



Ask An Astrobiologist



EPISODE 31: APRIL 14TH, 2020

DR. BETÜL KAÇAR



Astrobiology Program

1
00:00:36,530 --> 00:00:34,479

[Music]

2
00:00:39,260 --> 00:00:36,540
greetings friends of astrobiology

3
00:00:40,910 --> 00:00:39,270
welcome to a brand new episode of asking

4
00:00:42,860 --> 00:00:40,920
astrobiologists a show where we

5
00:00:45,020 --> 00:00:42,870
celebrate science and celebrate

6
00:00:46,040 --> 00:00:45,030
scientists my name is Sanjay saman this

7
00:00:47,660 --> 00:00:46,050
program is made possible by

8
00:00:50,119 --> 00:00:47,670
contributions from the NASA Astrobiology

9
00:00:52,460 --> 00:00:50,129
program and the non profit blue mobile

10
00:00:54,290 --> 00:00:52,470
space last month I had the great

11
00:00:56,329 --> 00:00:54,300
privilege of speaking with dr. Colin

12
00:00:57,799 --> 00:00:56,339
robot of the University of Victoria and

13
00:00:59,780 --> 00:00:57,809

we talked about a bunch of different

14

00:01:02,210 --> 00:00:59,790

topics going from the early earth all

15

00:01:04,130 --> 00:01:02,220

the way to the exoplanets using the

16

00:01:06,290 --> 00:01:04,140

tools and insights that come from

17

00:01:07,999 --> 00:01:06,300

atmospheric sciences and today we're

18

00:01:10,370 --> 00:01:08,009

going to do the same journey by looking

19

00:01:13,100 --> 00:01:10,380

on much smaller scales at the tool of

20

00:01:15,260 --> 00:01:13,110

molecular genetics and my guest today is

21

00:01:17,330 --> 00:01:15,270

going to be dr. batulcar

22

00:01:20,270 --> 00:01:17,340

of the university of arizona which we're

23

00:01:23,600 --> 00:01:20,280

very excited to talk to but first it's

24

00:01:25,669 --> 00:01:23,610

time for your field challenge quiz the

25

00:01:27,620 --> 00:01:25,679

competition formerly known as the

26
00:01:29,690 --> 00:01:27,630
background quiz but right now my studio

27
00:01:31,969 --> 00:01:29,700
is my kitchen so we have to do something

28
00:01:36,280 --> 00:01:31,979
new so Mike if you could put up the feel

29
00:01:43,070 --> 00:01:39,560
many of you got it right as you can tell

30
00:01:45,680 --> 00:01:43,080
it is Lake Salle des in turkey it is the

31
00:01:47,870 --> 00:01:45,690
Maldives of the turkey beautiful white

32
00:01:50,180 --> 00:01:47,880
sand and it's very unique it's a bit of

33
00:01:53,260 --> 00:01:50,190
alkaline water pH a little higher the

34
00:01:56,480 --> 00:01:53,270
neutral 8 or 9 and that prevents

35
00:01:58,820 --> 00:01:56,490
bruising or undersea of microbial mats

36
00:02:02,420 --> 00:01:58,830
that form using a specific mineral

37
00:02:04,400 --> 00:02:02,430
called hydro magnesite structures are

38
00:02:05,990 --> 00:02:04,410

called stromatolites and some of those

39

00:02:07,670 --> 00:02:06,000

these stromatolites are some of the

40

00:02:09,620 --> 00:02:07,680

evidence of the oldest lives on earth

41

00:02:12,230 --> 00:02:09,630

many exist in the fossil records that

42

00:02:13,670 --> 00:02:12,240

are over two and a half almost 3 plus

43

00:02:15,710 --> 00:02:13,680

billion years old

44

00:02:17,750 --> 00:02:15,720

so these astrobiology field side of

45

00:02:19,670 --> 00:02:17,760

locational interests like the one in

46

00:02:22,340 --> 00:02:19,680

like zelda allows scientists to get an

47

00:02:25,340 --> 00:02:22,350

insight of how life existed back then

48

00:02:28,850 --> 00:02:25,350

our big winner for this competition is

49

00:02:30,560 --> 00:02:28,860

at Azul bin Oba congratulations for

50

00:02:33,199 --> 00:02:30,570

getting it right you will win the

51
00:02:35,000 --> 00:02:33,209
astrobiology graphics novel but in his

52
00:02:37,670 --> 00:02:35,010
time of sheltering from home I have no

53
00:02:39,770 --> 00:02:37,680
means to get them to you so but in any

54
00:02:42,470 --> 00:02:39,780
case please DM us your address and we'll

55
00:02:44,090 --> 00:02:42,480
ship them to you whenever we can but you

56
00:02:46,759 --> 00:02:44,100
know that you can download all these

57
00:02:49,729 --> 00:02:46,769
graphic novels online and at Michael's

58
00:02:51,050 --> 00:02:49,739
set up the URL for you all to see so

59
00:02:52,910 --> 00:02:51,060
thank you very much for playing this

60
00:02:55,100 --> 00:02:52,920
week's feel challenge I wouldn't give

61
00:02:56,840 --> 00:02:55,110
another big shout out to our ambassador

62
00:02:59,660 --> 00:02:56,850
of the month this is one of you who does

63
00:03:02,000 --> 00:02:59,670

more than the usual to promote our

64

