in

883
00:42:14,780 --> 00:42:12,300
both directions from the top down and

884
00:42:18,470 --> 00:42:14,790
from the bottom up but there are many

885
00:42:21,950 --> 00:42:18,480
other groups as well doing one or both

886
00:42:24,890 --> 00:42:21,960
of those and so we we I think we are

887
00:42:28,340 --> 00:42:24,900
closing in but it's a tremendously

888
00:42:32,810 --> 00:42:28,350

difficult problem because the simplest

889
00:42:35,480 --> 00:42:32,820
cell is vastly vastly more complex than

890
00:42:37,220 --> 00:42:35,490
the most complex chemical network that

891
00:42:39,500 --> 00:42:37,230
we've created in the laboratory in

892
00:42:42,110 --> 00:42:39,510
studying prebiotic chemistry so there

893
00:42:45,620 --> 00:42:42,120
still is a big gap between those how

894
00:42:48,140 --> 00:42:45,630
long it will take for that gap to be

895
00:42:50,660 --> 00:42:48,150
bridged I certainly couldn't say but it

896
00:42:52,940 --> 00:42:50,670
is very encouraging that people are

897
00:42:54,920 --> 00:42:52,950
working together and they're working in

898
00:42:57,550 --> 00:42:54,930
both directions and they are trying to

899
00:43:03,080 --> 00:42:57,560
find places to meet in the middle

900
00:43:05,480 --> 00:43:03,090
indeed Adam Smith asks what's the most

901
00:43:09,590 --> 00:43:05,490
attractive astrobiology target in a

902
00:43:12,080 --> 00:43:09,600
solar system well I don't know as any AI

903
00:43:15,710 --> 00:43:12,090
director I try to avoid taking sides on

904
00:43:18,020 --> 00:43:15,720
that I have to acknowledge a certain

905
00:43:20,570 --> 00:43:18,030
affection that I have for Europa because

906
00:43:23,480 --> 00:43:20,580
Europa helped me get my PhD and I've

907
00:43:28,340 --> 00:43:23,490
always been grateful to it for for that

908
00:43:33,230 --> 00:43:28,350
reason one of my my papers published as

909
00:43:36,380 --> 00:43:33,240
a graduate student was the discovery of

910
00:43:40,220 --> 00:43:36,390
water frost on Europa done

911
00:43:42,920 --> 00:43:40,230
astronomically so I've always had a

912
00:43:45,530 --> 00:43:42,930
particular fondness for Europa but

913
00:43:48,980 --> 00:43:45,540

certainly Enceladus and Titan are both

914
00:43:51,920 --> 00:43:48,990
very very exciting bodies and cela das's

915
00:43:54,470 --> 00:43:51,930
delivering samples of its ocean to space

916
00:43:56,480 --> 00:43:54,480
so we don't even have to melt our way

917
00:43:59,270 --> 00:43:56,490
through the ice and Titan of course we

918
00:44:01,460 --> 00:43:59,280
can land on a lake in principle and

919
00:44:04,190 --> 00:44:01,470
frankly I'm really interested in Triton

920
00:44:06,350 --> 00:44:04,200
I would love to know what's going on in

921
00:44:09,980 --> 00:44:06,360
those pools of liquid nitrogen now it's

922
00:44:12,080 --> 00:44:09,990
probably only chemistry but but there

923
00:44:13,260 --> 00:44:12,090
are geysers there are no nitrogen

924
00:44:16,380 --> 00:44:13,270
geysers on

925
00:44:17,820 --> 00:44:16,390
and they're spewing out dark particles I

926
00:44:20,880 --> 00:44:17,830
would love to know what's in those dark

927
00:44:22,970 --> 00:44:20,890
particles so I think there are a lot of

928
00:44:26,550 --> 00:44:22,980
very interesting candidates although

929
00:44:29,850 --> 00:44:26,560
deep in my heart I I think of my

930
00:44:32,340 --> 00:44:29,860
affection for Europa is is is something

931
00:44:34,500 --> 00:44:32,350
that's very long-lasting so you

932
00:44:36,390 --> 00:44:34,510
discovered water Frost's on Europa as a

933
00:44:39,980 --> 00:44:36,400
grad student thanks for making us all

934
00:44:43,920 --> 00:44:39,990
look average in our graduate degrees

935
00:44:45,660 --> 00:44:43,930
steve Kroft asks do you see the search

936
00:44:48,360 --> 00:44:45,670
for extraterrestrial intelligence

937
00:44:50,900 --> 00:44:48,370
