Ask An Astrobiologist

Episode 43: August 25th, 2021

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NASA Astrobiology Program

1
00:00:01,120 --> 00:00:30,310
[Music]

2
00:00:34,229 --> 00:00:33,350
greetings friends fellow explorers and

3
00:00:37,190 --> 00:00:34,239
um

4
00:00:39,190 --> 00:00:37,200
potential descendants of martians what

5
00:00:41,670 --> 00:00:39,200
welcome to ask an astrobiologist the

6
00:00:43,990 --> 00:00:41,680
show that celebrates the science and the

7
00:00:45,750 --> 00:00:44,000
scientists involved in our quest to

8
00:00:48,709 --> 00:00:45,760
understand the nature of life in the

9
00:00:50,069 --> 00:00:48,719
cosmos i'm your host dr graham lau and

10
00:00:53,750 --> 00:00:50,079
we're brought to you by the nasa

11
00:00:55,189 --> 00:00:53,760
astrobiology program and saginet.org and

12
00:00:56,950 --> 00:00:55,199
this month's episode is going to be

13
00:00:59,830 --> 00:00:56,960

really awesome we are chatting with an

14
00:01:01,670 --> 00:00:59,840
astrobiologist who has specialized in

15
00:01:03,830 --> 00:01:01,680
how we can use remote extreme

16
00:01:06,550 --> 00:01:03,840
environments on our planet earth to

17
00:01:07,750 --> 00:01:06,560
better understand how we could find life

18
00:01:09,590 --> 00:01:07,760
out there

19
00:01:11,350 --> 00:01:09,600
before i introduced our guest though i'd

20
00:01:13,990 --> 00:01:11,360
like to just give a shout out to all of

21
00:01:16,550 --> 00:01:14,000
you out there in twitterland on social

22
00:01:18,230 --> 00:01:16,560
media sharing us through emails and

23
00:01:20,230 --> 00:01:18,240
talking to your family and friends about

24
00:01:22,310 --> 00:01:20,240
our show and sharing this wondrous

25
00:01:23,830 --> 00:01:22,320
nature of astrobiology with us

26
00:01:27,390 --> 00:01:23,840
this month i want to give a special

27
00:01:30,390 --> 00:01:27,400
shout out to one twitter user at

28
00:01:33,270 --> 00:01:30,400
nickbe24 who asked a question on our

29
00:01:35,429 --> 00:01:33,280
twitter poll from nasa astrobio about

30
00:01:38,310 --> 00:01:35,439
how can one become an astrobiologist

31
00:01:40,230 --> 00:01:38,320
what was your path after high school

32
00:01:42,789 --> 00:01:40,240
this is a very important question and

33
00:01:44,550 --> 00:01:42,799
one that we get very often on this show

34
00:01:46,469 --> 00:01:44,560
and if you have very specific questions

35
00:01:48,069 --> 00:01:46,479
about the career of today's guest please

36
00:01:50,870 --> 00:01:48,079
ask those during the q a a little bit

37
00:01:52,550 --> 00:01:50,880
later but for nick and others who are

38
00:01:55,190 --> 00:01:52,560

interested you can go to the nasa

39
00:01:57,749 --> 00:01:55,200
astrobiology website specifically at

40
00:02:00,709 --> 00:01:57,759
astrobiology.nasa.gov

41
00:02:03,670 --> 00:02:00,719
slash career path suggestions with a

42
00:02:05,190 --> 00:02:03,680
hyphen in between those three words

43
00:02:07,910 --> 00:02:05,200
that'll show you our career path

44
00:02:09,589 --> 00:02:07,920
suggestions page from nasa astro bio

45
00:02:11,430 --> 00:02:09,599
which will help you kind of guiding

46
00:02:13,510 --> 00:02:11,440
yourself forward and thinking about how

47
00:02:15,589 --> 00:02:13,520
to pursue the right courses in high

48
00:02:17,350 --> 00:02:15,599
school and college and to think about

49
00:02:19,830 --> 00:02:17,360
your future career

50
00:02:22,390 --> 00:02:19,840
now all of that said i'm very excited to

51
00:02:24,390 --> 00:02:22,400
introduce today's guest dr alfonso

52
00:02:26,790 --> 00:02:24,400
davila is joining us he's a research

53
00:02:29,270 --> 00:02:26,800
scientist at nasa's ames research center

54
00:02:31,270 --> 00:02:29,280
an expert in bio signatures and life

55
00:02:33,190 --> 00:02:31,280
detection remote environments and

56
00:02:35,190 --> 00:02:33,200
searching for life elsewhere

57
00:02:37,750 --> 00:02:35,200
alfonso hello and thank you for joining

58
00:02:39,509 --> 00:02:37,760
us for ask master biologist hey graeme

59
00:02:42,229 --> 00:02:39,519
it's uh nice to be here thanks for

60
00:02:43,990 --> 00:02:42,239
having me i'm so glad you could join us

61
00:02:45,750 --> 00:02:44,000
um one thing i love with our guests you

62
00:02:48,070 --> 00:02:45,760
know we like to showcase your work as a

63
00:02:50,070 --> 00:02:48,080

researcher but we also like for our

64
00:02:52,229 --> 00:02:50,080
audience to get to know you and some of

65
00:02:53,589 --> 00:02:52,239
your own career path as i mentioned we

66
00:02:56,390 --> 00:02:53,599
have a lot of young people who want to

67
00:02:58,550 --> 00:02:56,400
know how to become astrobiologists

68
00:03:00,710 --> 00:02:58,560
you started off in your undergraduate

69
00:03:03,350 --> 00:03:00,720
and master's degree studying marine

70
00:03:04,949 --> 00:03:03,360
science marine physics marine geology

71
00:03:07,190 --> 00:03:04,959
and then you earned your phd at the

72
00:03:09,670 --> 00:03:07,200
university of munich

73
00:03:11,509 --> 00:03:09,680
where you studied in geophysics and then

74
00:03:13,589 --> 00:03:11,519
transferred into the seti institute and

75
00:03:15,030 --> 00:03:13,599
then nasa's ames research center i'm

76
00:03:16,630 --> 00:03:15,040
wondering for our audience though if you

77
00:03:19,270 --> 00:03:16,640
can tell them you know what what really

78
00:03:20,949 --> 00:03:19,280
drove you into this this career what

79
00:03:22,710 --> 00:03:20,959
what was it that that really gave you

80
00:03:24,309 --> 00:03:22,720
that first impetus to want to pursue

81
00:03:25,110 --> 00:03:24,319
these sciences

82
00:03:28,470 --> 00:03:25,120
well

83
00:03:29,990 --> 00:03:28,480
most of all was chance um i'm not the

84
00:03:31,670 --> 00:03:30,000
poster child for somebody who wants to

85
00:03:34,149 --> 00:03:31,680
do

86
00:03:35,990 --> 00:03:34,159
uh when i went to college that was i

87
00:03:38,309 --> 00:03:36,000
went to college at the same time as the

88
00:03:40,949 --> 00:03:38,319

allen hills meteorite paper was coming

89
00:03:42,710 --> 00:03:40,959
out in the mid-90s so astrobiology was

90
00:03:44,630 --> 00:03:42,720
not meant it became mainstream all of a

91
00:03:45,589 --> 00:03:44,640
sudden but it was a mainstream when i

92
00:03:48,550 --> 00:03:45,599
was in

93
00:03:51,190 --> 00:03:48,560
in high school for example or in school

94
00:03:54,070 --> 00:03:51,200
and even when i was in college it didn't

95
00:03:56,390 --> 00:03:54,080
make it all the way to europe so to

96
00:03:58,229 --> 00:03:56,400
speak i was probably it was growing in

97
00:03:59,270 --> 00:03:58,239
the us but it was internationally still

98
00:04:02,229 --> 00:03:59,280
not that

99
00:04:04,630 --> 00:04:02,239
huge feel that it became afterwards so

100
00:04:06,789 --> 00:04:04,640
i was i had it very clear in my head

101
00:04:07,990 --> 00:04:06,799
that i wanted to do science for a number

102
00:04:10,949 --> 00:04:08,000
of reasons

103
00:04:13,030 --> 00:04:10,959
um i chose a science path in high school

104
00:04:15,509 --> 00:04:13,040
and then through colleges you just said

105
00:04:17,509 --> 00:04:15,519
when the opportunity came up to do a phd

106
00:04:18,949 --> 00:04:17,519
in munich i thought

107
00:04:20,789 --> 00:04:18,959
sounds like fun

108
00:04:23,030 --> 00:04:20,799
uh it was a very interesting topic that

109
00:04:25,350 --> 00:04:23,040
had nothing to do with my undergrad

110
00:04:28,070 --> 00:04:25,360
uh even better

111
00:04:30,150 --> 00:04:28,080
and so i went there and that's when

112
00:04:32,629 --> 00:04:30,160
towards the end of my phd

113
00:04:33,990 --> 00:04:32,639

i got in touch with astrobiology i was

114
00:04:36,070 --> 00:04:34,000
approached by

115
00:04:37,749 --> 00:04:36,080
people at nasa ames chris mckay and

116
00:04:39,430 --> 00:04:37,759
iamra friedman

117
00:04:40,150 --> 00:04:39,440
who back then was working with that with

118
00:04:41,830 --> 00:04:40,160
chris

119
00:04:43,350 --> 00:04:41,840
nasa ames and they were looking for

120
00:04:44,550 --> 00:04:43,360
somebody with a certain line of

121
00:04:47,030 --> 00:04:44,560
expertise

122
00:04:48,550 --> 00:04:47,040
uh that coincided with with what i was

123
00:04:50,070 --> 00:04:48,560
doing in germany

124
00:04:53,590 --> 00:04:50,080
and uh they invited me to come to the

125
00:04:55,990 --> 00:04:53,600
u.s for 15 days through a very a kind of

126
00:04:57,590 --> 00:04:56,000
pilot study and i came and i thought it

127
00:04:59,670 --> 00:04:57,600
was the funniest thing i've ever done in

128
00:05:01,909 --> 00:04:59,680
my life we went looking for fossils in

129
00:05:03,029 --> 00:05:01,919
the desert in the mojave desert

130
00:05:05,110 --> 00:05:03,039
uh

131
00:05:07,029 --> 00:05:05,120
and then i learned about astrobiology at

132
00:05:08,469 --> 00:05:07,039
that point it was at the end of towards

133
00:05:10,629 --> 00:05:08,479
the end of my phd and i thought it was

134
00:05:12,629 --> 00:05:10,639
the coolest thing ever

135
00:05:14,870 --> 00:05:12,639
it was a chance to put

136
00:05:17,029 --> 00:05:14,880
into practice all the multidisciplinary

137
00:05:19,510 --> 00:05:17,039
science that i had learned in college

138
00:05:21,350 --> 00:05:19,520

geology physics biology chemistry what

139
00:05:24,469 --> 00:05:21,360
not and then some sprinkles of

140
00:05:27,110 --> 00:05:24,479
geophysics that i learned in my phd to

141
00:05:28,870 --> 00:05:27,120
answer a profound question that was very

142
00:05:30,629 --> 00:05:28,880
inspiring to me is there life on other

143
00:05:31,670 --> 00:05:30,639
planets i didn't know you could get paid

144
00:05:33,590 --> 00:05:31,680
to do that

145
00:05:35,990 --> 00:05:33,600
uh that was a realization at that point

146
00:05:37,990 --> 00:05:36,000
and then so i came to the us to do a

147
00:05:40,710 --> 00:05:38,000
postdoc at nasa that was the outcome of

148
00:05:42,230 --> 00:05:40,720
that pilot study i did an asset postdoc

149
00:05:44,870 --> 00:05:42,240
for three years and then i continued on

150
00:05:47,110 --> 00:05:44,880
i decided okay enough wandering around

151
00:05:48,469 --> 00:05:47,120
this is what i want to be i can spend 50

152
00:05:49,670 --> 00:05:48,479
years of my life

153
00:05:52,469 --> 00:05:49,680
searching for life on other planets

154
00:05:53,830 --> 00:05:52,479
seems like a worthwhile thing to do and

155
00:05:55,590 --> 00:05:53,840
here i am

156
00:05:58,309 --> 00:05:55,600
fantastic and now you're an expert as an

157
00:05:59,749 --> 00:05:58,319
astrobiologist um that's fantastic i

158
00:06:01,270 --> 00:05:59,759
think that's the case for many of us

159
00:06:03,430 --> 00:06:01,280
when we first start college and maybe

160
00:06:05,189 --> 00:06:03,440
even through graduate school don't quite

161
00:06:06,710 --> 00:06:05,199
know that we're on the path to becoming

162
00:06:08,230 --> 00:06:06,720
astrobiologists

163
00:06:10,309 --> 00:06:08,240

i just had a young student just this

164
00:06:11,990 --> 00:06:10,319
morning reached out to me from india she

165
00:06:13,749 --> 00:06:12,000
wanted to know if i had a list of all

166
00:06:16,070 --> 00:06:13,759
the master's degrees programs that have

167
00:06:17,670 --> 00:06:16,080
astrobiology in the title and my

168
00:06:19,830 --> 00:06:17,680
response was you know most of us who are

169
00:06:21,749 --> 00:06:19,840
astrobiologists don't have degrees that

170
00:06:23,990 --> 00:06:21,759
have astrobiology in the title we come

171
00:06:26,070 --> 00:06:24,000
from many different disciplines

172
00:06:27,270 --> 00:06:26,080
working together and so it's really cool

173
00:06:28,950 --> 00:06:27,280
to hear about your pathway and then

174
00:06:30,390 --> 00:06:28,960
going into geophysics

175
00:06:31,830 --> 00:06:30,400
for your phd

176
00:06:33,990 --> 00:06:31,840
but then you've also now become an

177
00:06:35,590 --> 00:06:34,000
expert in an analog environment so not

178
00:06:37,510 --> 00:06:35,600
only looking at fossils in the mojave

179
00:06:38,950 --> 00:06:37,520
for that pilot study but you've now

180
00:06:41,350 --> 00:06:38,960
traveled the world and you've gone to

181
00:06:43,909 --> 00:06:41,360
places like the atacama and antarctica

182
00:06:45,029 --> 00:06:43,919
to do field research i wonder for our

183
00:06:47,270 --> 00:06:45,039
audience if you can give them an

184
00:06:49,990 --> 00:06:47,280
understanding of why you think it's

185
00:06:52,710 --> 00:06:50,000
important for us to go to these systems

186
00:06:54,070 --> 00:06:52,720
to look for life elsewhere

187
00:06:56,710 --> 00:06:54,080
well um

188
00:06:58,950 --> 00:06:56,720

so this is a great question the um

189
00:07:00,469 --> 00:06:58,960
what analogs gives you is a way to

190
00:07:02,870 --> 00:07:00,479
experience firsthand

191
00:07:04,710 --> 00:07:02,880
conditions that might that resemble

192
00:07:05,830 --> 00:07:04,720
conditions on other planets

193
00:07:06,870 --> 00:07:05,840
uh

194
00:07:10,790 --> 00:07:06,880
as a

195
00:07:13,270 --> 00:07:10,800
with your inputs not through the eyes or

196
00:07:15,270 --> 00:07:13,280
or the uh ears of a robot

197
00:07:17,990 --> 00:07:15,280
i would through your own and also to

198
00:07:19,749 --> 00:07:18,000
look at them uh this multi-dimensional

199
00:07:21,990 --> 00:07:19,759
space that is a natural environment not

200
00:07:24,230 --> 00:07:22,000
just whatever data comes from one

201
00:07:25,510 --> 00:07:24,240
instrument but multiple instruments that

202
00:07:27,350 --> 00:07:25,520
you're using all the time

203
00:07:30,070 --> 00:07:27,360
so if analog research gives you the

204
00:07:32,790 --> 00:07:30,080
complexity natural complexity of things

205
00:07:34,710 --> 00:07:32,800
it also gives you a closer view of what

206
00:07:38,230 --> 00:07:34,720
the life of a microbe on a place like

207
00:07:39,830 --> 00:07:38,240
mars might be like today or in the past

208
00:07:41,189 --> 00:07:39,840
which is very different from the

209
00:07:43,189 --> 00:07:41,199
environment you experience as a human

210
00:07:45,270 --> 00:07:43,199
even in an extreme environment so

211
00:07:47,110 --> 00:07:45,280
learning to see the world from the

212
00:07:48,790 --> 00:07:47,120
perspective of a microbe that's very

213
00:07:51,029 --> 00:07:48,800

important and especially important in an

214
00:07:52,550 --> 00:07:51,039
extreme environment where conditions

215
00:07:54,230 --> 00:07:52,560
around the microbial can be very

216
00:07:56,150 --> 00:07:54,240
different from the conditions

217
00:07:57,510 --> 00:07:56,160
a meter away or

218
00:07:59,350 --> 00:07:57,520
from the microbe

219
00:08:01,510 --> 00:07:59,360
that's another one and the third one is

220
00:08:02,550 --> 00:08:01,520
that it uh gives you the opportunity of

221
00:08:04,309 --> 00:08:02,560
test

222
00:08:06,869 --> 00:08:04,319
scientific ideas

223
00:08:08,550 --> 00:08:06,879
and hypotheses and also test technology

224
00:08:10,070 --> 00:08:08,560
uh that one day you might want to send

225
00:08:11,510 --> 00:08:10,080
to other planets to

226
00:08:13,589 --> 00:08:11,520
uh search for evidence of life for

227
00:08:15,749 --> 00:08:13,599
example test especially the technology

228