00:03:03,979 --> 00:03:02,010

program on the interwebs on Twitter on

65

00:03:06,320 --> 00:03:03,989

Facebook on instagrams and whoever all

66

00:03:08,240 --> 00:03:06,330

he might exist online thank you so much

67

00:03:10,160 --> 00:03:08,250

this show is only successful because you

68

00:03:12,170 --> 00:03:10,170

share it to your friends and family and

69

00:03:14,080 --> 00:03:12,180

to your followers so this month

70

00:03:17,000 --> 00:03:14,090

ambassador of the month is once again

71

00:03:19,520 --> 00:03:17,010

birthing from other hit who tweets as at

72

00:03:21,110 --> 00:03:19,530

birth in that space thank you so much

73

00:03:24,290 --> 00:03:21,120

for your support perfectness awesome to

74

00:03:26,509 --> 00:03:24,300

have you in the show so I'm excited

75

00:03:29,030 --> 00:03:26,519

today to welcome astrobiologists

76

00:03:31,789 --> 00:03:29,040

extraordinaire dr. Betty Lucas ah a

77

00:03:34,039 --> 00:03:31,799

professor at the University of Arizona I

78

00:03:36,259 --> 00:03:34,049

think one of the very few if not the

79

00:03:37,880 --> 00:03:36,269

only professor in the United States if

80

00:03:41,120 --> 00:03:37,890

not the world that has a dual

81

00:03:43,760 --> 00:03:41,130

appointment in both cell biology and

82

00:03:45,890 --> 00:03:43,770

astronomy a true mark of an

83

00:03:47,559 --> 00:03:45,900

astrobiologist but you thank you so much

84

00:03:49,460 --> 00:03:47,569

for being on the program with us today

85

00:03:51,710 --> 00:03:49,470

thanks for having me

86

00:03:53,360 --> 00:03:51,720

like and we enjoy doing in the show is

87

00:03:56,210 --> 00:03:53,370

turned back to wheels of time a little

88

00:03:58,010 --> 00:03:56,220

bit and get back into the child that I

89

00:04:00,020 --> 00:03:58,020

was looking into space that you were and

90

00:04:01,460 --> 00:04:00,030

he could share perhaps an anecdote or a

91

00:04:04,700 --> 00:04:01,470

story when you were young that got you

92

00:04:09,760 --> 00:04:04,710

excited about science and space because

93

00:04:12,740 --> 00:04:09,770

I think moments look at those face and

94

00:04:15,440 --> 00:04:12,750

ok the stars and think what is out there

95

00:04:18,259 --> 00:04:15,450

are the alone in the universe I am NOT

96

00:04:22,009 --> 00:04:18,269

one of those kids I didn't even think

97

00:04:25,610 --> 00:04:22,019

that in a career that involved space and

98

00:04:27,770 --> 00:04:25,620

stars was waiting for me in the future

99

00:04:29,150 --> 00:04:27,780

so my I would say I was actually

100

00:04:32,060 --> 00:04:29,160

thinking about this because I knew you

101
00:04:33,440 --> 00:04:32,070
were gonna ask me that moment and so I

102
00:04:35,600 --> 00:04:33,450
was doing some soul-searching this

103
00:04:37,790 --> 00:04:35,610
morning while washing the dishes you

104
00:04:40,160 --> 00:04:37,800
know moving back back back back all the

105
00:04:43,310 --> 00:04:40,170
way back I think they wanna clearest

106
00:04:45,740 --> 00:04:43,320
moments that I had is related to a movie

107
00:04:47,540 --> 00:04:45,750
I watched and it is not about the movie

108
00:04:50,120 --> 00:04:47,550
itself but the way the movie was

109
00:04:54,560 --> 00:04:50,130
portraying the scientists in the movie

110
00:04:56,270 --> 00:04:54,570
so that will be it and the talking and

111
00:04:58,220 --> 00:04:56,280
thinking about that movie a lot where

112
00:05:01,610 --> 00:04:58,230
they have the scientists here that is

113
00:05:03,650 --> 00:05:01,620

exploring well not the rocks per se but

114

00:05:06,650 --> 00:05:03,660

mysteries that are embedded in Pyramus

115

00:05:09,110 --> 00:05:06,660

and and then gets transported to another

116

00:05:10,880 --> 00:05:09,120

dimension and finds out a completely

117

00:05:12,880 --> 00:05:10,890

different civilization that wasn't

118

00:05:15,920 --> 00:05:12,890

necessarily originated in other planets

119

00:05:18,500 --> 00:05:15,930

but nevertheless equals another

120

00:05:21,200 --> 00:05:18,510

differently than our own civilization

121

00:05:23,090 --> 00:05:21,210

here on earth so I think what's what is

122

00:05:25,280 --> 00:05:23,100

interesting about that movie was that it

123

00:05:29,740 --> 00:05:25,290

portrays a scientist that wasn't

124

00:05:32,270 --> 00:05:29,750

necessarily a masculine sort of dorky

125

00:05:34,310 --> 00:05:32,280

character that I couldn't relate to I

126

00:05:37,010 --> 00:05:34,320

was thinking actually how feminine or