so SETI being included once again in the

938
00:44:53,490 --> 00:44:50,910

NASA Astrobiology program going forward

939
00:44:55,710 --> 00:44:53,500
you know I don't know whether it will be

940
00:44:58,740 --> 00:44:55,720
included formally in the program which

941
00:45:00,840 --> 00:44:58,750
really means that NASA money will be

942
00:45:02,910 --> 00:45:00,850
going toward that but I think it's

943
00:45:07,680 --> 00:45:02,920
certainly intellectually part of the

944
00:45:09,630 --> 00:45:07,690
astrobiology program certainly what we

945
00:45:12,420 --> 00:45:09,640
want to understand is about the

946
00:45:13,800 --> 00:45:12,430
potential for life beyond Earth and the

947
00:45:15,810 --> 00:45:13,810
potential for life beyond Earth

948
00:45:18,350 --> 00:45:15,820
certainly includes the potential for

949
00:45:21,360 --> 00:45:18,360
intelligent life of the potential for

950
00:45:24,930 --> 00:45:21,370
civilizations and for technology so I

951
00:45:28,250 --> 00:45:24,940
think intellectually SETI is absolutely

952
00:45:31,170 --> 00:45:28,260
a part of astrobiology whether it is

953
00:45:34,640 --> 00:45:31,180
formally a part of NASA's astrobiology

954
00:45:37,620 --> 00:45:34,650
program is more of a question of

955
00:45:41,130 --> 00:45:37,630
economics and bureaucracy and and

956
00:45:42,630 --> 00:45:41,140
politics and priorities and I can't

957
00:45:45,570 --> 00:45:42,640
really say whether that's going to go

958
00:45:49,560 --> 00:45:45,580
but certainly intellectually I don't see

959
00:45:51,210 --> 00:45:49,570
how you can separate it indeed so we're

960
00:45:54,030 --> 00:45:51,220
getting close to the top of the hour so

961
00:45:57,330 --> 00:45:54,040
Shayne Carberry Mogan is gonna get the

962
00:46:00,210 --> 00:45:57,340
last question do you think life is just

963
00:46:10,920 --> 00:46:00,220

a process of chemistry or is there more

964
00:46:13,470 --> 00:46:10,930
to the phenomenon well I think the very

965
00:46:17,600 --> 00:46:13,480
interesting possibility is that life is

966
00:46:23,099 --> 00:46:17,610
a naturally self-organizing

967
00:46:33,029 --> 00:46:29,339
if if life is is basically a planetary

968
00:46:36,150 --> 00:46:33,039
process one one of the processes that

969
00:46:45,380 --> 00:46:36,160
happens on a planet under the right

970
00:46:49,829 --> 00:46:45,390
conditions then life is not just

971
00:46:53,729 --> 00:46:49,839
chemistry and physics but life is an

972
00:46:55,969 --> 00:46:53,739
emergent phenomenon that emerges from

973
00:46:58,739 --> 00:46:55,979
the laws of chemistry and physics but

974
00:47:02,699 --> 00:46:58,749
emerges as something that I think we can

975
00:47:05,549 --> 00:47:02,709
think of as as distinct you know one of

976
00:47:08,640 --> 00:47:05,559
the questions is are there laws of

977
00:47:12,839 --> 00:47:08,650
biology that are comparable to the laws

978
00:47:16,650 --> 00:47:12,849
of physics and chemistry and there may

979
00:47:21,660 --> 00:47:16,660
be there may be laws that govern this

980
00:47:25,199 --> 00:47:21,670
emergence that we call life and people

981
00:47:27,479 --> 00:47:25,209
are trying to investigate that and to

982
00:47:30,569 --> 00:47:27,489
try to determine if there are underlying

983
00:47:33,420 --> 00:47:30,579
laws of biology one of the arguments

984
00:47:36,870 --> 00:47:33,430
about why we find it so difficult to

985
00:47:39,839 --> 00:47:36,880
define life is that we don't have the

986
00:47:42,089 --> 00:47:39,849
underlying principles yeah and we don't

987
00:47:45,689 --> 00:47:42,099
know what the underlying laws of biology

988
00:47:47,789 --> 00:47:45,699

are and so as Carol Cleland and Chris

989
00:47:50,999 --> 00:47:47,799
tribe of said it's like trying to define

990
00:47:52,739 --> 00:47:51,009
water in the 16th century without

991
00:47:55,890 --> 00:47:52,749
knowing anything but atoms and molecules