00:08:17,430 --> 00:08:15,759
is an important one uh particularly

229
00:08:19,510 --> 00:08:17,440
sometimes some types of technologies

230
00:08:21,589 --> 00:08:19,520
like sample acquisition systems

231
00:08:23,670 --> 00:08:21,599
that need to operate on very weird

232
00:08:25,909 --> 00:08:23,680
brains that are not normally found in

233
00:08:27,510 --> 00:08:25,919
your in your backyard that's another

234
00:08:28,869 --> 00:08:27,520
research can get you that

235
00:08:30,469 --> 00:08:28,879
uh that

236
00:08:32,389 --> 00:08:30,479
that

237
00:08:34,949 --> 00:08:32,399
nice connection to

238
00:08:36,469 --> 00:08:34,959

whatever planet you want to explore

239
00:08:38,230 --> 00:08:36,479
it's a very good point and you know a

240
00:08:40,709 --> 00:08:38,240
lot of our research we start preparing

241
00:08:43,269 --> 00:08:40,719
for sending rovers and landers to other

242
00:08:44,870 --> 00:08:43,279
worlds we test them a lot in our analog

243
00:08:46,230 --> 00:08:44,880
environments here on earth

244
00:08:48,550 --> 00:08:46,240
a lot of folks might remember the famous

245
00:08:49,990 --> 00:08:48,560
picture of carl sagan standing beside

246
00:08:52,389 --> 00:08:50,000
one of the mock-ups of the viking

247
00:08:54,150 --> 00:08:52,399
landers in the desert in the mojave and

248
00:08:56,470 --> 00:08:54,160
we've done tests with lots of our other

249
00:08:58,310 --> 00:08:56,480
instruments our rovers i'm part of the

250
00:09:00,550 --> 00:08:58,320
university river challenge where we have

251
00:09:02,630 --> 00:09:00,560
undergraduate students uh every year

252
00:09:04,870 --> 00:09:02,640
bring their mars rovers they build out

253
00:09:07,269 --> 00:09:04,880
to the desert in utah and we give them

254
00:09:08,870 --> 00:09:07,279
challenges like they're on mars and i

255
00:09:11,670 --> 00:09:08,880
understand when you were in the atacama

256
00:09:13,269 --> 00:09:11,680
you also worked with a rover study uh

257
00:09:15,509 --> 00:09:13,279
doing some drilling in the atacama

258
00:09:17,910 --> 00:09:15,519
called airads or atacama rover

259
00:09:19,110 --> 00:09:17,920
astrobiology drilling studies i wonder

260
00:09:21,509 --> 00:09:19,120
if you could speak to what that what

261
00:09:23,350 --> 00:09:21,519
that mission was about for our audience

262
00:09:25,190 --> 00:09:23,360
yeah eric was a very interesting project

263
00:09:26,230 --> 00:09:25,200

we did in the uh it's the last big

264
00:09:28,070 --> 00:09:26,240
project we've done in the other camera

265
00:09:28,949 --> 00:09:28,080
so far just before coving

266
00:09:31,509 --> 00:09:28,959
um

267
00:09:33,110 --> 00:09:31,519
and the uh it was a multi-component

268
00:09:34,310 --> 00:09:33,120
project with the science and technology

269
00:09:37,430 --> 00:09:34,320
development the science but the

270
00:09:39,910 --> 00:09:37,440
technology part was to equip a roper

271
00:09:41,350 --> 00:09:39,920
with a few light detection instruments

272
00:09:43,110 --> 00:09:41,360
as well as sampling acquisition and

273
00:09:45,509 --> 00:09:43,120
sample preparation systems

274
00:09:47,590 --> 00:09:45,519
to simulate what a sampling and light

275
00:09:49,430 --> 00:09:47,600
detection campaign might look like or

276
00:09:51,030 --> 00:09:49,440
might be

277
00:09:51,910 --> 00:09:51,040
executed on mars

278
00:09:53,590 --> 00:09:51,920
um

279
00:09:54,389 --> 00:09:53,600
we were using the atacama as a place

280
00:09:56,470 --> 00:09:54,399
where

281
00:09:58,470 --> 00:09:56,480
when we could challenge the instruments

282
00:09:59,110 --> 00:09:58,480
to search to find evidence of life in an

283
00:10:03,430 --> 00:09:59,120
in

284
00:10:04,790 --> 00:10:03,440
extremely low levels so we're really

285
00:10:06,630 --> 00:10:04,800
pushing the limits of detection of the

286
00:10:07,430 --> 00:10:06,640
instruments and then we're challenging

287
00:10:10,470 --> 00:10:07,440
the

288
00:10:12,470 --> 00:10:10,480

acquisition system to

289
00:10:15,350 --> 00:10:12,480
go through unusual

290
00:10:17,110 --> 00:10:15,360
geological substrates where you can have

291
00:10:19,269 --> 00:10:17,120
very strong changes in hardness for

292
00:10:21,990 --> 00:10:19,279
example of the substrate as you drill

293
00:10:24,630 --> 00:10:22,000
down so we want we can check we can test

294
00:10:27,750 --> 00:10:24,640
for uh failures in the drilling system

295
00:10:29,269 --> 00:10:27,760
we can also test for software recovery

296
00:10:31,110 --> 00:10:29,279
uh

297
00:10:32,470 --> 00:10:31,120
actions and whatnot

298
00:10:34,069 --> 00:10:32,480
um

299
00:10:36,310 --> 00:10:34,079
and then we can also test for mobility

300
00:10:37,670 --> 00:10:36,320
for the rover uh especially when it

301
00:10:39,190 --> 00:10:37,680
comes to

302
00:10:40,870 --> 00:10:39,200
sending the rover to a place where a

303
00:10:42,949 --> 00:10:40,880
scientist sitting

304
00:10:44,630 --> 00:10:42,959
three thousand miles away or three

305
00:10:47,030 --> 00:10:44,640
hundred thousand miles away

306
00:10:48,069 --> 00:10:47,040
i might think is a good interesting spot

307
00:10:49,750 --> 00:10:48,079
and uh

308
00:10:51,350 --> 00:10:49,760
see how we can learn to tell the rover

309
00:10:53,430 --> 00:10:51,360
exactly where to go where to drill how

310
00:10:55,030 --> 00:10:53,440
to collect the sample and then analyze

311
00:10:57,430 --> 00:10:55,040
it with the instruments so it's it's a

312
00:10:59,670 --> 00:10:57,440
very nice opportunity to do end-to-end

313
00:11:01,030 --> 00:10:59,680

science and sample technology testing

314
00:11:03,030 --> 00:11:01,040
that's very important and one thing you

315
00:11:04,710 --> 00:11:03,040
said that kind of stuck out to me was

316
00:11:07,430 --> 00:11:04,720
the issue with drilling through

317
00:11:08,949 --> 00:11:07,440
different substrates uh as our audience

318
00:11:10,790 --> 00:11:08,959
may be aware we've had some issues

319
00:11:12,630 --> 00:11:10,800
drilling on mars already we've never

320
00:11:14,150 --> 00:11:12,640
been able to drill very deep and even

321
00:11:16,310 --> 00:11:14,160
with insight we were really hoping to

322
00:11:18,470 --> 00:11:16,320
get down nice and deep and we've had

323
00:11:20,550 --> 00:11:18,480
some issues with drilling but drilling

324
00:11:22,069 --> 00:11:20,560
really gives us access to the subsurface

325
00:11:24,389 --> 00:11:22,079
environment especially with the very

326
00:11:26,310 --> 00:11:24,399
oxidizing surface of mars

327
00:11:28,069 --> 00:11:26,320
if you had to guess how deep do you

328
00:11:29,990 --> 00:11:28,079
think we really need to drill to get a

329
00:11:31,509 --> 00:11:30,000
very good fresh subsurface sample on

330
00:11:33,750 --> 00:11:31,519
mars

331
00:11:35,590 --> 00:11:33,760
well an informed gas would be at least a

332
00:11:38,069 --> 00:11:35,600
meter deep

333
00:11:40,069 --> 00:11:38,079
and that has to do primarily with the

334
00:11:42,790 --> 00:11:40,079
long-term

335
00:11:45,750 --> 00:11:42,800
constant radiation exposure of the

336
00:11:47,590 --> 00:11:45,760
regular uh cosmic radiation which is

337
00:11:49,269 --> 00:11:47,600
something it's it's radiation that comes

338
00:11:51,190 --> 00:11:49,279

out of the sun and also from

339
00:11:53,750 --> 00:11:51,200
the universe surrounding us

340
00:11:55,670 --> 00:11:53,760
high energy particles

341
00:11:57,590 --> 00:11:55,680
that they don't come in high abundance

342
00:11:59,750 --> 00:11:57,600
but they're constantly pummeling the

343
00:12:01,670 --> 00:11:59,760
martian surface and they unlike other

344
00:12:02,710 --> 00:12:01,680
types of radiation like uv which only

345
00:12:04,710 --> 00:12:02,720
penetrates

346
00:12:06,949 --> 00:12:04,720
a skin layer of the surface that

347
00:12:09,269 --> 00:12:06,959
radiation can penetrate deeper and as it

348
00:12:11,590 --> 00:12:09,279
penetrates it actually cascades into the

349
00:12:13,190 --> 00:12:11,600
subsurface and we have very good models

350
00:12:15,509 --> 00:12:13,200
that can predict how far that radiation

351
00:12:17,590 --> 00:12:15,519
might go and they tell us that for time

352
00:12:19,670 --> 00:12:17,600
scales of millions of years they

353
00:12:20,470 --> 00:12:19,680
typically go a meter deep two meters

354
00:12:23,190 --> 00:12:20,480
deep

355
00:12:24,949 --> 00:12:23,200
and so if we if we want to

356
00:12:27,190 --> 00:12:24,959
get away from material that has been

357
00:12:29,509 --> 00:12:27,200
radiated to those levels

358
00:12:31,269 --> 00:12:29,519
it's relatively fresh especially that's

359
00:12:32,790 --> 00:12:31,279
especially relevant for microorganisms

360
00:12:35,110 --> 00:12:32,800
or biosignatures that might be great

361
00:12:37,350 --> 00:12:35,120
with radiation then one meter is it's

362
00:12:39,670 --> 00:12:37,360
probably a good starting point

363
00:12:41,269 --> 00:12:39,680

otherwise as you can

364
00:12:43,269 --> 00:12:41,279
yeah as deep as you can be nice it'd be

365
00:12:45,269 --> 00:12:43,279
nice to have a drilling rig an apparatus

366
00:12:46,710 --> 00:12:45,279
for going deep but one meter does sound

367
00:12:48,550 --> 00:12:46,720
pretty awesome if we can get that from

368
00:12:49,590 --> 00:12:48,560
mars and i do want to remind our

369
00:12:51,990 --> 00:12:49,600
audience the reason we're talking about

370
00:12:53,910 --> 00:12:52,000
the atacama this is the driest desert on

371
00:12:55,350 --> 00:12:53,920
the planet um i've never been there

372
00:12:57,990 --> 00:12:55,360
myself i've heard really cool things

373
00:12:59,430 --> 00:12:58,000
about exploration there especially as a

374
00:13:01,430 --> 00:12:59,440
mars analog we've been looking at

375
00:13:03,750 --> 00:13:01,440
deserts for a long time dry places as

376
00:13:06,230 --> 00:13:03,760
mars analogs because of the history of

377
00:13:08,629 --> 00:13:06,240
mars mars had what we think was a very

378
00:13:10,150 --> 00:13:08,639
wet ancient history in the milwaukee inn

379
00:13:11,829 --> 00:13:10,160
but as we move through the hesperian and

380
00:13:14,710 --> 00:13:11,839
amazonian we kind of come to this area

381
00:13:16,310 --> 00:13:14,720
where mars today is very dry i'm

382
00:13:18,550 --> 00:13:16,320
wondering if you can give our audience

383
00:13:22,629 --> 00:13:18,560
kind of your vision of what mars looked

384
00:13:24,310 --> 00:13:22,639
like maybe 3.5 to 3.9 billion years ago

385
00:13:26,230 --> 00:13:24,320
i think it looked like the atacama

386
00:13:27,750 --> 00:13:26,240
desert uh

387
00:13:30,150 --> 00:13:27,760
as you say the academy is the driest

388
00:13:32,470 --> 00:13:30,160

place on earth it's still very wet

389
00:13:33,670 --> 00:13:32,480
compared to mars we sometimes will lose

390
00:13:35,030 --> 00:13:33,680
this perspective we think that the

391
00:13:37,670 --> 00:13:35,040
driest place on earth might be a good

392
00:13:39,829 --> 00:13:37,680
analog to present day mars it is not

393
00:13:41,030 --> 00:13:39,839
it's about uh if you run if you run up

394
00:13:43,030 --> 00:13:41,040
the numbers the other camera is about a

395
00:13:44,870 --> 00:13:43,040
hundred to a thousand times wetter

396
00:13:47,189 --> 00:13:44,880
than the surface of mars

397
00:13:49,509 --> 00:13:47,199
um and so

398
00:13:51,269 --> 00:13:49,519
in my mind the other camera is a good

399
00:13:52,069 --> 00:13:51,279
analog or a good

400
00:13:53,990 --> 00:13:52,079
uh

401
00:13:56,550 --> 00:13:54,000
window into what mars might have looked

402
00:13:58,230 --> 00:13:56,560
like towards the end of that water reach

403
00:14:00,150 --> 00:13:58,240
period as you said towards the end of

404
00:14:01,670 --> 00:14:00,160
the his period when there were still

405
00:14:03,110 --> 00:14:01,680
pockets of liquid water in the surface

406
00:14:04,710 --> 00:14:03,120
but the planet was already cooling down

407
00:14:06,470 --> 00:14:04,720
and drying up

408
00:14:07,910 --> 00:14:06,480
significantly that's where i think the

409
00:14:09,269 --> 00:14:07,920
atacama

410
00:14:11,750 --> 00:14:09,279
sits

411
00:14:13,509 --> 00:14:11,760
as you move farther back in time

412
00:14:15,509 --> 00:14:13,519
then you can go to other you can think

413
00:14:16,550 --> 00:14:15,519

of other analogs on earth that might fit

414
00:14:18,389 --> 00:14:16,560
better than the other camera you could

415
00:14:20,550 --> 00:14:18,399
think of environments in the arctic

416
00:14:21,990 --> 00:14:20,560
which are still dry if you have ice

417
00:14:23,990 --> 00:14:22,000
covered lakes that might be a very

418
00:14:25,829 --> 00:14:24,000
animal for places like the old crater

419
00:14:28,150 --> 00:14:25,839
for example and if you go back in time

420
00:14:29,990 --> 00:14:28,160
then you can travel to more

421
00:14:31,590 --> 00:14:30,000
to let more benign environments on earth

422
00:14:33,670 --> 00:14:31,600
where you have temperatures closer to

423
00:14:35,750 --> 00:14:33,680
above freezing and whatnot but the other

424
00:14:37,590 --> 00:14:35,760
countries i think that sweet spot of the

425
00:14:39,829 --> 00:14:37,600
the tail end of

426
00:14:42,870 --> 00:14:39,839
mars being a relatively wet planet and

427
00:14:44,870 --> 00:14:42,880
then just going into extreme dryness

428
00:14:46,310 --> 00:14:44,880
absolutely and then now we we don't know

429
00:14:47,829 --> 00:14:46,320
if there is life on mars or if there was

430
00:14:49,269 --> 00:14:47,839
life on mars where we're going to find

431
00:14:51,430 --> 00:14:49,279
those samples there are some great

432
00:14:53,030 --> 00:14:51,440
targets like in jezreel crater looking

433
00:14:55,189 --> 00:14:53,040
at a potential river delta could be a

434
00:14:56,949 --> 00:14:55,199
great place to look the subsurface or

435
00:14:58,870 --> 00:14:56,959
maybe lava tubes could be great places

436
00:15:01,189 --> 00:14:58,880
to look as well there's a lot of places

437
00:15:02,790 --> 00:15:01,199
for us to explore if any of you watching

438
00:15:04,949 --> 00:15:02,800

have questions about

439
00:15:07,670 --> 00:15:04,959
dr davila's favorite places to look on

440
00:15:09,509 --> 00:15:07,680
mars for life please do ask right now

441
00:15:11,750 --> 00:15:09,519
you can ask in the chat on facebook or

442
00:15:13,750 --> 00:15:11,760
on segonnet those questions are coming

443
00:15:15,430 --> 00:15:13,760
in for me for our q a here in just a

444
00:15:17,590 --> 00:15:15,440
little bit but i have a few more

445
00:15:19,590 --> 00:15:17,600
questions yet of my own

446
00:15:22,550 --> 00:15:19,600
first i want to share a poll that we did

447
00:15:24,710 --> 00:15:22,560
through nasa astrobiology on twitter

448
00:15:26,310 --> 00:15:24,720
we we mentioned you know given your

449
00:15:28,710 --> 00:15:26,320
background and traveling to the autocoma

450
00:15:30,949 --> 00:15:28,720
antarctica and these other field sites

451
00:15:31,990 --> 00:15:30,959
we mentioned that you were in antarctica

452
00:15:33,910 --> 00:15:32,000
testing

453
00:15:36,230 --> 00:15:33,920
novel drilling techniques

454
00:15:38,389 --> 00:15:36,240
uh and we wondered for our audience if

455
00:15:40,710 --> 00:15:38,399
they kind of understood what that be an

456
00:15:43,590 --> 00:15:40,720