127

00:05:38,780 --> 00:05:37,020

even actually non-binary the character

128

00:05:41,420 --> 00:05:38,790

was that was different than those

129

00:05:43,460 --> 00:05:41,430

generals in the movie who were dictating

130

00:05:46,850 --> 00:05:43,470

him what to do and whatnot so I think I

131

00:05:49,640 --> 00:05:46,860

related to that character and meets that

132

00:05:52,520 --> 00:05:49,650

character made me think that I can do

133

00:05:54,920 --> 00:05:52,530

this because I am also someone that was

134

00:05:56,659 --> 00:05:54,930

very curious I still am I think it

135

00:05:59,659 --> 00:05:56,669

started with that that love for

136

00:06:01,940 --> 00:05:59,669

archaeology the past exploration

137

00:06:04,320 --> 00:06:01,950

unknowns knowing different masters and

138

00:06:07,059 --> 00:06:04,330

civilizations

139

00:06:09,790 --> 00:06:07,069

wonderful you are highlighted recently

140

00:06:11,890 --> 00:06:09,800

in an article by UN Women in which

141

00:06:13,659 --> 00:06:11,900

there's a beautiful quote by by you

142

00:06:16,480 --> 00:06:13,669

which I want to reiterate to our viewers

143

00:06:18,610 --> 00:06:16,490

a girl was determination can change the

144

00:06:21,309 --> 00:06:18,620

world how is it for you who grew up in

145

00:06:23,080 --> 00:06:21,319

in Turkey and then made your way to

146

00:06:24,879 --> 00:06:23,090

becoming a professor at the University

147

00:06:26,710 --> 00:06:24,889

of Arizona one of the elite institutions

148

00:06:28,330 --> 00:06:26,720

in a country if not the world you tell

149

00:06:33,390 --> 00:06:28,340

us a little bit about your academic path

150

00:06:36,760 --> 00:06:33,400

and how that went along is not a very

151
00:06:39,219 --> 00:06:36,770
sort of straightforward one and I think

152
00:06:41,020 --> 00:06:39,229
you can delete this I think who does in

153
00:06:44,439 --> 00:06:41,030
the field of astrobiology I think it

154
00:06:46,930 --> 00:06:44,449
takes it's not only outside the box that

155
00:06:51,370 --> 00:06:46,940
there is no box right the box is not

156
00:06:53,830 --> 00:06:51,380
existing but my career started I was

157
00:06:56,950 --> 00:06:53,840
actually my undergrad was in chemistry

158
00:06:58,870 --> 00:06:56,960
and my PhD also was in chemistry so

159
00:07:01,600 --> 00:06:58,880
that's the sort of an unknown fact about

160
00:07:05,249 --> 00:07:01,610
me that I didn't starts my journey as a

161
00:07:08,020 --> 00:07:05,259
biologist but I studied the chemistry of

162
00:07:10,240 --> 00:07:08,030
biomolecules and I was fascinated by

163
00:07:12,790 --> 00:07:10,250

proteins and how they can change

164

00:07:14,680 --> 00:07:12,800

everything and it is true it's not just

165

00:07:17,050 --> 00:07:14,690

three things alone molecules I mean look

166

00:07:19,589 --> 00:07:17,060

it's the kids why are you at home right

167

00:07:22,839 --> 00:07:19,599

now why am I here because a molecule is

168

00:07:25,149 --> 00:07:22,849

threatening our own civilization here on

169

00:07:29,140 --> 00:07:25,159

earth see they are so impactful and so

170

00:07:31,570 --> 00:07:29,150

do to understand that I remember the

171

00:07:34,089 --> 00:07:31,580

moments the first time I actually got to

172

00:07:36,339 --> 00:07:34,099

realize that molecules are so impactful

173

00:07:38,170 --> 00:07:36,349

not just within the cell but they can

174

00:07:41,950 --> 00:07:38,180

impact human health they can impact the

175

00:07:44,830 --> 00:07:41,960

whole population whole ecosystem it's my

176

00:07:47,680 --> 00:07:44,840

mind was when I never went back I was in

177

00:07:50,110 --> 00:07:47,690

love it hooked I was an undergrad and I

178

00:07:51,540 --> 00:07:50,120

thought to myself that that's the fact

179

00:07:55,330 --> 00:07:51,550

that you can spend your entire life

180

00:07:57,610 --> 00:07:55,340

chasing whatever molecule this and more

181

00:08:00,550 --> 00:07:57,620

interestingly I think what it did in the

182

00:08:03,820 --> 00:08:00,560

past there's what was no going back for

183

00:08:06,249 --> 00:08:03,830

me so after that I started after I got

184

00:08:08,890 --> 00:08:06,259

my PhD I was actually medical school and

185

00:08:10,839 --> 00:08:08,900

I was studying proteins but there was

186

00:08:13,089 --> 00:08:10,849

something me that I think always was

187

00:08:14,230 --> 00:08:13,099

very bothered by the way we are studying

188

00:08:16,180 --> 00:08:14,240