992
00:47:59,009 --> 00:47:55,900
you really can't do it terribly well so

993
00:48:02,430 --> 00:47:59,019
I think of life as an emergent

994
00:48:06,989 --> 00:48:02,440
phenomenon that might emerge anytime the

995
00:48:10,799 --> 00:48:06,999
conditions are suitable because it is a

996
00:48:16,170 --> 00:48:10,809
planetary process as some folks have

997
00:48:19,559 --> 00:48:16,180
said David Grinspoon and and others Eric

998
00:48:21,870 --> 00:48:19,569
Smith and and Harold marwat's life may

999
00:48:24,979 --> 00:48:21,880
be something that happens to a planet

1000
00:48:27,660 --> 00:48:24,989
not something that happens on a planet

1001
00:48:30,359 --> 00:48:27,670
well that's incredible words to to

1002
00:48:33,299 --> 00:48:30,369
slowly close this program but before we

1003
00:48:34,859 --> 00:48:33,309
do so those of you who are watching on

1004
00:48:36,380 --> 00:48:34,869
the live program please enter the

1005
00:48:38,359 --> 00:48:36,390
country where you're connecting from

1006
00:48:39,920 --> 00:48:38,369
in the different chat rooms but on

1007
00:48:42,079 --> 00:48:39,930
Twitter on the Signet chat will be cool

1008
00:48:44,720 --> 00:48:42,089
to see the the breath of the audience we

1009
00:48:46,910 --> 00:48:44,730
have karl has been an absolute pleasure

1010
00:48:48,979 --> 00:48:46,920
to share this hour with you thank you

1011
00:48:50,930 --> 00:48:48,989
very much for all those words of wisdom

1012
00:48:53,180 --> 00:48:50,940
perhaps you have some some parting

1013
00:48:56,180 --> 00:48:53,190

statements you would like to make well I

1014
00:49:00,049 --> 00:48:56,190
just wanted once again thank you say

1015
00:49:02,329 --> 00:49:00,059
enjoy and and Jacob and the others who

1016
00:49:06,410 --> 00:49:02,339
founded sagen it and who founded Blue

1017
00:49:09,380 --> 00:49:06,420
Marble space you are really a product of

1018
00:49:12,289 --> 00:49:09,390
the astrobiology program and you are the

1019
00:49:15,109 --> 00:49:12,299
future of the astrobiology program so I

1020
00:49:18,670 --> 00:49:15,119
just want to say that I think that the

1021
00:49:20,769 --> 00:49:18,680
the fact that the early career

1022
00:49:24,049 --> 00:49:20,779
astrobiologists have come together in

1023
00:49:28,069 --> 00:49:24,059
this magnificent way is for me

1024
00:49:30,880 --> 00:49:28,079
personally gratifying but as well really

1025
00:49:33,739 --> 00:49:30,890
points to a really bright future for

1026
00:49:37,190 --> 00:49:33,749
astrobiology so I just want to thank you

1027
00:49:39,410 --> 00:49:37,200
Sanjoy personally and thank all of your

1028
00:49:42,950 --> 00:49:39,420
early career and now mid-career

1029
00:49:47,120 --> 00:49:42,960
colleagues for doing all that you're

1030
00:49:50,180 --> 00:49:47,130
doing to to advance the field and ensure

1031
00:49:52,009 --> 00:49:50,190
a really brilliant future for it well

1032
00:49:54,769 --> 00:49:52,019
thank you Colin Signet was indeed born

1033
00:49:56,839 --> 00:49:54,779
in 2011 during the astrobiology

1034
00:49:59,109 --> 00:49:56,849
graduates Union conference which is a

1035
00:50:02,210 --> 00:49:59,119
conference at the NASA Astrobiology

1036
00:50:04,579 --> 00:50:02,220
trusts early career students to put

1037
00:50:04,940 --> 00:50:04,589
together and run so this is a product of

1038
00:50:08,900 --> 00:50:04,950

this

1039
00:50:11,120 --> 00:50:08,910
so with that Karl have a wonderful

1040
00:50:13,779 --> 00:50:11,130
evening and day in in California all the

1041
00:50:17,210 --> 00:50:13,789
bests and we hope to talk to you soon

1042
00:50:19,640 --> 00:50:17,220
Watchers please make sure you keep an

1043
00:50:21,950 --> 00:50:19,650
eye on Signet org for the announcement

1044
00:50:24,410 --> 00:50:21,960
of the nest next ask an astrobiologist

1045
00:50:25,270 --> 00:50:24,420
and until then stay curious bye bye for