analog for and we gave them the options

457
00:15:45,749 --> 00:15:43,600
of venus mars or earth's moon

458
00:15:49,189 --> 00:15:45,759
and the primary answer with only about

459
00:15:50,790 --> 00:15:49,199
100 out of 200 votes was mars but we

460
00:15:53,509 --> 00:15:50,800
also had a pretty decent breakdown of

461
00:15:54,629 --> 00:15:53,519
votes for venus and earth's moon as well

462
00:15:56,949 --> 00:15:54,639
so i'm wondering if you can let our

463
00:15:59,430 --> 00:15:56,959

audience know alfonso why you went to

464
00:16:01,910 --> 00:15:59,440
antarctica and why you were drilling in

465
00:16:04,550 --> 00:16:01,920
this site in that doctor right that's a

466
00:16:07,189 --> 00:16:04,560
that's a very good example of where an

467
00:16:09,189 --> 00:16:07,199
analog can really help you

468
00:16:10,790 --> 00:16:09,199
develop instruments and instrumentation

469
00:16:13,030 --> 00:16:10,800
for other planets in this case we went

470
00:16:14,310 --> 00:16:13,040
to antarctica because of its connection

471
00:16:16,150 --> 00:16:14,320
to mars

472
00:16:18,389 --> 00:16:16,160
as you say grand mars is a very cold

473
00:16:20,150 --> 00:16:18,399
planet today it's uh it's so cold that

474
00:16:22,550 --> 00:16:20,160
most of the surface of mars never goes

475
00:16:24,629 --> 00:16:22,560
above freezing as maybe except for a

476
00:16:26,949 --> 00:16:24,639
thin layer of the surface the ground

477
00:16:28,629 --> 00:16:26,959
stays below freezing all the time we

478
00:16:29,910 --> 00:16:28,639
call that type of ground that never

479
00:16:31,350 --> 00:16:29,920
warms up about freezing we call it

480
00:16:41,189 --> 00:16:31,360
permafrost

481
00:16:43,189 --> 00:16:41,199
mountains it's not in common but martian

482
00:16:44,870 --> 00:16:43,199
permafrost is fairly unique

483
00:16:45,910 --> 00:16:44,880
in that it's

484
00:16:47,990 --> 00:16:45,920
it's uh

485
00:16:49,030 --> 00:16:48,000
it's actually starts with a layer of

486
00:16:50,389 --> 00:16:49,040
soil

487
00:16:51,829 --> 00:16:50,399
that is dry

488
00:16:54,470 --> 00:16:51,839

but it's frozen

489
00:16:56,710 --> 00:16:54,480
we call that dry permafrost and then in

490
00:16:59,189 --> 00:16:56,720
some per in some places of mars if you

491
00:17:01,829 --> 00:16:59,199
dig deep enough then you start to find

492
00:17:04,630 --> 00:17:01,839
permafrost that contains ice is

493
00:17:06,949 --> 00:17:04,640
isometric permafrost and this transition

494
00:17:09,429 --> 00:17:06,959
from dry permafrost to isometric

495
00:17:11,909 --> 00:17:09,439
permafrost which is very common on mars

496
00:17:15,669 --> 00:17:11,919
is extremely rare on earth most

497
00:17:16,949 --> 00:17:15,679
permafrost on earth has the top is wet

498
00:17:18,949 --> 00:17:16,959
and then at some point you find the

499
00:17:20,949 --> 00:17:18,959
permafrost layer then it's frozen but

500
00:17:23,029 --> 00:17:20,959
the wet the top is either frozen or is

501
00:17:24,069 --> 00:17:23,039
it muddy slush that's what you find in

502
00:17:26,549 --> 00:17:24,079
the arctic

503
00:17:28,309 --> 00:17:26,559
uh in antarctica it's one of antarctica

504
00:17:30,070 --> 00:17:28,319
the dry valleys of antarctica especially

505
00:17:30,830 --> 00:17:30,080
the ones that are high elevation which

506
00:17:33,190 --> 00:17:30,840
are the

507
00:17:35,190 --> 00:17:33,200
coldest that's one of the few places on

508
00:17:37,750 --> 00:17:35,200
earth where we find the same type of

509
00:17:40,150 --> 00:17:37,760
permafrost we see on mars try permafrost

510
00:17:41,510 --> 00:17:40,160
and then isolate permafrost and when

511
00:17:43,110 --> 00:17:41,520
you're testing technology it's very

512
00:17:45,190 --> 00:17:43,120
important to get that

513
00:17:46,870 --> 00:17:45,200

transition and the strength that goes

514
00:17:48,549 --> 00:17:46,880
with it the material strength that goes

515
00:17:49,830 --> 00:17:48,559
in uh

516
00:17:51,590 --> 00:17:49,840
it's important that your instruments go

517
00:17:53,350 --> 00:17:51,600
through it if you want to really test

518
00:17:54,870 --> 00:17:53,360
them in an environment that is very

519
00:17:56,789 --> 00:17:54,880
similar to what you will find on mars so

520
00:17:58,390 --> 00:17:56,799
that's a unique trait of the of the

521
00:17:59,909 --> 00:17:58,400
antarctic dry valleys

522
00:18:01,990 --> 00:17:59,919
wow very cool yeah i can i can

523
00:18:03,990 --> 00:18:02,000
definitely testify to being in the

524
00:18:06,390 --> 00:18:04,000
arctic and using a hand powered drill to

525
00:18:08,710 --> 00:18:06,400
drill some geological samples and having

526
00:18:11,430 --> 00:18:08,720
the drill bit get stuck in that wet

527
00:18:13,909 --> 00:18:11,440
permafrost uh as soon as the drill got

528
00:18:15,909 --> 00:18:13,919
stuck within a split second the drill

529
00:18:18,950 --> 00:18:15,919
bit was frozen in place because that wet

530
00:18:19,990 --> 00:18:18,960
permafrost trapped it exactly yeah so

531
00:18:21,510 --> 00:18:20,000
the different different kinds of

532
00:18:23,909 --> 00:18:21,520
drilling regimes we have around the

533
00:18:25,510 --> 00:18:23,919
planet in permafrost and that's exactly

534
00:18:27,990 --> 00:18:25,520
precisely one of the things we wanted to

535
00:18:30,390 --> 00:18:28,000
test is how do you dry how do you drill

536
00:18:33,029 --> 00:18:30,400
into permafrost that is so cold that it

537
00:18:34,870 --> 00:18:33,039
never thaws and the one number one rule

538
00:18:37,750 --> 00:18:34,880

you want to avoid which is the one

539
00:18:39,590 --> 00:18:37,760
number one rule as you said is avoid

540
00:18:41,190 --> 00:18:39,600
high temperatures when you drill you

541
00:18:44,310 --> 00:18:41,200
want to keep the ground and the drill

542
00:18:46,390 --> 00:18:44,320
bit as cold as possible so that exactly

543
00:18:48,150 --> 00:18:46,400
what you said then doesn't happen that

544
00:18:50,150 --> 00:18:48,160
you thaw the eyes and then it flash

545
00:18:51,669 --> 00:18:50,160
freezes and then you lose your mission

546
00:18:52,789 --> 00:18:51,679
so that's that was one of the lessons

547
00:18:54,470 --> 00:18:52,799
that we were learning as we were

548
00:18:56,150 --> 00:18:54,480
drilling in antarctica

549
00:18:57,990 --> 00:18:56,160
yeah i mean it's a very important lesson

550
00:18:59,990 --> 00:18:58,000
and it's why we go with these places and

551
00:19:02,070 --> 00:19:00,000
we test our instruments we test our

552
00:19:03,029 --> 00:19:02,080
tactics and techniques and methods

553
00:19:04,870 --> 00:19:03,039
because we don't want to have something

554
00:19:06,950 --> 00:19:04,880
happen on mars where we have the mission

555
00:19:08,950 --> 00:19:06,960
fail because we weren't prepared um

556
00:19:11,029 --> 00:19:08,960
which is very awesome i wonder if you

557
00:19:13,909 --> 00:19:11,039
can speak now to the icebreaker life

558
00:19:16,230 --> 00:19:13,919
mission concept um and what the idea was

559
00:19:17,590 --> 00:19:16,240
behind that mission concept and and what

560
00:19:19,110 --> 00:19:17,600
you think of that kind of going forward

561
00:19:21,270 --> 00:19:19,120
for future research

562
00:19:23,750 --> 00:19:21,280
icebreaker was precisely what motivated

563
00:19:25,190 --> 00:19:23,760

the uh the trip to antarctica or the the

564
00:19:28,310 --> 00:19:25,200
expeditions to antarctica to test the

565
00:19:30,789 --> 00:19:28,320
drilling icebreaker is a mission concept

566
00:19:34,070 --> 00:19:30,799
the idea is to go back to mars

567
00:19:36,470 --> 00:19:34,080
to a place where there is ice

568
00:19:38,150 --> 00:19:36,480
bearing permafrost close to the surface

569
00:19:41,590 --> 00:19:38,160
think about the phoenix lander that went

570
00:19:43,350 --> 00:19:41,600
to mars in uh circuit 2008 and just by

571
00:19:45,990 --> 00:19:43,360
scraping a few centimeters off the top

572
00:19:48,070 --> 00:19:46,000
of the regulator it discovered eyes very

573
00:19:49,750 --> 00:19:48,080
close to the surface ice is a great

574
00:19:51,510 --> 00:19:49,760
thing for microbes because ice can be a

575
00:19:52,710 --> 00:19:51,520
source of liquid water if temperatures

576
00:19:54,470 --> 00:19:52,720
are high enough

577
00:19:57,350 --> 00:19:54,480
and so ice character would ask the

578
00:19:59,750 --> 00:19:57,360
question is the ice bearing permafrost

579
00:20:00,950 --> 00:19:59,760
on mars a habitat for life and is it

580
00:20:03,669 --> 00:20:00,960
inhabited

581
00:20:06,149 --> 00:20:03,679
can it sustain life is actually life

582
00:20:08,870 --> 00:20:06,159
uh in embedded in the permafrost the

583
00:20:10,390 --> 00:20:08,880
idea that the the general idea about ice

584
00:20:13,190 --> 00:20:10,400
icebreaker is that while mars is

585
00:20:15,430 --> 00:20:13,200
extremely cold today and that ice

586
00:20:17,590 --> 00:20:15,440
permafrost icy permafrost is

587
00:20:19,510 --> 00:20:17,600
it's frozen it would not be a good place

588
00:20:21,990 --> 00:20:19,520

for microbes to be today

589
00:20:24,230 --> 00:20:22,000
uh when you go back in time the climate

590
00:20:26,070 --> 00:20:24,240
of mars changes just like the climate of

591
00:20:28,549 --> 00:20:26,080
the earth and it changes in response of

592
00:20:29,669 --> 00:20:28,559
changes in orbital dynamics obliquity

593
00:20:31,830 --> 00:20:29,679
and whatnot

594
00:20:33,830 --> 00:20:31,840
and some of those changes can trigger

595
00:20:36,149 --> 00:20:33,840
significant a significant rise in

596
00:20:38,950 --> 00:20:36,159
temperature it's uh high enough that

597
00:20:40,549 --> 00:20:38,960
some of that ground ice could melt

598
00:20:42,070 --> 00:20:40,559
and at that point then you start to

599
00:20:43,430 --> 00:20:42,080
think of let's start to deal with

600
00:20:45,750 --> 00:20:43,440
permafrost that is very similar to the

601
00:20:47,750 --> 00:20:45,760
arctic permafrost where microbes can be

602
00:20:49,669 --> 00:20:47,760
frozen for a long period of time that

603
00:20:51,830 --> 00:20:49,679
when the ice melts they can become

604
00:20:54,230 --> 00:20:51,840
active do their thing and then go back

605
00:20:55,830 --> 00:20:54,240
to dormancy when the ice freezes again

606
00:20:57,190 --> 00:20:55,840
and we think that the last time that

607
00:20:59,430 --> 00:20:57,200
such a thing might have happened on mars

608
00:21:01,669 --> 00:20:59,440
was about five to ten million years ago

609
00:21:02,870 --> 00:21:01,679
not that long ago in the life of micro

610
00:21:04,230 --> 00:21:02,880
it's long

611
00:21:05,990 --> 00:21:04,240
it's not it's not a lot of time in the

612
00:21:07,830 --> 00:21:06,000
life of a microbe but it's a long time

613
00:21:10,549 --> 00:21:07,840

in our in for us

614
00:21:12,950 --> 00:21:10,559
and so that's what icebreaker is asking

615
00:21:14,950 --> 00:21:12,960
could five ten million years ago

616
00:21:17,029 --> 00:21:14,960
microorganisms in the icy permafrost

617
00:21:19,350 --> 00:21:17,039
mars be active and can refine the

618
00:21:20,710 --> 00:21:19,360
remains of those microbes today

619
00:21:22,310 --> 00:21:20,720
that's very cool and yeah there's so

620
00:21:23,669 --> 00:21:22,320
much more we could do on mars and

621
00:21:25,510 --> 00:21:23,679
looking for past life i also want to

622
00:21:27,830 --> 00:21:25,520
discuss some more recent work a paper

623
00:21:30,230 --> 00:21:27,840
you just published recently for instance

624
00:21:31,830 --> 00:21:30,240
before i do though a lot of our viewers

625
00:21:34,630 --> 00:21:31,840
they want to know you know what is it

626
00:21:36,630 --> 00:21:34,640
like to do field research on this planet

627
00:21:39,029 --> 00:21:36,640
um how can they be involved and also

628
00:21:41,270 --> 00:21:39,039
they know what is it like to live in the

629
00:21:43,190 --> 00:21:41,280
atacama or to live in antarctica for us

630
00:21:44,390 --> 00:21:43,200
for a prolonged period of time

631
00:21:45,909 --> 00:21:44,400
yeah the uh

632
00:21:48,149 --> 00:21:45,919
so

633
00:21:50,149 --> 00:21:48,159
the the atacama and the entirety and the

634
00:21:52,390 --> 00:21:50,159
antarctic fieldwork experience is very

635
00:21:53,669 --> 00:21:52,400
different it's very similar in terms of

636
00:21:55,350 --> 00:21:53,679
the extreme

637
00:21:56,710 --> 00:21:55,360
nature of the environment and a lot of

638
00:21:58,789 --> 00:21:56,720

the science we do is very connected

639
00:21:59,750 --> 00:21:58,799
despite their very seemingly different

640
00:22:01,990 --> 00:21:59,760
places

641
00:22:04,390 --> 00:22:02,000
but logistically there are two complete

642
00:22:06,789 --> 00:22:04,400
different worlds in the arakama you can

643
00:22:08,789 --> 00:22:06,799
go from the driest place on the planet

644
00:22:13,590 --> 00:22:08,799
to a four stars

645
00:22:17,510 --> 00:22:13,600
hotel and a shower in 45 minutes and so

646
00:22:19,830 --> 00:22:17,520
the logistics are relatively mild um

647
00:22:21,590 --> 00:22:19,840
you also have roads you can drive with

648
00:22:23,190 --> 00:22:21,600
your car there's a lot of mining

649
00:22:25,110 --> 00:22:23,200
activity there's human presence all over

650
00:22:27,029 --> 00:22:25,120
the place which is kind of bad for the

651
00:22:29,029 --> 00:22:27,039
science but it's kind of good for your

652
00:22:30,710 --> 00:22:29,039
own personal survival and so on and so

653
00:22:32,789 --> 00:22:30,720
forth in antarctica it's a very

654
00:22:35,110 --> 00:22:32,799
different place it's very different ball

655
00:22:37,350 --> 00:22:35,120
game you fly to antarctica to a to a

656
00:22:40,230 --> 00:22:37,360
station at murdo for example which is

657
00:22:41,990 --> 00:22:40,240
crowded with people about 1200 people

658
00:22:44,230 --> 00:22:42,000
then from there you deploy on a

659
00:22:46,549 --> 00:22:44,240
helicopter to a remote

660
00:22:49,110 --> 00:22:46,559
area in the dry valleys for example and

661
00:22:51,669 --> 00:22:49,120
there you can for six seven eight weeks

662
00:22:54,549 --> 00:22:51,679
uh with five other people that you

663
00:22:56,310 --> 00:22:54,559

learn to hate and hate love at the end

664
00:22:59,350 --> 00:22:56,320
of the of the field expedition it's a

665
00:23:01,669 --> 00:22:59,360
very interesting human experience where

666
00:23:03,110 --> 00:23:01,679
uh you're deprived of a lot of things

667
00:23:05,110 --> 00:23:03,120
mainly showers

668
00:23:06,390 --> 00:23:05,120
uh things that make you comfortable you

669
00:23:08,470 --> 00:23:06,400
don't get them

670
00:23:09,909 --> 00:23:08,480
it's cold all the time it's unpleasant

671
00:23:13,270 --> 00:23:09,919
most of the time

672
00:23:14,310 --> 00:23:13,280
um you eat what you can out of dried

673
00:23:16,149 --> 00:23:14,320
food

674
00:23:17,590 --> 00:23:16,159
uh and then

675
00:23:20,549 --> 00:23:17,600
um

676
00:23:22,390 --> 00:23:20,559
then and then you use you do your usual

677
00:23:23,830 --> 00:23:22,400
business and their conditions that most

678
00:23:25,990 --> 00:23:23,840
people would not

679
00:23:27,430 --> 00:23:26,000
uh like very much so it's a very

680
00:23:29,590 --> 00:23:27,440
different experience doing field work in

681
00:23:31,750 --> 00:23:29,600