biochemistry

189

00:08:16,510 --> 00:08:16,190

by the way we are trying to understand

190

00:08:17,890 --> 00:08:16,520

this

191

00:08:20,980 --> 00:08:17,900

and I felt that we are not really

192

00:08:24,460 --> 00:08:20,990

connecting it to the larger picture that

193

00:08:26,200 --> 00:08:24,470

is not necessarily our on you know

194

00:08:29,020 --> 00:08:26,210

planets like I thought you're not

195

00:08:31,809 --> 00:08:29,030

pointing to the space it's the largest

196

00:08:34,510 --> 00:08:31,819

stable possible and around that time

197

00:08:38,310 --> 00:08:34,520

which was about 2009 or 10 I was

198

00:08:43,180 --> 00:08:38,320

finishing my PhD I realized that NASA

199

00:08:45,699 --> 00:08:43,190

supported biological studies that seek

200

00:08:47,889 --> 00:08:45,709

answers to the questions that I was very

201
00:08:50,079 --> 00:08:47,899
deeply interested in that was very

202
00:08:52,090 --> 00:08:50,089
surprising for me because it's NASA

203
00:08:55,210 --> 00:08:52,100
you know why are they interested in

204
00:08:59,560 --> 00:08:55,220
microbes and that's how I discovered the

205
00:09:04,030 --> 00:08:59,570
astrobiology program and I I knocked on

206
00:09:06,750 --> 00:09:04,040
the well I actually did the to the door

207
00:09:12,490 --> 00:09:06,760
that's that's more like it

208
00:09:14,590 --> 00:09:12,500
and welcomed me and I've been working

209
00:09:17,380 --> 00:09:14,600
with Astro bells program since that's

210
00:09:19,269 --> 00:09:17,390
been ten years now it's wonderful

211
00:09:22,150 --> 00:09:19,279
because now your postdoc is the NASA

212
00:09:24,100 --> 00:09:22,160
Astrobiology funded postdoc is now in

213
00:09:27,010 --> 00:09:24,110

your lab doing Astro biological research

214

00:09:29,139 --> 00:09:27,020

with the tools that your lab have

215

00:09:31,240 --> 00:09:29,149

developed and so you're an expert in

216

00:09:33,730 --> 00:09:31,250

ancestral gene reconstruction another

217

00:09:35,170 --> 00:09:33,740

way of saying this is paleogenetics can

218

00:09:36,819 --> 00:09:35,180

you tell us a little bit about about

219

00:09:41,440 --> 00:09:36,829

about this field in general and how does

220

00:09:44,730 --> 00:09:41,450

it apply to astrobiology that was nice

221

00:09:48,240 --> 00:09:44,740

about astrobiology program and I think

222

00:09:50,740 --> 00:09:48,250

that's the the researchers that's

223

00:09:53,139 --> 00:09:50,750

challenged their worldview that

224

00:09:59,019 --> 00:09:53,149

challenged the way the new science and

225

00:10:02,139 --> 00:09:59,029

maybe study things so I think that's why

226

00:10:04,510 --> 00:10:02,149

since the time I started working at NASA

227

00:10:07,660 --> 00:10:04,520

we clicked visually snow in terms of

228

00:10:09,579 --> 00:10:07,670

vision and one one thing and it was

229

00:10:12,940 --> 00:10:09,589

bothering me was that molecules are so

230

00:10:15,760 --> 00:10:12,950

impactful they change our planets is be

231

00:10:17,470 --> 00:10:15,770

speech and they continue to do so but we

232

00:10:20,079 --> 00:10:17,480

know very little about what they have

233

00:10:22,449 --> 00:10:20,089

done in the past so my postdoctoral

234

00:10:24,640 --> 00:10:22,459

studies focused on developing

235

00:10:27,130 --> 00:10:24,650

experimental systems that will allow us

236

00:10:30,170 --> 00:10:27,140

to study what many have have passed that

237

00:10:33,710 --> 00:10:30,180

shaped the planets the way we see today

238

00:10:35,150 --> 00:10:33,720

and and something that's very special I

239

00:10:37,430 --> 00:10:35,160

think that happened to me that doesn't

240

00:10:39,380 --> 00:10:37,440

happen follow the researchers there are

241

00:10:41,090 --> 00:10:39,390

actually multiple things but the main

242

00:10:43,040 --> 00:10:41,100

one was that I was able to transition

243

00:10:45,680 --> 00:10:43,050

from a medical field to a very

244

00:10:47,750 --> 00:10:45,690

fundamental basic ariel's

245

00:10:50,720 --> 00:10:47,760

research that I had no particular

246

00:10:52,100 --> 00:10:50,730

training for but then also brought just

247

00:10:54,199 --> 00:10:52,110

in the sense that I had to develop

248

00:10:58,699 --> 00:10:54,209

everything as we go so for the past 10

249

00:11:01,910 --> 00:10:58,709

years slowly and patiently I systems

250

00:11:06,260 --> 00:11:01,920

allow us to rewind the clock so to speak

251
00:11:09,380 --> 00:11:06,270
and allow us to molecules and the