both environments and both of them are

682
00:23:32,630 --> 00:23:31,760
to me they're fascinating i

683
00:23:34,630 --> 00:23:32,640
uh

684
00:23:36,789 --> 00:23:34,640
going going to antarctica has been a

685
00:23:38,549 --> 00:23:36,799
huge personal experience

686
00:23:40,789 --> 00:23:38,559
going to the atacama has been as well

687
00:23:43,269 --> 00:23:40,799
for different reasons but scientifically

688
00:23:44,950 --> 00:23:43,279

both of them have been very illuminating

689
00:23:46,470 --> 00:23:44,960
yeah it's wonderful and i always

690
00:23:48,549 --> 00:23:46,480
recommend younger people who want to get

691
00:23:50,230 --> 00:23:48,559
involved in field research look for

692
00:23:52,149 --> 00:23:50,240
others of us who've done field research

693
00:23:54,070 --> 00:23:52,159
and ask us you know do you have open

694
00:23:56,149 --> 00:23:54,080
projects are there available you know

695
00:23:57,669 --> 00:23:56,159
positions to come along do you need a

696
00:23:59,590 --> 00:23:57,679
graduate student you know who wants to

697
00:24:01,669 --> 00:23:59,600
go out in the field and learn more about

698
00:24:03,510 --> 00:24:01,679
this there's a lot of ways to get

699
00:24:05,590 --> 00:24:03,520
involved in field research there's also

700
00:24:07,269 --> 00:24:05,600
citizen science programs that allow

701
00:24:09,350 --> 00:24:07,279
citizens uh to go out and do some of

702
00:24:11,430 --> 00:24:09,360
this field research as well i uh and

703
00:24:13,110 --> 00:24:11,440
there are grants specifically to fund

704
00:24:15,029 --> 00:24:13,120
fieldwork in extreme environments the

705
00:24:16,149 --> 00:24:15,039
lewis and clark comes to mind

706
00:24:17,430 --> 00:24:16,159
um

707
00:24:19,110 --> 00:24:17,440
the first time i went in the field that

708
00:24:21,350 --> 00:24:19,120
was when i was doing my

709
00:24:23,510 --> 00:24:21,360
uh working on my phd and i went to a

710
00:24:25,590 --> 00:24:23,520
field site as a field assistant it had

711
00:24:27,110 --> 00:24:25,600
nothing to do with my phd but it was a

712
00:24:28,789 --> 00:24:27,120
great opportunity to do field work i've

713
00:24:30,789 --> 00:24:28,799

never done field work before it was a

714
00:24:33,110 --> 00:24:30,799
great experience for me so that's that's

715
00:24:33,990 --> 00:24:33,120
where you want to start uh get a taste

716
00:24:36,230 --> 00:24:34,000
for it

717
00:24:38,390 --> 00:24:36,240
uh if you think if you still like it at

718
00:24:39,669 --> 00:24:38,400
the end then that's when you might

719
00:24:41,830 --> 00:24:39,679
consider doing

720
00:24:43,590 --> 00:24:41,840
research in field analogues the one

721
00:24:44,390 --> 00:24:43,600
thing i would say about field science is

722
00:24:45,669 --> 00:24:44,400
that

723
00:24:48,549 --> 00:24:45,679
um

724
00:24:50,230 --> 00:24:48,559
field science is not different from

725
00:24:53,190 --> 00:24:50,240
laboratory science

726
00:24:54,870 --> 00:24:53,200
doing science in the field is a skill

727
00:24:58,149 --> 00:24:54,880
that you develop through experience just

728
00:24:59,990 --> 00:24:58,159
like doing science in the laboratory

729
00:25:01,430 --> 00:25:00,000
in many senses a difficult skill to

730
00:25:02,710 --> 00:25:01,440
acquire because

731
00:25:04,390 --> 00:25:02,720
it's not something you're familiar with

732
00:25:06,710 --> 00:25:04,400
it's not something they train you for

733
00:25:08,950 --> 00:25:06,720
normally in college

734
00:25:10,470 --> 00:25:08,960
um but it's also a skill that is

735
00:25:11,750 --> 00:25:10,480
difficult to learn because the more

736
00:25:13,029 --> 00:25:11,760
you're in the field the more you learn

737
00:25:16,789 --> 00:25:13,039
about the field the better your science

738
00:25:18,950 --> 00:25:16,799

is going to be so a one and one and off

739
00:25:20,549 --> 00:25:18,960
a one and only field experience is not

740
00:25:22,390 --> 00:25:20,559
gonna cut it you wanna if you wanna

741
00:25:24,710 --> 00:25:22,400
commit to field work you're committing

742
00:25:25,909 --> 00:25:24,720
to many years of visiting the same site

743
00:25:27,190 --> 00:25:25,919
to get this

744
00:25:29,110 --> 00:25:27,200
knowledge about the site that then

745
00:25:30,310 --> 00:25:29,120
allows you to answer the important

746
00:25:32,070 --> 00:25:30,320
questions so

747
00:25:33,590 --> 00:25:32,080
uh be careful what you wish for if you

748
00:25:35,350 --> 00:25:33,600
want to do field signs

749
00:25:37,190 --> 00:25:35,360
uh sharpen up your camping tents because

750
00:25:39,350 --> 00:25:37,200
you're gonna use them

751
00:25:41,110 --> 00:25:39,360
indeed um i'd like to switch topics just

752
00:25:44,549 --> 00:25:41,120
a little bit now you had a very recent

753
00:25:46,470 --> 00:25:44,559
paper out this past year in astrobiology

754
00:25:47,909 --> 00:25:46,480
um questioning with the search for life

755
00:25:49,990 --> 00:25:47,919
on mars

756
00:25:52,310 --> 00:25:50,000
is there is there the potential for

757
00:25:54,390 --> 00:25:52,320
biological transfer between earth and

758
00:25:56,310 --> 00:25:54,400
mars uh and so could we be descendant

759
00:25:58,630 --> 00:25:56,320
martians or could we find mars life

760
00:25:59,990 --> 00:25:58,640
that's descendant earth life uh through

761
00:26:02,710 --> 00:26:00,000
the process of panspermia through

762
00:26:04,390 --> 00:26:02,720
biological transfer or if we find signs

763
00:26:06,470 --> 00:26:04,400

of life on mars

764
00:26:09,190 --> 00:26:06,480
could we actually find signs of a second

765
00:26:12,070 --> 00:26:09,200
genesis a second origination or second

766
00:26:14,070 --> 00:26:12,080
several originations of life on mars i'm

767
00:26:15,909 --> 00:26:14,080
wondering if you could highlight for our

768
00:26:18,149 --> 00:26:15,919
audience uh some of the takeaways of

769
00:26:20,549 --> 00:26:18,159
that research right yeah so this is not

770
00:26:22,310 --> 00:26:20,559
a new idea the idea that life on mars

771
00:26:24,310 --> 00:26:22,320
might have existed because it was

772
00:26:26,310 --> 00:26:24,320
transferred from earth or vice versa

773
00:26:27,909 --> 00:26:26,320
that live on earth came from us that's

774
00:26:29,990 --> 00:26:27,919
that's not a new idea

775
00:26:32,070 --> 00:26:30,000
but what it was what i tried to do with

776
00:26:33,909 --> 00:26:32,080
this paper was to look at the problem a

777
00:26:37,269 --> 00:26:33,919
bit more deeply

778
00:26:38,950 --> 00:26:37,279
uh and also with the time component so

779
00:26:41,590 --> 00:26:38,960
there's been plenty of studies looking

780
00:26:44,789 --> 00:26:41,600
at uh the likelihood that microbes from

781
00:26:47,269 --> 00:26:44,799
earth might be might survive a right

782
00:26:49,269 --> 00:26:47,279
a right to mars on a meteorite

783
00:26:52,070 --> 00:26:49,279
typically those studies they

784
00:26:54,390 --> 00:26:52,080
they assume modern types of organisms

785
00:26:56,310 --> 00:26:54,400
that are that have the benefit of four

786
00:26:58,070 --> 00:26:56,320
billion years of evolution to figure out

787
00:27:00,230 --> 00:26:58,080
how to deal with radiation dryness and

788
00:27:02,950 --> 00:27:00,240

things like this but obviously black on

789
00:27:05,029 --> 00:27:02,960
earth wasn't like that all the time so i

790
00:27:07,110 --> 00:27:05,039
first went in asking the question

791
00:27:09,909 --> 00:27:07,120
at the time where transferring between

792
00:27:12,710 --> 00:27:09,919
arizona and mars was at the peak

793
00:27:14,710 --> 00:27:12,720
life on earth was not highly evolved yet

794
00:27:16,149 --> 00:27:14,720
so what did what does that mean in terms

795
00:27:18,710 --> 00:27:16,159
of the survival of the transfer the

796
00:27:20,389 --> 00:27:18,720
likelihood of survival that's number one

797
00:27:21,830 --> 00:27:20,399
and the other one is

798
00:27:23,350 --> 00:27:21,840
uh

799
00:27:25,029 --> 00:27:23,360
so early on in the history of life on

800
00:27:27,510 --> 00:27:25,039
earth we didn't have diversity of life

801
00:27:30,070 --> 00:27:27,520
we have now especially is very early on

802
00:27:32,549 --> 00:27:30,080
we only had pretty much one branch of

803
00:27:35,269 --> 00:27:32,559
life it was all unicellular

804
00:27:37,590 --> 00:27:35,279
barely cell-like looking organisms

805
00:27:39,669 --> 00:27:37,600
um and so if that form those forms of

806
00:27:41,909 --> 00:27:39,679
life had been transferred at that point

807
00:27:43,909 --> 00:27:41,919
rival mars would have looked differently

808
00:27:45,190 --> 00:27:43,919
than if more evolved

809
00:27:47,590 --> 00:27:45,200
terrestrial organisms have been

810
00:27:49,029 --> 00:27:47,600
transferred later on and i wanted to see

811
00:27:51,110 --> 00:27:49,039
what would be the implications of an

812
00:27:53,269 --> 00:27:51,120
early transfer versus

813
00:27:55,350 --> 00:27:53,279

the implications of a late transfer in

814
00:27:56,230 --> 00:27:55,360
terms of what we might find and then all

815
00:27:59,669 --> 00:27:56,240
that

816
00:28:02,070 --> 00:27:59,679
i was interested to uh think about

817
00:28:04,789 --> 00:28:02,080
how can we interpret any evidence we

818
00:28:06,950 --> 00:28:04,799
find of life on mars today how can we

819
00:28:08,389 --> 00:28:06,960
interpret it in this in the context of

820
00:28:10,630 --> 00:28:08,399
an early transfer

821
00:28:11,669 --> 00:28:10,640
a late transfer or an independent

822
00:28:14,549 --> 00:28:11,679
genesis

823
00:28:16,870 --> 00:28:14,559
because uh the conclusions we might get

824
00:28:18,549 --> 00:28:16,880
out of each one of those scenarios would

825
00:28:20,630 --> 00:28:18,559
be very different fundamentally

826
00:28:22,630 --> 00:28:20,640
different particularly

827
00:28:24,789 --> 00:28:22,640
if uh live on mars

828
00:28:26,149 --> 00:28:24,799
represented a transfer from earth if we

829
00:28:27,830 --> 00:28:26,159
could figure that out

830
00:28:29,269 --> 00:28:27,840
that would mean that were very cool it

831
00:28:31,190 --> 00:28:29,279
means that life can transfer between

832
00:28:33,269 --> 00:28:31,200
planets but it doesn't it wouldn't tell

833
00:28:35,590 --> 00:28:33,279
you it wouldn't tell us much about how

834
00:28:37,750 --> 00:28:35,600
common life is in the universe uh it

835
00:28:39,430 --> 00:28:37,760
would still be a local phenomenon

836
00:28:41,190 --> 00:28:39,440
but if we found life on mars and we

837
00:28:42,470 --> 00:28:41,200
could evidence of life on mars we could

838
00:28:43,510 --> 00:28:42,480

establish there was an independent

839
00:28:45,510 --> 00:28:43,520
genesis

840
00:28:47,510 --> 00:28:45,520
that means two times independently in

841
00:28:49,510 --> 00:28:47,520
the same solar system equals a lot of

842
00:28:51,510 --> 00:28:49,520
life out there very fundamentally

843
00:28:52,230 --> 00:28:51,520
different implications of your results

844
00:28:54,310 --> 00:28:52,240
so

845
00:28:56,630 --> 00:28:54,320
i wanted this paper to be an opportunity

846
00:28:58,789 --> 00:28:56,640
to think about how we interpret

847
00:28:59,750 --> 00:28:58,799
any evidence of life with final mars and

848
00:29:02,070 --> 00:28:59,760
to be

849
00:29:05,430 --> 00:29:02,080
careful with the implications of any

850
00:29:07,029 --> 00:29:05,440
finding that we might want to uh

851
00:29:09,029 --> 00:29:07,039
any implications we might we might reach

852
00:29:11,029 --> 00:29:09,039
with those findings yeah this is still

853
00:29:12,549 --> 00:29:11,039
very profound for people to think about

854
00:29:14,389 --> 00:29:12,559
you know we don't know if panspermia

855
00:29:16,149 --> 00:29:14,399
happened it's an interesting hypothesis

856
00:29:17,909 --> 00:29:16,159
an interesting idea but we don't have

857
00:29:19,430 --> 00:29:17,919
evidence yet that it's happened but we

858
00:29:21,269 --> 00:29:19,440
do have some very good modeling that it

859
00:29:23,669 --> 00:29:21,279
could happen but i love this idea that

860
00:29:26,310 --> 00:29:23,679
you know if we do find an alternative

861
00:29:28,389 --> 00:29:26,320
origin of life within our solar system

862
00:29:29,990 --> 00:29:28,399
that one it gives us comparative biology

863
00:29:32,549 --> 00:29:30,000

it gives us a lot that we can do right

864
00:29:34,389 --> 00:29:32,559
now in figuring out a more universal

865
00:29:36,149 --> 00:29:34,399
theory of life

866
00:29:38,310 --> 00:29:36,159
but it also then tells us that life

867
00:29:40,789 --> 00:29:38,320
might be common out there it is it is

868
00:29:42,230 --> 00:29:40,799
also a gram an interesting

869
00:29:43,669 --> 00:29:42,240
thing to consider when you think about

870
00:29:45,190 --> 00:29:43,679
what are you looking for when you search

871
00:29:47,190 --> 00:29:45,200
for evidence of life

872
00:29:49,350 --> 00:29:47,200
because if you if you go in with this

873
00:29:51,590 --> 00:29:49,360
mindset of well i want to know if life

874
00:29:52,950 --> 00:29:51,600
is common in the universe therefore i

875
00:29:55,029 --> 00:29:52,960
want to know if there has been a second

876
00:29:56,870 --> 00:29:55,039
genesis of life anywhere in the solar

877
00:29:57,750 --> 00:29:56,880
system that was the equation i just

878
00:29:59,750 --> 00:29:57,760
mentioned

879
00:30:02,070 --> 00:29:59,760
to to independent genesis equals a lot

880
00:30:04,070 --> 00:30:02,080
of life now

881
00:30:05,830 --> 00:30:04,080
what do you need to find in order to

882
00:30:06,870 --> 00:30:05,840
tell a second genesis from a common

883
00:30:08,710 --> 00:30:06,880
ancestor

884
00:30:10,470 --> 00:30:08,720
not every evidence of life is going to

885
00:30:13,350 --> 00:30:10,480
allow you to distinguish that

886
00:30:14,470 --> 00:30:13,360
uh and in fact only certain biochemical

887
00:30:16,789 --> 00:30:14,480
traits

888
00:30:19,430 --> 00:30:16,799

might allow you to tell a second genesis

889
00:30:20,870 --> 00:30:19,440
from a closed from a close cousin and so

890
00:30:22,389 --> 00:30:20,880
that is an important thing to consider

891
00:30:23,669 --> 00:30:22,399
when you design your missions what am i

892
00:30:25,190 --> 00:30:23,679
going to search for

893
00:30:27,830 --> 00:30:25,200
uh and

894
00:30:30,389 --> 00:30:27,840
and so i also wanted to put that

895
00:30:31,990 --> 00:30:30,399
continue that discussion in the uh

896
00:30:33,990 --> 00:30:32,000
within the science community so that we

897
00:30:36,389 --> 00:30:34,000
want we don't lose track of those high

898
00:30:39,190 --> 00:30:36,399
level questions that we want to answer

899
00:30:41,029 --> 00:30:39,200
absolutely dr jim pass has asked with

900
00:30:43,190 --> 00:30:41,039
the discovery of life on mars be it a

901
00:30:44,630 --> 00:30:43,200
fossilized form or from the same genesis

902
00:30:47,190 --> 00:30:44,640
as with life

903
00:30:49,350 --> 00:30:47,200
uh it will obviously impact humanity in

904
00:30:51,029 --> 00:30:49,360
profound uh anticipated and

905
00:30:53,350 --> 00:30:51,039
unpredictable ways

906
00:30:55,909 --> 00:30:53,360
jim wants to know how you think uh such

907
00:30:57,990 --> 00:30:55,919
a discovery will impact astrobiology as

908
00:30:59,990 --> 00:30:58,000
a field and in terms of funding and

909
00:31:01,590 --> 00:31:00,000
changes in our selection for future

910
00:31:03,269 --> 00:31:01,600
missions

911
00:31:04,870 --> 00:31:03,279
well that's a tough one it's hard to

912
00:31:06,149 --> 00:31:04,880
predict how a program might evolve

913
00:31:08,149 --> 00:31:06,159

because if there's a lot of components

914
00:31:10,230 --> 00:31:08,159
not just the scientific merit

915
00:31:12,870 --> 00:31:10,240
of course but i would think that if we

916
00:31:15,350 --> 00:31:12,880
found evidence of life on another planet

917
00:31:17,269 --> 00:31:15,360
uh astrobiology would cease to exist as

918
00:31:18,710 --> 00:31:17,279
it existed today and it would become an

919
00:31:21,669 --> 00:31:18,720
entirely different

920
00:31:23,909 --> 00:31:21,679
field with the program in itself i think

921
00:31:26,230 --> 00:31:23,919
we would want to study that evidence

922
00:31:27,430 --> 00:31:26,240
with as much technology as we could

923
00:31:29,190 --> 00:31:27,440
uh

924
00:31:30,630 --> 00:31:29,200
if we would want to

925
00:31:32,630 --> 00:31:30,640
bring samples back

926
00:31:35,669 --> 00:31:32,640
as safely as possible

927
00:31:37,669 --> 00:31:35,679
we would want to pursue the same type of

928
00:31:39,750 --> 00:31:37,679
thing now that we know that life can be

929
00:31:41,350 --> 00:31:39,760
common either because it spreads easily

930
00:31:43,029 --> 00:31:41,360
or because it appears easily on

931
00:31:45,029 --> 00:31:43,039
different planets we want to search for

932
00:31:47,909 --> 00:31:45,039
it on other places so i would think the

933
00:31:50,470 --> 00:31:47,919
astrobiology program would be a its own

934
00:31:52,470 --> 00:31:50,480
exploration pro program if we can all

935
00:31:54,870 --> 00:31:52,480
agree that understanding life beyond

936
00:31:57,110 --> 00:31:54,880
earth deserves uh such an important

937
00:31:59,029 --> 00:31:57,120
investment in technology and funding so

938
00:32:01,990 --> 00:31:59,039

in practical terms that would i think

939
00:32:03,909 --> 00:32:02,000
that would be the big revolution uh

940
00:32:05,750 --> 00:32:03,919
uh there will be other obviously other

941
00:32:06,630 --> 00:32:05,760
outcomes but that's that's the main one

942
00:32:08,549 --> 00:32:06,640
i think

943
00:32:09,909 --> 00:32:08,559
that's really awesome yeah

944
00:32:12,470 --> 00:32:09,919
we mentioned earlier you kind of first

945
00:32:13,830 --> 00:32:12,480
got into this realm of studying of

946
00:32:16,630 --> 00:32:13,840
yourself right around the time the allen

947
00:32:18,470 --> 00:32:16,640
hills meteorite paper came out in 1996

948
00:32:20,630 --> 00:32:18,480
which that paper kind of

949
00:32:22,710 --> 00:32:20,640
created the use of the word astrobiology

950
00:32:24,389 --> 00:32:22,720
for nasa and now we have a nasa

951
00:32:26,470 --> 00:32:24,399
astrobiology program so it is cool

952
00:32:27,909 --> 00:32:26,480
thinking forward how the program itself

953
00:32:29,669 --> 00:32:27,919
could evolve into its own thing in the

954
00:32:30,950 --> 00:32:29,679
future we would move from something you

955
00:32:32,389 --> 00:32:30,960
just said mention graham which i think

956
00:32:34,230 --> 00:32:32,399
is critical we would move from life

957
00:32:35,990 --> 00:32:34,240
detection to

958
00:32:38,470 --> 00:32:36,000
comparative biology what a great

959
00:32:40,470 --> 00:32:38,480
opportunity uh the big hurdle is life

960
00:32:42,389 --> 00:32:40,480
detection once we find evidence of life

961
00:32:43,830 --> 00:32:42,399
on another planet studying it is

962
00:32:45,830 --> 00:32:43,840
relatively steep forward we do it all

963
00:32:47,029 --> 00:32:45,840

the time on earth we know how to study

964
00:32:48,389 --> 00:32:47,039
life forms

965
00:32:50,389 --> 00:32:48,399
finding them on another planet is the

966
00:32:52,870 --> 00:32:50,399
big hurdle after that comparative

967
00:32:54,830 --> 00:32:52,880
biology will become the the new game in

968
00:32:56,630 --> 00:32:54,840
town and i think it would be a

969
00:32:59,269 --> 00:32:56,640
fascinating we will be in for a

970
00:33:01,269 --> 00:32:59,279
fascinating rollercoaster for many years

971
00:33:03,029 --> 00:33:01,279
absolutely well one thing that myself

972
00:33:04,789 --> 00:33:03,039
and others think about in our pursuit of

973
00:33:07,110 --> 00:33:04,799
trying to find life out there and find

974
00:33:09,190 --> 00:33:07,120
some comparative biology to study is

975
00:33:11,590 --> 00:33:09,200
whether or not humans ourselves will go

976
00:33:14,870 --> 00:33:11,600
out there our next question comes from

977
00:33:18,149 --> 00:33:14,880
potatomind at mindpotato uh great great

978
00:33:21,190 --> 00:33:18,159
handle on twitter and uh my potato wants

979
00:33:22,710 --> 00:33:21,200
to know uh what you see the future for

980
00:33:24,630 --> 00:33:22,720
humans on mars do you think they'll be

981
00:33:26,710 --> 00:33:24,640
living in bubble-like structures above

982
00:33:28,710 --> 00:33:26,720
the surface or maybe underground

983
00:33:31,909 --> 00:33:28,720
structures what do you envision for the

984
00:33:33,909 --> 00:33:31,919
future of humans on mars if we go there

985
00:33:36,470 --> 00:33:33,919
well i always like this idea of going

986
00:33:38,470 --> 00:33:36,480
back to the caves for humans and going

987
00:33:41,190 --> 00:33:38,480
back to going to mars gives you these

988
00:33:42,470 --> 00:33:41,200

these this romantic uh idea of we came

989
00:33:43,990 --> 00:33:42,480
out of the caves

990
00:33:45,909 --> 00:33:44,000
we went to mars we went back into the

991
00:33:47,190 --> 00:33:45,919
cave at least for a while because we

992
00:33:48,870 --> 00:33:47,200
need shelter and protection from

993
00:33:50,389 --> 00:33:48,880
radiation for example extreme

994
00:33:52,070 --> 00:33:50,399
temperatures and whatnot

995
00:33:52,950 --> 00:33:52,080
but it's a nice symbolism that i always

996
00:33:54,389 --> 00:33:52,960
enjoyed

997
00:33:56,389 --> 00:33:54,399
uh eventually

998
00:33:57,909 --> 00:33:56,399
uh you would want to see

999
00:34:03,269 --> 00:33:57,919
it's

1000
00:34:05,190 --> 00:34:03,279
future i think it in my mind is a a wish

1001
00:34:07,509 --> 00:34:05,200
of what i

1002
00:34:10,710 --> 00:34:07,519
i i would hope humanity would

1003
00:34:12,310 --> 00:34:10,720
would strive to uh go to as as a human

1004
00:34:14,629 --> 00:34:12,320
as a species

1005
00:34:15,990 --> 00:34:14,639
uh being confined to your own planet

1006
00:34:17,990 --> 00:34:16,000
it's like being confined to your own

1007
00:34:20,149 --> 00:34:18,000
room really the moment you know that

1008
00:34:23,750 --> 00:34:20,159
there is other places restaurants and

1009
00:34:25,349 --> 00:34:23,760
pubs and uh and and live concerts and

1010
00:34:26,710 --> 00:34:25,359
all these type of stuff going on out in

1011
00:34:28,389 --> 00:34:26,720
the streets

1012
00:34:30,310 --> 00:34:28,399
that's a good excuse to go out of your

1013
00:34:32,550 --> 00:34:30,320

room and explore the world and grow as a

1014
00:34:34,470 --> 00:34:32,560
person i think growing as a species it's

1015
00:34:36,869 --> 00:34:34,480
just the same uh

1016
00:34:38,950 --> 00:34:36,879
staying confined to your own cozy room

1017
00:34:42,149 --> 00:34:38,960
uh although it might become not very

1018
00:34:43,990 --> 00:34:42,159
cozy in the not so distant future

1019
00:34:46,310 --> 00:34:44,000
but it's an opportunity for to grow as a

1020
00:34:48,310 --> 00:34:46,320
species and to ask a whole set of new

1021
00:34:50,310 --> 00:34:48,320
questions that i think we need to ask

1022
00:34:52,230 --> 00:34:50,320
ourselves when we think about evolution

1023
00:34:54,310 --> 00:34:52,240
of the evolution of the human species

1024
00:34:55,430 --> 00:34:54,320
how do we interact with the environment

1025
00:34:56,869 --> 00:34:55,440
how do we

1026
00:34:58,150 --> 00:34:56,879
change the environment in a way that is

1027
00:35:00,950 --> 00:34:58,160
sustainable but at the same time is

1028
00:35:02,630 --> 00:35:00,960
beneficial to us and all forms of life

1029
00:35:04,069 --> 00:35:02,640
even more fascinating is if we find an

1030
00:35:06,390 --> 00:35:04,079
environment with life in it with

1031
00:35:08,870 --> 00:35:06,400
extraterrestrial admin how do we deal

1032
00:35:10,870 --> 00:35:08,880
with the ethical and morale and moral

1033
00:35:12,069 --> 00:35:10,880
questions related to that

1034
00:35:13,670 --> 00:35:12,079
all those questions i think they're

1035
00:35:16,630 --> 00:35:13,680
going to help us asking those questions

1036
00:35:17,829 --> 00:35:16,640
is going to help us grow as a species uh

1037
00:35:20,390 --> 00:35:17,839
and so

1038
00:35:23,030 --> 00:35:20,400

just going to other planets is

1039
00:35:23,990 --> 00:35:23,040
as humans uh several other planets would

1040
00:35:25,190 --> 00:35:24,000
speak

1041
00:35:27,510 --> 00:35:25,200
um

1042
00:35:29,430 --> 00:35:27,520
it's only going to always ask those

1043
00:35:31,589 --> 00:35:29,440
questions and more profound ones

1044
00:35:33,349 --> 00:35:31,599
absolutely and one of our next questions

1045
00:35:35,990 --> 00:35:33,359
comes from a longtime viewer as well tom

1046
00:35:38,310 --> 00:35:36,000
caruso who's watching on facebook tom is

1047
00:35:41,510 --> 00:35:38,320
often interested in the icy worlds of

1048
00:35:43,990 --> 00:35:41,520
our solar system and the ocean dynamics

1049
00:35:46,470 --> 00:35:44,000
dynamics of isis and his question for

1050
00:35:47,670 --> 00:35:46,480
you you may wish to speak to it is if

1051
00:35:49,670 --> 00:35:47,680
you can talk about the dynamic

1052
00:35:51,589 --> 00:35:49,680
environment of ice brine channels here

1053
00:35:53,750 --> 00:35:51,599
on earth and their potential for

1054
00:35:56,150 --> 00:35:53,760
relating to life under the ice on icy

1055
00:35:59,109 --> 00:35:56,160
moons or exoplanets

1056
00:36:00,230 --> 00:35:59,119
yeah um

1057
00:36:13,910 --> 00:36:00,240
the

1058
00:36:15,750 --> 00:36:13,920
creative biology can be at resolving

1059
00:36:17,349 --> 00:36:15,760
environmental puzzles especially in

1060
00:36:19,270 --> 00:36:17,359
extreme environments

1061
00:36:21,270 --> 00:36:19,280
the other one is

1062
00:36:22,950 --> 00:36:21,280
what types of environments we might want

1063
00:36:24,230 --> 00:36:22,960

to explore to search for evidence of

1064
00:36:25,910 --> 00:36:24,240
life

1065
00:36:28,470 --> 00:36:25,920
when i think about ocean waters though i

1066
00:36:30,069 --> 00:36:28,480
don't think about brian channels um

1067
00:36:31,829 --> 00:36:30,079
when i think about ocean water i think

1068
00:36:33,990 --> 00:36:31,839
of dark

1069
00:36:35,030 --> 00:36:34,000
uh environments where sunlight never

1070
00:36:39,829 --> 00:36:35,040
gets

1071
00:36:42,390 --> 00:36:39,839
microbes have to fight for every

1072
00:36:45,109 --> 00:36:42,400
possible source of energy they can find

1073
00:36:47,030 --> 00:36:45,119
it's a struggle to stay alive

1074
00:36:49,510 --> 00:36:47,040
uh that's not that's that's a very

1075
00:36:51,829 --> 00:36:49,520
different kind of extreme than brian

1076
00:36:54,069 --> 00:36:51,839
channels where you have to deal with

1077
00:36:55,030 --> 00:36:54,079
other problems but one of them is not

1078
00:36:56,470 --> 00:36:55,040
energy

1079
00:36:58,230 --> 00:36:56,480
or food

1080
00:37:00,310 --> 00:36:58,240
however you want to

1081
00:37:04,390 --> 00:37:00,320
slice it

1082
00:37:05,670 --> 00:37:04,400
deep subsurface biospheres dark

1083
00:37:07,589 --> 00:37:05,680
environments that's what i think of when

1084
00:37:09,670 --> 00:37:07,599
i think of ocean walls worlds

1085
00:37:12,150 --> 00:37:09,680
awesome um our next question comes from

1086
00:37:13,750 --> 00:37:12,160
navanil saranji on segonnet

1087
00:37:15,589 --> 00:37:13,760
navanil wants to know

1088
00:37:18,630 --> 00:37:15,599

what would you look for in a core

1089
00:37:21,030 --> 00:37:18,640
extracted from the dry valleys

1090
00:37:22,790 --> 00:37:21,040
well a number of things

1091
00:37:24,630 --> 00:37:22,800
one question we went in when we went to

1092
00:37:27,829 --> 00:37:24,640
the dry valleys was remember i told you

1093
00:37:30,230 --> 00:37:27,839
we had this layering of dry permafrost

1094
00:37:31,990 --> 00:37:30,240
and then isometric permafrost so one

1095
00:37:34,390 --> 00:37:32,000
question one hypothesis we went in when

1096
00:37:36,150 --> 00:37:34,400
we went there was that we wouldn't find

1097
00:37:38,230 --> 00:37:36,160
a lot of biology in the dry permafrost

1098
00:37:40,069 --> 00:37:38,240
there's no water for them

1099
00:37:41,670 --> 00:37:40,079
and we wouldn't find a lot of biology

1100
00:37:43,910 --> 00:37:41,680
deep into the permafrost because it's

1101
00:37:46,710 --> 00:37:43,920
very frozen but we might find some

1102
00:37:48,550 --> 00:37:46,720
biology a sweet spot at the interface

1103
00:37:51,349 --> 00:37:48,560
between the dry permafrost and the ice

1104
00:37:52,790 --> 00:37:51,359
bearing us we call that the eyes table

1105
00:37:55,109 --> 00:37:52,800
so one of the things we paid a lot of

1106
00:37:56,790 --> 00:37:55,119
attention was to study the microbiology

1107
00:37:59,430 --> 00:37:56,800
in those in those three regions the dry

1108
00:38:01,190 --> 00:37:59,440
permafrost the ice table and underneath

1109
00:38:02,829 --> 00:38:01,200
it turns out that in the dry valleys the

1110
00:38:05,910 --> 00:38:02,839
ice table is not even a good place for

1111
00:38:08,069 --> 00:38:05,920
microbes uh just too extreme for for for

1112
00:38:09,990 --> 00:38:08,079
them but then we learned as well that as

1113
00:38:12,069 --> 00:38:10,000

you go deep into the eyes uh you're

1114
00:38:14,150 --> 00:38:12,079
going back in time because permafrost is

1115
00:38:15,990 --> 00:38:14,160
also uh it's depending on how it forms

1116
00:38:17,510 --> 00:38:16,000
it can record

1117
00:38:19,270 --> 00:38:17,520
climate conditions at the time of its

1118
00:38:20,950 --> 00:38:19,280
formation including the biology and

1119
00:38:22,790 --> 00:38:20,960
whatnot so we could still find

1120
00:38:24,310 --> 00:38:22,800
biosignatures of life frozen in the

1121
00:38:25,910 --> 00:38:24,320
ground we could see

1122
00:38:27,750 --> 00:38:25,920
chemical biosignatures isotopic

1123
00:38:29,349 --> 00:38:27,760
biosignatures what not

1124
00:38:31,589 --> 00:38:29,359
and then we also learned about how the

1125
00:38:33,589 --> 00:38:31,599
ice formed did it come from melting

1126
00:38:35,190 --> 00:38:33,599
water did it come from freezing vapor

1127
00:38:36,150 --> 00:38:35,200
and you could see differences in them so

1128
00:38:37,190 --> 00:38:36,160
you can learn a lot about the

1129
00:38:39,510 --> 00:38:37,200
environment

1130
00:38:41,190 --> 00:38:39,520
the context and the microbiology at the

1131
00:38:43,910 --> 00:38:41,200
time of formation

1132
00:38:46,710 --> 00:38:43,920
well let's relate it then to mars

1133
00:38:49,510 --> 00:38:46,720
um so user uh mateo bori on facebook

1134
00:38:51,430 --> 00:38:49,520
wants to know if we have plans to to dig

1135
00:38:54,470 --> 00:38:51,440
for life or to look for life at the

1136
00:38:56,150 --> 00:38:54,480