252
00:11:12,740 --> 00:11:09,390
organisms that pushed them behaved in

253
00:11:14,389 --> 00:11:12,750
the past it is quite unusual I think

254
00:11:17,949 --> 00:11:14,399
because this day and age we are so

255
00:11:21,110 --> 00:11:17,959
focused on immediate results first and

256
00:11:25,240 --> 00:11:21,120
assistance that will give products right

257
00:11:28,040 --> 00:11:25,250
away and its really thinking about

258
00:11:29,780 --> 00:11:28,050
programs that found that they didn't

259
00:11:34,900 --> 00:11:29,790
expect an immediate outcome because a

260
00:11:38,050 --> 00:11:34,910
real research years years and

261
00:11:42,769 --> 00:11:38,060
development especially pioneering a new

262
00:11:46,699 --> 00:11:42,779
area of study so not only we are able to

263
00:11:48,680 --> 00:11:46,709

predict what the ancestral states of DNA

264

00:11:50,060 --> 00:11:48,690

may have been like what the proteins

265

00:11:53,510 --> 00:11:50,070

that we studied today and their

266

00:11:56,120 --> 00:11:53,520

ancestors maybe in the past they are now

267

00:11:58,850 --> 00:11:56,130

able to recall this resurrection that we

268

00:12:02,720 --> 00:11:58,860

bring them sort of - - to life so to

269

00:12:04,970 --> 00:12:02,730

speak to say what they do it is

270

00:12:07,910 --> 00:12:04,980

important to note that we may not be

271

00:12:10,970 --> 00:12:07,920

working with the truth right so if they

272

00:12:12,050 --> 00:12:10,980

are and you're dealing it the past when

273

00:12:14,300 --> 00:12:12,060

you're dealing it the past

274

00:12:17,750 --> 00:12:14,310

you never may never be able to capture

275

00:12:22,100 --> 00:12:17,760

what exactly happened and that is fine

276

00:12:25,640 --> 00:12:22,110

by me and I think by my I haven't I'm

277

00:12:27,560 --> 00:12:25,650

really lucky I have beliefs spirited you

278

00:12:28,910 --> 00:12:27,570

know hard-working team students working

279

00:12:31,460 --> 00:12:28,920

with me right now in postdocs

280

00:12:35,120 --> 00:12:31,470

I think we are aware that's it's not the

281

00:12:37,040 --> 00:12:35,130

pursue of the exact absolute truth but

282

00:12:37,670 --> 00:12:37,050

it is getting close to what may have

283

00:12:40,370 --> 00:12:37,680

happens

284

00:12:44,540 --> 00:12:40,380

getting extensive what's happened in the

285

00:12:47,670 --> 00:12:44,550

past and how molecules that we see today

286

00:12:51,300 --> 00:12:47,680

structured themselves over billions and

287

00:12:54,900 --> 00:12:51,310

billions years of time so more

288

00:12:58,590 --> 00:12:54,910

specifically you use existing biological

289

00:13:01,380 --> 00:12:58,600

machinery of cells and the news computer

290

00:13:03,270 --> 00:13:01,390

simulations to deduce what there could

291

00:13:05,730 --> 00:13:03,280

have been in the past using the tools of

292

00:13:08,550 --> 00:13:05,740

genetics and then reconstructs those

293

00:13:18,960 --> 00:13:08,560

ancient genes put them in live cells and

294

00:13:21,660 --> 00:13:18,970

see how they evolve back row dispense we

295

00:13:25,350 --> 00:13:21,670

start you can imagine that we are almost

296

00:13:28,140 --> 00:13:25,360

capturing all the languages that all the

297

00:13:29,610 --> 00:13:28,150

human populations study today this is

298

00:13:32,070 --> 00:13:29,620

similar to what we do at the DNA level

299

00:13:33,810 --> 00:13:32,080

be trying to capture all the DNA that

300

00:13:36,210 --> 00:13:33,820

belongs to all the microbial

301
00:13:38,520 --> 00:13:36,220
particularly organism studies today as

302
00:13:41,450 --> 00:13:38,530
much as we can as much as available at

303
00:13:44,310 --> 00:13:41,460
the sequence level and then we try to

304
00:13:47,460 --> 00:13:44,320
walk we walk our way back into the past

305
00:13:50,630 --> 00:13:47,470
and try to infer what the ancestral

306
00:13:53,550 --> 00:13:50,640
languages were so in some ways we are

307
00:13:57,080 --> 00:13:53,560
resurrecting ancient languages just like

308
00:14:00,570 --> 00:13:57,090
in circuits so we are trying to predict

309
00:14:02,790 --> 00:14:00,580
organisms spoke in the past and how

310
00:14:04,080 --> 00:14:02,800
deepen it is and we have a way of doing

311
00:14:05,640 --> 00:14:04,090
this in the sense that you're not

312
00:14:07,500 --> 00:14:05,650
necessarily going all the way into the

313
00:14:09,900 --> 00:14:07,510

past but you're trying to take snapshots

314

00:14:11,730 --> 00:14:09,910