martian polar caps um and maybe you know

1137
00:38:57,589 --> 00:38:56,160
is that terrain too hostile for rovers

1138
00:38:59,430 --> 00:38:57,599

and landers is there a reason we haven't

1139
00:39:00,790 --> 00:38:59,440
done that yet

1140
00:39:03,990 --> 00:39:00,800
well it's certainly technologically

1141
00:39:05,829 --> 00:39:04,000
complicated um it's uh it's it's very

1142
00:39:07,430 --> 00:39:05,839
cold that's one but the main problem of

1143
00:39:08,550 --> 00:39:07,440
going to the polar regions of mars is

1144
00:39:10,630 --> 00:39:08,560
darkness

1145
00:39:12,390 --> 00:39:10,640
you only have a certain amount of

1146
00:39:13,750 --> 00:39:12,400
daylight in the year

1147
00:39:15,910 --> 00:39:13,760
and then you go into pitch black

1148
00:39:18,069 --> 00:39:15,920
extremely cold conditions so

1149
00:39:20,310 --> 00:39:18,079
you cannot run on things like solar

1150
00:39:21,990 --> 00:39:20,320
panels for long periods of time phoenix

1151
00:39:23,750 --> 00:39:22,000
the phoenix lander was

1152
00:39:25,750 --> 00:39:23,760
limited to a few months on the surface

1153
00:39:27,750 --> 00:39:25,760
precisely because of that reason now you

1154
00:39:30,150 --> 00:39:27,760
can get around that by

1155
00:39:32,470 --> 00:39:30,160
bringing your own isotopic

1156
00:39:33,510 --> 00:39:32,480
uh energy source but then you have all

1157
00:39:36,069 --> 00:39:33,520
different

1158
00:39:38,230 --> 00:39:36,079
set of problems because those types of

1159
00:39:40,230 --> 00:39:38,240
energy sources generate a lot of heat

1160
00:39:41,829 --> 00:39:40,240
now you're mixing heat with eyes not a

1161
00:39:43,270 --> 00:39:41,839
good idea we already discussed what

1162
00:39:44,950 --> 00:39:43,280
happens when you do both

1163
00:39:46,470 --> 00:39:44,960

and so technologically certainly very

1164
00:39:48,230 --> 00:39:46,480
challenging and then on top of that is

1165
00:39:51,349 --> 00:39:48,240
the terrain it's not an easy terrain to

1166
00:39:52,470 --> 00:39:51,359
navigate uh frozen soil or

1167
00:39:54,230 --> 00:39:52,480
pure ice

1168
00:39:56,710 --> 00:39:54,240
and so uh that's probably one of the

1169
00:39:58,710 --> 00:39:56,720
main reasons why we haven't done it yet

1170
00:40:00,950 --> 00:39:58,720
well like we mentioned earlier i i'd

1171
00:40:03,190 --> 00:40:00,960
love like a really deep sample drilled

1172
00:40:04,550 --> 00:40:03,200
from mars or i'm really excited by lava

1173
00:40:05,990 --> 00:40:04,560
tubes i think you know going to the

1174
00:40:07,990 --> 00:40:06,000
caves going back to the caves is a great

1175
00:40:10,390 --> 00:40:08,000
place for human exploration as well as

1176
00:40:11,990 --> 00:40:10,400
robotic exploration uh there's a nasa

1177
00:40:14,230 --> 00:40:12,000
funded project called nasa braille

1178
00:40:15,109 --> 00:40:14,240
that's been going into lava tube caves

1179
00:40:17,030 --> 00:40:15,119
using

1180
00:40:18,950 --> 00:40:17,040
boston dynamics spot robots to look

1181
00:40:20,870 --> 00:40:18,960
around these caves and map them um

1182
00:40:23,750 --> 00:40:20,880
there's so many cool things in the near

1183
00:40:25,990 --> 00:40:23,760
future for exploring for life on mars on

1184
00:40:27,430 --> 00:40:26,000
venus on europa on enceladus and all

1185
00:40:28,550 --> 00:40:27,440
these other worlds of our solar system

1186
00:40:31,349 --> 00:40:28,560
and beyond

1187
00:40:35,030 --> 00:40:31,359
our next question comes from user

1188
00:40:37,589 --> 00:40:35,040

atlu the rover a great name on twitter

1189
00:40:39,750 --> 00:40:37,599
and lou wants to know that if money or

1190
00:40:40,630 --> 00:40:39,760
current technological abilities didn't

1191
00:40:43,349 --> 00:40:40,640
matter

1192
00:40:45,910 --> 00:40:43,359
where would you want to send a probe to

1193
00:40:46,790 --> 00:40:45,920
check for signs of life right now

1194
00:40:48,309 --> 00:40:46,800
well

1195
00:40:50,710 --> 00:40:48,319
my number one place would be the

1196
00:40:53,109 --> 00:40:50,720
subsurface ocean of enceladus

1197
00:40:54,710 --> 00:40:53,119
uh hands down i don't think

1198
00:40:57,190 --> 00:40:54,720
i don't think it needs a lot of

1199
00:40:59,750 --> 00:40:57,200
explanation but if you want a few points

1200
00:41:02,790 --> 00:40:59,760
there uh we know it's just there we have

1201
00:41:05,109 --> 00:41:02,800
an ocean a global ocean of liquid water

1202
00:41:06,150 --> 00:41:05,119
we know there is hydrothermal activity

1203
00:41:07,510 --> 00:41:06,160
there is very strong evidence of

1204
00:41:09,190 --> 00:41:07,520
hydrothermal activity at the bottom of

1205
00:41:11,349 --> 00:41:09,200
the ocean that's important for a number

1206
00:41:13,190 --> 00:41:11,359
of things hydrothermal activity

1207
00:41:15,670 --> 00:41:13,200
generates the kinds of nutrients that

1208
00:41:17,349 --> 00:41:15,680
life needs to grow and to exist and

1209
00:41:19,510 --> 00:41:17,359
hydrothermal environments are also one

1210
00:41:20,790 --> 00:41:19,520
of the environments that theoretically

1211
00:41:24,230 --> 00:41:20,800
could have been

1212
00:41:26,790 --> 00:41:24,240
the birthplace of life on earth um

1213
00:41:28,390 --> 00:41:26,800

so it would allow us to test this very

1214
00:41:30,630 --> 00:41:28,400
specific fundamental hypothesis whether

1215
00:41:31,910 --> 00:41:30,640
life can exist in those environments

1216
00:41:33,270 --> 00:41:31,920
um

1217
00:41:34,950 --> 00:41:33,280
we know from cassini that there is

1218
00:41:36,630 --> 00:41:34,960
organic matter in the ocean we know

1219
00:41:38,150 --> 00:41:36,640
there is complex organic matter and

1220
00:41:39,670 --> 00:41:38,160
there's nutrients and there's energy

1221
00:41:41,750 --> 00:41:39,680
sources so

1222
00:41:43,270 --> 00:41:41,760
i know personally i'm familiar with one

1223
00:41:45,750 --> 00:41:43,280
type of microbe at least who will be a

1224
00:41:47,670 --> 00:41:45,760
happy camper in the enceladus ocean so i

1225
00:41:49,030 --> 00:41:47,680
don't think we can say the same thing

1226
00:41:51,190 --> 00:41:49,040
about any other place in the solar

1227
00:41:52,550 --> 00:41:51,200
system right now maybe in the future

1228
00:41:54,150 --> 00:41:52,560
with other missions like flipper we

1229
00:41:57,589 --> 00:41:54,160
learned a couple of things about europa

1230
00:41:58,950 --> 00:41:57,599
but enceladus is right now is as good as

1231
00:42:01,670 --> 00:41:58,960
it gets it's a wet dream for an

1232
00:42:02,710 --> 00:42:01,680
astrobiologist really literally and

1233
00:42:04,470 --> 00:42:02,720
secretly

1234
00:42:06,470 --> 00:42:04,480
yeah getting back to enceladus would be

1235
00:42:08,390 --> 00:42:06,480
very cool uh for our audience if you're

1236
00:42:10,790 --> 00:42:08,400
interested in seeing a really cool tech

1237
00:42:13,670 --> 00:42:10,800
idea for a potential upcoming mission go

1238
00:42:15,829 --> 00:42:13,680

to enfold.org and watch our one of our

1239
00:42:18,309 --> 00:42:15,839
recent webinars uh delivered delivered

1240
00:42:20,950 --> 00:42:18,319
by kailyn carpenter and morgan cable of

1241
00:42:23,750 --> 00:42:20,960
nasa jpl uh morgan has been on our show

1242
00:42:25,910 --> 00:42:23,760
before uh morgan and caitlin talk about

1243
00:42:27,910 --> 00:42:25,920
the potential for eels as they call them

1244
00:42:30,790 --> 00:42:27,920
these long snake-like robots to climb

1245
00:42:32,069 --> 00:42:30,800
down the vents of enceladus um we have

1246
00:42:34,470 --> 00:42:32,079
some very cool things at nasa

1247
00:42:35,670 --> 00:42:34,480
astrobiology in the future coming up uh

1248
00:42:36,870 --> 00:42:35,680
here for us

1249
00:42:38,390 --> 00:42:36,880
i do want to get some more questions

1250
00:42:40,790 --> 00:42:38,400
though we actually have a bunch more uh

1251
00:42:43,109 --> 00:42:40,800
in my queue here we have one from at

1252
00:42:44,390 --> 00:42:43,119
organism19874

1253
00:42:46,390 --> 00:42:44,400
on twitter

1254
00:42:47,190 --> 00:42:46,400
and this user wants to know

1255
00:42:49,190 --> 00:42:47,200
um

1256
00:42:51,349 --> 00:42:49,200
they say is the omnipresence of life in

1257
00:42:53,030 --> 00:42:51,359
extreme environments on earth dependent

1258
00:42:55,030 --> 00:42:53,040
on the presence of life in more suitable

1259
00:42:56,710 --> 00:42:55,040
environments and this is actually a

1260
00:42:58,870 --> 00:42:56,720
conversation i've had before with others

1261
00:43:01,030 --> 00:42:58,880
like carol cleland and philosophers of

1262
00:43:02,950 --> 00:43:01,040
science trying to figure out you know

1263
00:43:04,470 --> 00:43:02,960

are we kind of fooling ourselves maybe

1264
00:43:06,309 --> 00:43:04,480
by going to analog environments and

1265
00:43:08,710 --> 00:43:06,319
finding so much life there

1266
00:43:10,630 --> 00:43:08,720
is it more likely that life started in

1267
00:43:13,030 --> 00:43:10,640
more clement environments on earth and

1268
00:43:14,630 --> 00:43:13,040
that's why we find it in analog systems

1269
00:43:16,950 --> 00:43:14,640
or do you think it's really really

1270
00:43:18,790 --> 00:43:16,960
important to have these analog systems

1271
00:43:20,950 --> 00:43:18,800
yeah that's a tricky question

1272
00:43:23,510 --> 00:43:20,960
uh quick answer is depends on the

1273
00:43:25,750 --> 00:43:23,520
extreme and it's not a quick quick quick

1274
00:43:28,069 --> 00:43:25,760
way out that i'll try to explain myself

1275
00:43:28,790 --> 00:43:28,079
not all extremes are the same

1276
00:43:31,589 --> 00:43:28,800
and

1277
00:43:34,069 --> 00:43:31,599
ex particularly extreme dryness

1278
00:43:35,510 --> 00:43:34,079
stands out extreme cold also but extreme

1279
00:43:38,150 --> 00:43:35,520
dryness stands out from all the other

1280
00:43:39,670 --> 00:43:38,160
extremes here's why there are extreme

1281
00:43:41,670 --> 00:43:39,680
temperatures

1282
00:43:43,829 --> 00:43:41,680
and there are microorganisms that thrive

1283
00:43:45,430 --> 00:43:43,839
under those conditions i would die

1284
00:43:47,589 --> 00:43:45,440
in any other environment there are

1285
00:43:49,349 --> 00:43:47,599
extremes of ph and also we find

1286
00:43:51,670 --> 00:43:49,359
organisms that thrive in those extremes

1287
00:43:54,390 --> 00:43:51,680
and would die in more normal conditions

1288
00:43:56,550 --> 00:43:54,400

same with salinity mycharisms thrive in

1289
00:43:58,550 --> 00:43:56,560
very salty environments there are no

1290
00:44:01,589 --> 00:43:58,560
organisms that thrive

1291
00:44:03,670 --> 00:44:01,599
in extreme dryness or extreme cold

1292
00:44:05,829 --> 00:44:03,680
those are very different extremes

1293
00:44:07,670 --> 00:44:05,839
the microorganisms that

1294
00:44:09,990 --> 00:44:07,680
we find in extremely dry or extremely

1295
00:44:13,430 --> 00:44:10,000
cold environments those are survivors

1296
00:44:15,829 --> 00:44:13,440
they're not drivers they're survivors

1297
00:44:17,510 --> 00:44:15,839
and that is because and in that case

1298
00:44:19,270 --> 00:44:17,520
those organisms exist in those

1299
00:44:21,190 --> 00:44:19,280
environments because they exist in more

1300
00:44:22,870 --> 00:44:21,200
climate conditions they're very good at

1301
00:44:23,910 --> 00:44:22,880
surviving they're not very good at

1302
00:44:26,710 --> 00:44:23,920
driving

1303
00:44:30,390 --> 00:44:26,720
so to answer the question he has a no

1304
00:44:32,470 --> 00:44:30,400
we need life in normal environments so

1305
00:44:34,550 --> 00:44:32,480
that some of the some of those organisms

1306
00:44:36,710 --> 00:44:34,560
can survive in some of the extreme

1307
00:44:38,950 --> 00:44:36,720
environments cold and dry

1308
00:44:41,109 --> 00:44:38,960
maybe we don't need life in normal

1309
00:44:43,670 --> 00:44:41,119
environments to survive other extremes

1310
00:44:45,109 --> 00:44:43,680
like extreme heat or extreme ph that

1311
00:44:47,589 --> 00:44:45,119
depends that goes up to at the core of

1312
00:44:49,910 --> 00:44:47,599
what you said what the origin of life or

1313
00:44:52,150 --> 00:44:49,920

the early evolution of life was like if

1314
00:44:53,910 --> 00:44:52,160
the every evolution of life was in

1315
00:44:55,990 --> 00:44:53,920
extreme hot then

1316
00:44:57,750 --> 00:44:56,000
i would tell us extreme heart is not

1317
00:44:59,670 --> 00:44:57,760
that big of a problem but the extreme

1318
00:45:02,069 --> 00:44:59,680
cold and extreme dry is a very different

1319
00:45:04,550 --> 00:45:02,079
beast that often doesn't get recognized

1320
00:45:05,750 --> 00:45:04,560
that's very important about indeed um i

1321
00:45:07,030 --> 00:45:05,760
do want to switch topics just a little

1322
00:45:08,950 --> 00:45:07,040
bit to something more in the realm of

1323
00:45:10,950 --> 00:45:08,960
planetary protection now um we've

1324
00:45:13,670 --> 00:45:10,960
discussed this potential for biological

1325
00:45:15,829 --> 00:45:13,680
transfer uh versus having another origin

1326
00:45:17,430 --> 00:45:15,839
of life on mars and one thing a lot of

1327
00:45:18,950 --> 00:45:17,440
people wonder you know if we find

1328
00:45:20,550 --> 00:45:18,960
microbes on mars or we're seeing a

1329
00:45:22,069 --> 00:45:20,560
sample return right now with

1330
00:45:24,390 --> 00:45:22,079
perseverance we're going to be caching

1331
00:45:26,630 --> 00:45:24,400
samples bringing those back to earth to

1332
00:45:27,670 --> 00:45:26,640
study and analyze potentially for signs

1333
00:45:29,349 --> 00:45:27,680
of life

1334
00:45:32,150 --> 00:45:29,359
if there is martian bacteria is it going

1335
00:45:34,309 --> 00:45:32,160
to be harmful for us and so user sangeet

1336
00:45:37,430 --> 00:45:34,319
diman on second net wants to know

1337
00:45:39,750 --> 00:45:37,440
especially for crude missions to mars um

1338
00:45:41,190 --> 00:45:39,760

do you think it'd be likely or possible

1339
00:45:43,349 --> 00:45:41,200
for microbial life there to be

1340
00:45:45,430 --> 00:45:43,359
pathogenic and potentially dangerous for

1341
00:45:46,470 --> 00:45:45,440
humans and should we have a protocol to

1342
00:45:49,030 --> 00:45:46,480
deal with that

1343
00:45:51,030 --> 00:45:49,040
well if it was uh if we if it was a

1344
00:45:53,430 --> 00:45:51,040
common ancestor if we shared the common

1345
00:45:55,510 --> 00:45:53,440
ancestor with them i they were close

1346
00:45:57,190 --> 00:45:55,520
cousins so to speak of us the chances of

1347
00:45:58,069 --> 00:45:57,200
them being pathogenic to us would be

1348
00:45:59,430 --> 00:45:58,079
higher

1349
00:46:01,349 --> 00:45:59,440
because their biochemistry would be a

1350
00:46:03,589 --> 00:46:01,359
lot more compatible with ours

1351
00:46:05,430 --> 00:46:03,599
and so one would want to be careful with

1352
00:46:07,030 --> 00:46:05,440
that if they were a second independent

1353
00:46:08,710 --> 00:46:07,040
genesis

1354
00:46:10,230 --> 00:46:08,720
it's hard to tell we don't know what

1355
00:46:12,630 --> 00:46:10,240
they would look like but my guess is

1356
00:46:13,510 --> 00:46:12,640
that the chances of being a pathogen

1357
00:46:14,830 --> 00:46:13,520
would be

1358
00:46:16,470 --> 00:46:14,840
less

1359
00:46:18,309 --> 00:46:16,480
[Music]