between now and the past and now once

315

00:14:13,800 --> 00:14:11,740

once we reconstruct these ancestral

316

00:14:16,310 --> 00:14:13,810

genes and I need to point out that

317

00:14:18,120 --> 00:14:16,320

migrant is not the only group who are

318

00:14:20,730 --> 00:14:18,130

reconstructing ancient genes it's

319

00:14:25,800 --> 00:14:20,740

available selfish field right now but we

320

00:14:27,720 --> 00:14:25,810

are I think all of you and only these hi

321

00:14:32,490 --> 00:14:27,730

these ancient genes to understand our

322

00:14:35,520 --> 00:14:32,500

planets early condition so we focus on

323

00:14:39,540 --> 00:14:35,530

DNA and things in particular that we

324

00:14:44,730 --> 00:14:39,550

think impacted our planets as well so

325

00:14:47,010 --> 00:14:44,740

some of maybe any gloss over even the

326

00:14:49,640 --> 00:14:47,020

outside fields be listening to us right

327

00:14:52,250 --> 00:14:49,650

now they may be wondering wait a minute

328

00:14:57,269 --> 00:14:52,260

DNA and planets

329

00:14:59,790 --> 00:14:57,279

scale-wise is possible and what is yes

330

00:15:01,650 --> 00:14:59,800

I molecules are so cool it's like that

331

00:15:04,920 --> 00:15:01,660

you can expect

332

00:15:08,910 --> 00:15:04,930

diera protein molecule to impact the

333

00:15:10,889 --> 00:15:08,920

planets yeah and it's extraordinary for

334

00:15:15,340 --> 00:15:10,899

those of you who are watching make sure

335

00:15:19,910 --> 00:15:17,200

you watch on our Facebook life put them

336

00:15:22,530 --> 00:15:22,009

little bits thank you so much for all

337

00:15:24,000 --> 00:15:22,540

the

338

00:15:26,790 --> 00:15:24,010

are coming in it's awesome really

339

00:15:30,360 --> 00:15:26,800

appreciate it so last last month with

340

00:15:32,190 --> 00:15:30,370

Colin we taught about biogeochemical

341

00:15:34,830 --> 00:15:32,200

cycles how earth and life have

342

00:15:36,750 --> 00:15:34,840

co-evolved together over time and the

343

00:15:39,360 --> 00:15:36,760

air that the air on the planet has

344

00:15:41,730 --> 00:15:39,370

changed substantially and and the planet

345

00:15:43,890 --> 00:15:41,740

today would look nothing like it did if

346

00:15:46,290 --> 00:15:43,900

life had not occurred and so the tools

347

00:15:49,380 --> 00:15:46,300

you are using are able to work out some

348

00:15:52,110 --> 00:15:49,390

insights into linking the environment in

349

00:15:54,600 --> 00:15:52,120

which those bicycle products came to be

350

00:15:56,820 --> 00:15:54,610

one it won over the example is is

351

00:16:00,180 --> 00:15:56,830

nitrogen fixation so the process of

352

00:16:02,280 --> 00:16:00,190

taking very chemically stable triple

353

00:16:04,230 --> 00:16:02,290

bonded nitrogen breaking it down and

354

00:16:06,000 --> 00:16:04,240

bring it the nitrogen into the

355

00:16:07,920 --> 00:16:06,010

biological cell because nitrogen is such

356

00:16:10,590 --> 00:16:07,930

a fundamental piece of the molecular

357

00:16:12,660 --> 00:16:10,600

machinery and that needed an innovation

358

00:16:15,750 --> 00:16:12,670

in enzymes enzymes are proteins which

359

00:16:18,690 --> 00:16:15,760

your study and and you've spend a lot of

360

00:16:20,550 --> 00:16:18,700

time thinking about how is early

361

00:16:22,800 --> 00:16:20,560

molecules that were able to break down

362

00:16:27,360 --> 00:16:22,810

his nitrogen evolved over time and some

363

00:16:34,170 --> 00:16:29,910

important to note that entire field of

364

00:16:38,670 --> 00:16:34,180

geobiology also say innovated youngish

365

00:16:43,860 --> 00:16:38,680

peel and you know what does work on

366

00:16:45,630 --> 00:16:43,870

linking what entire systems right so

367

00:16:47,700 --> 00:16:45,640

what what I think my group brought into

368

00:16:50,130 --> 00:16:47,710

this is the integration of artificial

369

00:16:52,680 --> 00:16:50,140

systems artificial biology actual

370

00:16:57,890 --> 00:16:52,690

reconstruction of ancestral genes and

371

00:17:02,220 --> 00:16:57,900

also linking evolutionary biology beyond

372

00:17:04,710 --> 00:17:02,230

phylogeny beyond generating trees so the

373

00:17:07,890 --> 00:17:04,720

fact that we are able to reconstruct and

374

00:17:11,610 --> 00:17:07,900

not just a ton of these proteins but but

375

00:17:13,350 --> 00:17:11,620

make a lot and in sanskrit all the

376

00:17:15,480 --> 00:17:13,360

possibilities is i think what makes this

377