1360
00:46:20,150 --> 00:46:18,319
so if that's another reason why it's

1361
00:46:22,870 --> 00:46:20,160
important to consider that issue of

1362
00:46:24,630 --> 00:46:22,880
independent genes in common ancestry

1363
00:46:28,069 --> 00:46:24,640

i would say though that

1364
00:46:29,430 --> 00:46:28,079
before we send humans to mars

1365
00:46:32,630 --> 00:46:29,440
there is very likely going to be a

1366
00:46:34,790 --> 00:46:32,640
biological hazard assessment of whether

1367
00:46:36,309 --> 00:46:34,800
we find anything there that can be

1368
00:46:37,190 --> 00:46:36,319
pathogenic and there are ways we can do

1369
00:46:39,670 --> 00:46:37,200
that

1370
00:46:40,829 --> 00:46:39,680
and sample with mars sample return

1371
00:46:43,750 --> 00:46:40,839
already

1372
00:46:46,550 --> 00:46:43,760
has mechanisms in place to sterilize the

1373
00:46:48,710 --> 00:46:46,560
sample so that precisely what this

1374
00:46:50,390 --> 00:46:48,720
viewer was asking doesn't happen that

1375
00:46:52,790 --> 00:46:50,400
there are no microbes floating around in

1376
00:46:54,390 --> 00:46:52,800
a sample chamber that could

1377
00:46:56,069 --> 00:46:54,400
be harmful to us

1378
00:46:58,309 --> 00:46:56,079
so it's a very important question to

1379
00:46:59,990 --> 00:46:58,319
have to ask it has

1380
00:47:03,750 --> 00:47:00,000
implications for scientific and

1381
00:47:05,430 --> 00:47:03,760
programmatic and technological

1382
00:47:06,870 --> 00:47:05,440
very important and i think our next

1383
00:47:09,030 --> 00:47:06,880
question is one that's very intriguing

1384
00:47:12,390 --> 00:47:09,040
as well that others have wondered is

1385
00:47:14,870 --> 00:47:12,400
should we seed life elsewhere so user at

1386
00:47:17,510 --> 00:47:14,880
small robot army on twitter wants to

1387
00:47:18,950 --> 00:47:17,520
know um so say we find no life on mars

1388
00:47:21,109 --> 00:47:18,960

which i'm not sure how soon that would

1389
00:47:22,549 --> 00:47:21,119
happen but say we find no life on mars

1390
00:47:25,109 --> 00:47:22,559
do you think it'd be scientifically

1391
00:47:26,470 --> 00:47:25,119
interesting and i'll even add ethically

1392
00:47:29,270 --> 00:47:26,480
responsible

1393
00:47:32,470 --> 00:47:29,280
um to take earth life there and and

1394
00:47:33,750 --> 00:47:32,480
specifically target seeding life on mars

1395
00:47:36,950 --> 00:47:33,760
yeah this is a

1396
00:47:39,270 --> 00:47:36,960
this is a good question the uh

1397
00:47:42,470 --> 00:47:39,280
my answer to that question is i i've

1398
00:47:45,030 --> 00:47:42,480
bought prismacase and and uh uh

1399
00:47:46,630 --> 00:47:45,040
rationale for this uh which is published

1400
00:47:49,030 --> 00:47:46,640
in a number of papers which i found to

1401
00:47:50,790 --> 00:47:49,040
be very logical and very fascinating and

1402
00:47:52,549 --> 00:47:50,800
the rationale is that

1403
00:47:54,549 --> 00:47:52,559
an environment with life

1404
00:47:56,230 --> 00:47:54,559
has more intrinsic value than an

1405
00:47:57,990 --> 00:47:56,240
environment without life

1406
00:47:59,670 --> 00:47:58,000
uh now you can buy that argument or not

1407
00:48:01,510 --> 00:47:59,680
and there are there's a lot more

1408
00:48:03,510 --> 00:48:01,520
information in in some of those papers

1409
00:48:05,349 --> 00:48:03,520
in other papers but i did buy that

1410
00:48:06,950 --> 00:48:05,359
argument and so

1411
00:48:09,670 --> 00:48:06,960
i do think that

1412
00:48:13,109 --> 00:48:09,680
as a species that has the capability of

1413
00:48:15,349 --> 00:48:13,119

populating other environments with life

1414
00:48:17,829 --> 00:48:15,359
uh it would not only be

1415
00:48:19,750 --> 00:48:17,839
uh okay but i think it would be our

1416
00:48:22,549 --> 00:48:19,760
obligate obligation

1417
00:48:25,270 --> 00:48:22,559
to try to ex to to

1418
00:48:27,430 --> 00:48:25,280
to spread life as much as we can again

1419
00:48:29,190 --> 00:48:27,440
with the important caveat that the place

1420
00:48:31,190 --> 00:48:29,200
is not already taken first

1421
00:48:33,670 --> 00:48:31,200
um if it is then that's a whole

1422
00:48:36,150 --> 00:48:33,680
different uh that's a whole different

1423
00:48:38,710 --> 00:48:36,160
but i think as much as i like deserts

1424
00:48:40,230 --> 00:48:38,720
their deserts and places without life

1425
00:48:41,910 --> 00:48:40,240
i still like to see a tree every now and

1426
00:48:43,589 --> 00:48:41,920
then so yeah

1427
00:48:45,510 --> 00:48:43,599
absolutely reminds me of doing the

1428
00:48:46,549 --> 00:48:45,520
university river challenge and being at

1429
00:48:48,309 --> 00:48:46,559
the desert of utah which is very

1430
00:48:51,030 --> 00:48:48,319
mars-like but we still see some shrubs

1431
00:48:52,710 --> 00:48:51,040
and bushes and and i once watched disney

1432
00:48:54,309 --> 00:48:52,720
filming uh john carter when they were

1433
00:48:55,670 --> 00:48:54,319
out there filming and it was kind of

1434
00:48:56,870 --> 00:48:55,680
interesting i watched the movie and i

1435
00:48:58,630 --> 00:48:56,880
know that like right beside where the

1436
00:49:01,109 --> 00:48:58,640
actors were in this martian desert is

1437
00:49:03,109 --> 00:49:01,119
plants growing um which is pretty funny

1438
00:49:04,630 --> 00:49:03,119

and you cannot ignore that biology is

1439
00:49:05,750 --> 00:49:04,640
probably the most

1440
00:49:07,510 --> 00:49:05,760
uh

1441
00:49:10,069 --> 00:49:07,520
the most phenomenal force in the

1442
00:49:11,589 --> 00:49:10,079
universe we often talk about quantum

1443
00:49:12,390 --> 00:49:11,599
physics and the atoms and things like

1444
00:49:13,349 --> 00:49:12,400
this

1445
00:49:16,710 --> 00:49:13,359
but

1446
00:49:19,109 --> 00:49:16,720
you get when you form a molecule that

1447
00:49:20,390 --> 00:49:19,119
can self self replicate and evolve

1448
00:49:22,710 --> 00:49:20,400
there's nothing else in the universe

1449
00:49:23,910 --> 00:49:22,720
that can achieve that

1450
00:49:26,150 --> 00:49:23,920
the the

1451
00:49:28,230 --> 00:49:26,160
amazing level of complexity so the more

1452
00:49:29,430 --> 00:49:28,240
we can crank that machine i think the

1453
00:49:32,630 --> 00:49:29,440
more interesting the universe is going

1454
00:49:34,150 --> 00:49:32,640
to be 99 hydrogen and helium is not that

1455
00:49:36,150 --> 00:49:34,160
interesting and maybe you can sparkle

1456
00:49:37,990 --> 00:49:36,160
some dna into it or whatever make it

1457
00:49:40,230 --> 00:49:38,000
more interesting yeah it's a very cool

1458
00:49:41,109 --> 00:49:40,240
viewpoint you know life uh finds a way

1459
00:49:42,950 --> 00:49:41,119
right

1460
00:49:45,349 --> 00:49:42,960
um our next question we're going back

1461
00:49:47,990 --> 00:49:45,359
now to some more mars research our next

1462
00:49:49,750 --> 00:49:48,000
question from our nava padar um at

1463
00:49:50,870 --> 00:49:49,760

erinava2512

1464
00:49:52,870 --> 00:49:50,880
on twitter

1465
00:49:55,109 --> 00:49:52,880
wants to know um what are the future

1466
00:49:57,030 --> 00:49:55,119
challenges for things like the exomars

1467
00:49:58,470 --> 00:49:57,040
rover and perseverance

1468
00:49:59,829 --> 00:49:58,480
specifically you know in your own

1469
00:50:02,790 --> 00:49:59,839
viewpoint having done research in the

1470
00:50:05,109 --> 00:50:02,800
autocoma and antarctica

1471
00:50:07,589 --> 00:50:05,119
well the challenges are for for

1472
00:50:09,750 --> 00:50:07,599
perseverance um

1473
00:50:12,549 --> 00:50:09,760
navigation is going to be one

1474
00:50:13,910 --> 00:50:12,559
and uh and selecting the right samples

1475
00:50:15,670 --> 00:50:13,920
uh

1476
00:50:17,990 --> 00:50:15,680
the

1477
00:50:20,790 --> 00:50:18,000
uh because one thing you're getting one

1478
00:50:21,990 --> 00:50:20,800
thing you learn in going to the field

1479
00:50:23,589 --> 00:50:22,000
is that

1480
00:50:24,950 --> 00:50:23,599
you really need to have this global

1481
00:50:27,190 --> 00:50:24,960
context

1482
00:50:28,950 --> 00:50:27,200
uh before you pick the right samples i

1483
00:50:30,390 --> 00:50:28,960
know we don't worry too much about it on

1484
00:50:32,870 --> 00:50:30,400
earth because we can always go back and

1485
00:50:35,030 --> 00:50:32,880
get the sample we didn't get or the one

1486
00:50:36,950 --> 00:50:35,040
that we missed that's not what that's

1487
00:50:38,790 --> 00:50:36,960
not the case in sample return in my

1488
00:50:41,030 --> 00:50:38,800

sample return d that's that's a one-way

1489
00:50:42,950 --> 00:50:41,040
ticket it's a two-way ticket but uh you

1490
00:50:44,309 --> 00:50:42,960
don't get to get to do it a third time

1491
00:50:46,630 --> 00:50:44,319
please not in a

1492
00:50:48,150 --> 00:50:46,640
in our lifetime so

1493
00:50:50,230 --> 00:50:48,160
so the challenge is going to be to

1494
00:50:52,549 --> 00:50:50,240
really

1495
00:50:54,710 --> 00:50:52,559
walk that thin line between

1496
00:50:56,390 --> 00:50:54,720
collecting the samples now

1497
00:50:58,470 --> 00:50:56,400
and getting enough context so that we

1498
00:51:01,109 --> 00:50:58,480
could recollect the right samples for

1499
00:51:02,950 --> 00:51:01,119
exomars i think is drilling deep that's

1500
00:51:05,430 --> 00:51:02,960
going to be the number one thing the

1501
00:51:07,270 --> 00:51:05,440
exomars if i'm not mistaken the goal is

1502
00:51:09,430 --> 00:51:07,280
to reach at least two meters

1503
00:51:11,109 --> 00:51:09,440
a lot of a lot of things can go wrong in

1504
00:51:12,549 --> 00:51:11,119
two meters so uh

1505
00:51:13,990 --> 00:51:12,559
uh that's gonna be the main challenge

1506
00:51:16,630 --> 00:51:14,000
i'm sure they have the technology to do

1507
00:51:19,190 --> 00:51:16,640
it but it's gonna be uh it's gonna be

1508
00:51:20,710 --> 00:51:19,200
scary at the very least

1509
00:51:22,549 --> 00:51:20,720
yeah i mean drilling is hard you know

1510
00:51:24,710 --> 00:51:22,559
and sending a rover or a lander to do

1511
00:51:26,470 --> 00:51:24,720
drilling is is difficult uh even for

1512
00:51:28,790 --> 00:51:26,480
humans on earth it's hard for us to

1513
00:51:30,230 --> 00:51:28,800

drill with a bunch of people with power

1514
00:51:32,069 --> 00:51:30,240
and you know a lot of horsepower pushing

1515
00:51:34,549 --> 00:51:32,079
these drills and so it's a very

1516
00:51:36,230 --> 00:51:34,559
interesting thing um to think about and

1517
00:51:38,710 --> 00:51:36,240
maybe following on from that we have

1518
00:51:42,470 --> 00:51:38,720
another question from a user at astro

1519
00:51:44,309 --> 00:51:42,480
augusto on twitter um argusto carbadido

1520
00:51:46,470 --> 00:51:44,319
wants to know what are some outstanding

1521
00:51:49,589 --> 00:51:46,480
problems in general in terrestrial

1522
00:51:51,589 --> 00:51:49,599
analog and biosignature research

1523
00:51:53,190 --> 00:51:51,599
well um i won't speak for all of them

1524
00:51:55,349 --> 00:51:53,200
but i will tell you a couple of things

1525
00:51:57,270 --> 00:51:55,359
about live in extreme about extreme

1526
00:51:59,030 --> 00:51:57,280
extremely dry environments

1527
00:52:01,190 --> 00:51:59,040
uh number one

1528
00:52:03,270 --> 00:52:01,200
we still don't really understand

1529
00:52:05,349 --> 00:52:03,280
what is it that limits life in extremely

1530
00:52:07,670 --> 00:52:05,359
dry environment you would say duh is the

1531
00:52:10,069 --> 00:52:07,680
lack of water yes but we still find

1532
00:52:11,829 --> 00:52:10,079
microorganisms in those very dry

1533
00:52:13,349 --> 00:52:11,839
environments and they don't have

1534
00:52:14,630 --> 00:52:13,359
adaptations

1535
00:52:17,510 --> 00:52:14,640
that are

1536
00:52:21,270 --> 00:52:19,109
make them all that much better using

1537
00:52:23,510 --> 00:52:21,280
water at least not different from their

1538
00:52:25,030 --> 00:52:23,520

counterparts in in wetter environments

1539
00:52:26,870 --> 00:52:25,040
they're very similar

1540
00:52:28,790 --> 00:52:26,880
so we still don't really understand what

1541
00:52:30,710 --> 00:52:28,800
is it that limits life in extremely dry

1542
00:52:32,390 --> 00:52:30,720
environments you have i have a personal

1543
00:52:34,549 --> 00:52:32,400
hypothesis which is

1544
00:52:36,630 --> 00:52:34,559
that life in extremely dry environments

1545
00:52:38,309 --> 00:52:36,640
is actually energy limited which is a

1546
00:52:39,190 --> 00:52:38,319
bit of a counter-intuitive hypothesis

1547
00:52:41,349 --> 00:52:39,200
because

1548
00:52:43,670 --> 00:52:41,359
uh in deserts if anything you get is

1549
00:52:47,109 --> 00:52:43,680
sunlight and sunlight is extremely

1550
00:52:49,270 --> 00:52:47,119
powerful energy source for life but uh

1551
00:52:51,190 --> 00:52:49,280
but what's happening in deserts is that

1552
00:52:52,950 --> 00:52:51,200
you cannot use all that sunlight you can

1553
00:52:56,069 --> 00:52:52,960
only use it when there is water around

1554
00:52:57,349 --> 00:52:56,079
and that's a scarce resource and so

1555
00:52:59,910 --> 00:52:57,359
a lot of the energy you get in the

1556
00:53:01,430 --> 00:52:59,920
desert it goes unused because you cannot

1557
00:53:03,270 --> 00:53:01,440
use it because you're tormented or

1558
00:53:04,630 --> 00:53:03,280
you're dry in a dry state and over a

1559
00:53:07,109 --> 00:53:04,640
long period of time i think that can

1560
00:53:08,950 --> 00:53:07,119
lead to energy starvation that's an

1561
00:53:10,870 --> 00:53:08,960
hypothesis that comes out for many years

1562
00:53:13,030 --> 00:53:10,880
of studying living and great in extreme

1563
00:53:14,549 --> 00:53:13,040

deserts meeting other people and that

1564
00:53:17,109 --> 00:53:14,559
we're trying to test with some specific

1565
00:53:19,430 --> 00:53:17,119
hypotheses uh these days

1566
00:53:21,270 --> 00:53:19,440
the other one is what happens to

1567
00:53:23,670 --> 00:53:21,280
dead organisms in extreme legends how do

1568
00:53:25,349 --> 00:53:23,680
they decay it's one good thing one bad

1569
00:53:27,430 --> 00:53:25,359
thing about extreme dryness or extremely

1570
00:53:28,710 --> 00:53:27,440
dry environment is that not a lot a lot

1571
00:53:31,270 --> 00:53:28,720
of things can grow

1572
00:53:33,270 --> 00:53:31,280
but but it leaves behind beautifully

1573
00:53:34,069 --> 00:53:33,280
preserved bodies and so

1574
00:53:36,069 --> 00:53:34,079
uh

1575
00:53:37,910 --> 00:53:36,079
there's this

1576
00:53:39,510 --> 00:53:37,920
trade that you can play well i'm not

1577
00:53:40,950 --> 00:53:39,520
getting a lot of signal but the signal

1578
00:53:42,150 --> 00:53:40,960
is very well preserved

1579
00:53:43,670 --> 00:53:42,160
versus another environment where you

1580
00:53:45,349 --> 00:53:43,680
might get a lot of signal but most of it

1581
00:53:47,670 --> 00:53:45,359
gets degraded before it can be

1582
00:53:49,190 --> 00:53:47,680
fossilized so those traits are also

1583
00:53:51,030 --> 00:53:49,200
interesting questions

1584
00:53:53,109 --> 00:53:51,040
uh and then the third one is

1585
00:53:54,710 --> 00:53:53,119
what is between cold and dry i think

1586
00:53:57,030 --> 00:53:54,720
cold and dry

1587
00:53:58,150 --> 00:53:57,040
uh lack of water and cold temperatures

1588
00:54:00,230 --> 00:53:58,160

are very

1589
00:54:02,710 --> 00:54:00,240
similar in many different ways and i

1590
00:54:04,309 --> 00:54:02,720
like to explore how organisms cope with

1591
00:54:06,710 --> 00:54:04,319
one and the other and whether the coping

1592
00:54:08,710 --> 00:54:06,720
mechanisms are related let's just give

1593
00:54:10,390 --> 00:54:08,720
you three of them awesome yeah there's

1594
00:54:12,150 --> 00:54:10,400
still much more research for those who

1595
00:54:13,510 --> 00:54:12,160
are watching who are maybe high school

1596
00:54:15,270 --> 00:54:13,520
students or undergraduate college

1597
00:54:16,710 --> 00:54:15,280
students or even graduate students who

1598
00:54:18,710 --> 00:54:16,720
want to be involved there's still a lot

1599
00:54:20,950 --> 00:54:18,720
more work to do in terrestrial analog

1600
00:54:22,230 --> 00:54:20,960
research and in bio signatures there's a

1601
00:54:24,549 --> 00:54:22,240
lot of us doing that work and we can

1602
00:54:27,030 --> 00:54:24,559
always use more people more perspectives

1603
00:54:28,870 --> 00:54:27,040
more opinions and more work honestly to

1604
00:54:30,230 --> 00:54:28,880
continue that field forward

1605
00:54:31,430 --> 00:54:30,240
i do want to change gears now we have a

1606
00:54:33,030 --> 00:54:31,440
few minutes left and so i just want to

1607
00:54:34,790 --> 00:54:33,040
ask a couple more questions that are

1608
00:54:37,030 --> 00:54:34,800
kind of just like more fun open-ended

1609
00:54:38,630 --> 00:54:37,040
questions here um one uh navanil

1610
00:54:41,750 --> 00:54:38,640
swaranji has also asked a question on

1611
00:54:43,829 --> 00:54:41,760
twitter uh navanil has asked uh if you

1612
00:54:45,589 --> 00:54:43,839
know of an ideal analog system for the

1613
00:54:46,950 --> 00:54:45,599

dragonfly mission which we're sending to

1614
00:54:48,789 --> 00:54:46,960
titan

1615
00:54:51,910 --> 00:54:48,799
no

1616
00:54:53,910 --> 00:54:51,920
that is way too extreme uh the cold

1617
00:54:55,990 --> 00:54:53,920
something that has the cold temperatures

1618
00:54:57,670 --> 00:54:56,000
the organic content

1619
00:54:59,829 --> 00:54:57,680
uh

1620
00:55:01,670 --> 00:54:59,839
i i cannot think of one i mean in the

1621
00:55:02,470 --> 00:55:01,680
past people have talked about

1622
00:55:04,549 --> 00:55:02,480
um

1623
00:55:06,950 --> 00:55:04,559
what you call them

1624
00:55:08,549 --> 00:55:06,960
hydrocarbon lakes asphalt lakes as

1625
00:55:10,150 --> 00:55:08,559
possible analogs but

1626
00:55:11,829 --> 00:55:10,160
it's still a huge leap between that and

1627
00:55:12,549 --> 00:55:11,839
those are still water-rich environments

1628
00:55:14,069 --> 00:55:12,559
so

1629
00:55:16,710 --> 00:55:14,079
i don't think we have a good analog on

1630
00:55:18,789 --> 00:55:16,720
earth for dragonfly dragonfly is flying

1631
00:55:21,190 --> 00:55:18,799
blind in that sense not with it not with

1632
00:55:23,030 --> 00:55:21,200
the ground what we need to do is take a

1633
00:55:25,109 --> 00:55:23,040
giant warehouse and just build a giant

1634
00:55:26,710 --> 00:55:25,119
titanium atmosphere and and cold

1635
00:55:29,430 --> 00:55:26,720
environment inside of it to have a test

1636
00:55:30,950 --> 00:55:29,440
bed uh maybe nav neil can can make some

1637
00:55:32,950 --> 00:55:30,960
money maybe you know a couple billion

1638
00:55:34,870 --> 00:55:32,960

dollars and we'll build that

1639
00:55:36,309 --> 00:55:34,880
um

1640
00:55:37,349 --> 00:55:36,319
i think we have time for one more

1641
00:55:40,069 --> 00:55:37,359
question

1642
00:55:43,910 --> 00:55:40,079
um so let's ask this one from t vinnette

1643
00:55:46,309 --> 00:55:43,920
ready uh at t vinit ready2 on twitter uh

1644
00:55:48,870 --> 00:55:46,319
this user wants to know um

1645
00:55:50,870 --> 00:55:48,880
what would be the next step if we find a

1646
00:55:52,549 --> 00:55:50,880
habitable exoplanet which is not yet

1647
00:55:55,190 --> 00:55:52,559
inhabited

1648
00:55:57,589 --> 00:55:55,200
an exoplanet that is and we can confirm

1649
00:55:59,829 --> 00:55:57,599
that there is no life in it

1650
00:56:01,190 --> 00:55:59,839
well i don't know i would move on to the

1651
00:56:04,069 --> 00:56:01,200
next one and see if there's life in the

1652
00:56:05,750 --> 00:56:04,079
next one uh you know

1653
00:56:09,030 --> 00:56:05,760
a habitable

1654
00:56:13,750 --> 00:56:09,040
ex but not having it inhabited exoplanet

1655
00:56:16,950 --> 00:56:15,270
there's not a lot of things you can do

1656
00:56:18,390 --> 00:56:16,960
with it you can think about spending an

1657
00:56:20,390 --> 00:56:18,400
environment that is habitable why it's

1658
00:56:21,670 --> 00:56:20,400
not inhabited but it turns out we have

1659
00:56:23,510 --> 00:56:21,680
we might have a lot of those in our own

1660
00:56:25,109 --> 00:56:23,520
solar system we might have plenty of

1661
00:56:27,109 --> 00:56:25,119
environments that are habitable and

1662
00:56:28,390 --> 00:56:27,119
inhabited and we can study why so we

1663
00:56:29,990 --> 00:56:28,400

could answer it scientifically we could

1664
00:56:31,109 --> 00:56:30,000
answer that question in our own

1665
00:56:33,109 --> 00:56:31,119
neighborhood

1666
00:56:35,750 --> 00:56:33,119
um personally with thousands of

1667
00:56:37,510 --> 00:56:35,760
potentially of habitable exoplanets and

1668
00:56:39,750 --> 00:56:37,520
some of them potentially inhabited i

1669
00:56:41,670 --> 00:56:39,760
just moved i would i would move down the

1670
00:56:42,710 --> 00:56:41,680
list to the next one

1671
00:56:44,710 --> 00:56:42,720
awesome

1672
00:56:46,870 --> 00:56:44,720
alfonso thank you so much for joining us

1673
00:56:48,069 --> 00:56:46,880
for ask an astrobiologist uh it's been a

1674
00:56:49,349 --> 00:56:48,079
real pleasure having you here for the

1675
00:56:51,430 --> 00:56:49,359
show thank you graham it's been a lot of

1676
00:56:53,510 --> 00:56:51,440
fun thank you for having me awesome and

1677
00:56:55,190 --> 00:56:53,520
for our viewers watching you know we

1678
00:56:56,470 --> 00:56:55,200
discussed this issue with alfonso's

1679
00:56:58,549 --> 00:56:56,480
recent paper which we'll link in the

1680
00:57:01,030 --> 00:56:58,559
youtube video um you know could there

1681
00:57:03,349 --> 00:57:01,040
have been an alternative origin of life

1682
00:57:05,910 --> 00:57:03,359
on mars or are we potential descendants

1683
00:57:07,910 --> 00:57:05,920
of martian life or vice versa uh we'd

1684
00:57:08,950 --> 00:57:07,920
love to hear your opinion on this do you

1685
00:57:10,390 --> 00:57:08,960
think that there could be multiple

1686
00:57:12,470 --> 00:57:10,400
origins of life in different worlds in

1687
00:57:14,870 --> 00:57:12,480
our solar system or do you think we all

1688
00:57:16,950 --> 00:57:14,880

shared a single origin with biological

1689
00:57:21,829 --> 00:57:16,960
transfer happening uh let us know on

1690
00:57:23,109 --> 00:57:21,839
twitter at nasaastrobio or at sagan.org

1691
00:57:24,870 --> 00:57:23,119
and then you know for all of you who

1692
00:57:26,069 --> 00:57:24,880
want to stay in the loop with our show

1693
00:57:27,829 --> 00:57:26,079
with more things going on in the

1694
00:57:29,349 --> 00:57:27,839
astrobiology realm

1695
00:57:31,910 --> 00:57:29,359
you can always sign up for the nasa

1696
00:57:33,910 --> 00:57:31,920
astrobiology programs newsletter and

1697
00:57:36,309 --> 00:57:33,920
also we now have a new sign up address

1698
00:57:39,990 --> 00:57:36,319
for joining the sega net newsletter you

1699
00:57:41,829 --> 00:57:40,000
can join that at signup.sagonnet.org

1700
00:57:43,910 --> 00:57:41,839
it's been great having alfonso on the

1701
00:57:45,270 --> 00:57:43,920
show a pleasure as always to speak to

1702
00:57:47,430 --> 00:57:45,280
our entire audience and share the

1703
00:57:49,030 --> 00:57:47,440
wonders of astrobiology with you thanks

1704
00:57:53,750 --> 00:57:49,040
for joining us and until next time