00:17:19,199 --> 00:17:15,490

area at least work for me and my group i

378

00:17:22,410 --> 00:17:19,209

think exciting is that that we are able

379

00:17:24,630 --> 00:17:22,420

to sort of unlock the the possibilities

380

00:17:26,819 --> 00:17:24,640

of biology or not his interest is

381

00:17:28,620 --> 00:17:26,829

understanding what happens that's minik

382

00:17:31,799 --> 00:17:28,630

acting and i want to know what i was

383

00:17:36,180 --> 00:17:31,809

what could m happens and why and why

384

00:17:39,210 --> 00:17:36,190

nots we do so nitrogen fixation is that

385

00:17:40,890 --> 00:17:39,220

we study right now especially my postdoc

386

00:17:42,390 --> 00:17:40,900

amanda garcia also is a NASA

387

00:17:45,870 --> 00:17:42,400

Astrobiology boss that she's done

388

00:17:48,419 --> 00:17:45,880

amazing work on this and we have some

389

00:17:50,910 --> 00:17:48,429

cool new exciting papers coming out soon

390

00:17:54,150 --> 00:17:50,920

so they are going to be able to post up

391

00:17:56,250 --> 00:17:54,160

reprints on this later that summer we

392

00:17:58,380 --> 00:17:56,260

are tackling the nitrogen fixation and

393

00:18:01,430 --> 00:17:58,390

also looking at the metals involved in

394

00:18:05,310 --> 00:18:01,440

this and try to understand how elements

395

00:18:08,580 --> 00:18:05,320

themselves were selected ultimately our

396

00:18:10,799 --> 00:18:08,590

goal is to learn from the past and it's

397

00:18:15,210 --> 00:18:10,809

linked what we learned from our planets

398

00:18:17,580 --> 00:18:15,220

past to the observations that we make at

399

00:18:20,970 --> 00:18:17,590

the stellar scale so that is sort of our

400

00:18:22,140 --> 00:18:20,980

gastronomy that comes into place we are

401
00:18:24,480 --> 00:18:22,150
working provide

402
00:18:26,340 --> 00:18:24,490
writes mean I've been asking these

403
00:18:28,110 --> 00:18:26,350
questions to people already alone in the

404
00:18:30,299 --> 00:18:28,120
universe and casters to people who are

405
00:18:32,370 --> 00:18:30,309
listening to me anyone out there who

406
00:18:34,590 --> 00:18:32,380
thinks we are not alone maybe they're

407
00:18:37,350 --> 00:18:34,600
typing right now I don't know alone in

408
00:18:39,840 --> 00:18:37,360
the universe there's always one or two

409
00:18:40,770 --> 00:18:39,850
people and this is I can statistically

410
00:18:45,480 --> 00:18:40,780
tell you

411
00:18:55,230 --> 00:18:45,490
maybe out of thousands I get who think

412
00:18:58,410 --> 00:18:55,240
that yellow this is it because we are in

413
00:19:01,290 --> 00:18:58,420

fact alone and this is only study

414

00:19:03,270 --> 00:19:01,300

biology so we all gets to our very

415

00:19:04,650 --> 00:19:03,280

existence to understand what the hell is

416

00:19:07,530 --> 00:19:04,660

going on here okay because this may be

417

00:19:11,160 --> 00:19:07,540

the only planet that you can study

418

00:19:13,350 --> 00:19:11,170

geology you can study physics Street

419

00:19:16,230 --> 00:19:13,360

anywhere in the universe but this may be

420

00:19:18,540 --> 00:19:16,240

the only planet you can study the field

421

00:19:24,420 --> 00:19:18,550

of biology which makes biology extreme

422

00:19:26,910 --> 00:19:24,430

the site so what we are trying to oh

423

00:19:28,380 --> 00:19:26,920

it's just saying like the real value of

424

00:19:30,390 --> 00:19:28,390

your science in addition to looking at

425

00:19:32,820 --> 00:19:30,400

modern biology is that the the early

426

00:19:34,170 --> 00:19:32,830

Earth is another planet essentially for

427

00:19:36,090 --> 00:19:34,180

all intent and purpose is a different

428

00:19:38,310 --> 00:19:36,100

planet than modern Earth but I was very

429

00:19:40,230 --> 00:19:38,320

much alive with biology that we know is

430

00:19:42,660 --> 00:19:40,240

there and you are looking into ways of

431

00:19:44,730 --> 00:19:42,670

how was this biology actually there and

432

00:19:47,100 --> 00:19:44,740

using those metals you are talking about

433

00:19:49,520 --> 00:19:47,110

you can collect the molecular machinery

434

00:19:51,480 --> 00:19:49,530

to the environment and thus some

435

00:19:54,150 --> 00:19:51,490

conclusions was that which I find

436

00:19:56,420 --> 00:19:54,160

fascinating so it's amazing your world

437

00:19:59,100 --> 00:19:56,430

is of ancestral gene reconstruction

438

00:20:02,070 --> 00:19:59,110

paleogenetics is linking with the

439

00:20:15,990 --> 00:20:02,080

geochemical space of geobiology it's a

440

00:20:17,880 --> 00:20:16,000

new way of thinking turn shapes proteins

441

00:20:20,130 --> 00:20:17,890

and what we can learn about environment

442

00:20:22,410 --> 00:20:20,140

itself by looking at these parties I'm

443

00:20:24,780 --> 00:20:22,420

not necessarily referring to temperature

444

00:20:27,180 --> 00:20:24,790

I mean a lot of studies that try to

445

00:20:30,270 --> 00:20:27,190

connect the ancestral proteins and dirt

446

00:20:32,430 --> 00:20:30,280

that's not what you're doing right now

447

00:20:35,190 --> 00:20:32,440

you're looking at the cofactors and the

448

00:20:37,620 --> 00:20:35,200

free metals that these ancestral

449

00:20:39,840 --> 00:20:37,630

organisms ancestral proteins are binding

450

00:20:41,610 --> 00:20:39,850

and try to make inferences about the

451
00:20:44,760 --> 00:20:41,620
environment that in which they lived

452
00:20:47,580 --> 00:20:44,770
them maybe also not understand what are

453
00:20:51,000 --> 00:20:47,590
the other possibilities and and are

454
00:20:53,370 --> 00:20:51,010
waiting for census is so well that the

455
00:20:54,300 --> 00:20:53,380
planet studies are blooming right now

456
00:20:57,570 --> 00:20:54,310
because it's three

457
00:20:59,760 --> 00:20:57,580
exciting our solar system uses when

458
00:21:02,700 --> 00:20:59,770
outside of our solar systems is even

459
00:21:04,830 --> 00:21:02,710
more exciting you know the we don't know

460
00:21:07,380 --> 00:21:04,840
the more there's work for us it's great

461
00:21:08,790 --> 00:21:07,390
right it's a great it's great to be

462
00:21:10,620 --> 00:21:08,800
nothing else because there's a lot of

463
00:21:12,570 --> 00:21:10,630

stuff we don't know about and we are

464

00:21:15,870 --> 00:21:12,580

trying to understand by treating our

465

00:21:19,020 --> 00:21:15,880

planet as an alien planet itself you're

466

00:21:22,170 --> 00:21:19,030

trying to understand the policy and

467

00:21:25,910 --> 00:21:22,180

environmental possibilities specifically

468

00:21:28,380 --> 00:21:25,920

that may give rise to like solar system

469

00:21:30,690 --> 00:21:28,390

so your molecular work has also taken

470

00:21:33,690 --> 00:21:30,700

you to understand one of the greatest

471

00:21:35,310 --> 00:21:33,700

geo bot geo biological changes of our

472

00:21:37,560 --> 00:21:35,320

planet's history which has been the rise

473

00:21:39,390 --> 00:21:37,570

of oxygen roughly halfway through

474

00:21:41,130 --> 00:21:39,400

Earth's history and in particular you're

475

00:21:44,270 --> 00:21:41,140

looking at Rubisco which is the enzyme

476

00:21:46,980 --> 00:21:44,280

involved in photosynthesis and and

477

00:21:50,610 --> 00:21:46,990

through that you've been looking at the

478

00:21:55,580 --> 00:21:50,620

pigmentation of these bugs and pigments

479

00:22:04,730 --> 00:21:57,290

the case early on is that where your

480

00:22:06,680 --> 00:22:04,740

research has been taking you but not

481

00:22:08,720 --> 00:22:06,690

necessarily of anyone in my group that

482

00:22:09,200 --> 00:22:08,730

we don't we didn't pick anything that's

483

00:22:11,390 --> 00:22:09,210

easy

484

00:22:13,220 --> 00:22:11,400

so we know Bisco is the misko is a

485

00:22:16,000 --> 00:22:13,230

kingdom is that the same with

486

00:22:18,910 --> 00:22:16,010

heterogeneous it's not maybe

487

00:22:21,260 --> 00:22:18,920

straightforward to study this enzyme

488

00:22:26,150 --> 00:22:21,270

biochemically or at the organismic level

489

00:22:29,150 --> 00:22:26,160

the engine mod bacterial sufficient

490

00:22:32,300 --> 00:22:29,160

abisco sequences that that we infer to

491

00:22:34,100 --> 00:22:32,310

have existed prior to oxidation so

492

00:22:38,330 --> 00:22:34,110

you're talking about three million year

493

00:22:41,960 --> 00:22:38,340

old proteins that we think has impacted

494

00:22:44,120 --> 00:22:41,970

our planets in very fundamental way so

495

00:22:46,340 --> 00:22:44,130

one of them and we're doing a lot of

496

00:22:49,280 --> 00:22:46,350

work with pigments these days so not

497

00:22:52,370 --> 00:22:49,290

necessarily pigment that is generated by

498

00:22:55,550 --> 00:22:52,380

the cyanobacteria but actual protein

499

00:22:59,510 --> 00:22:55,560

pigments and how they may have impacted

500

00:23:04,280 --> 00:22:59,520

the entire ocean entire planets in that

501
00:23:06,680 --> 00:23:04,290
way any color they may have being away

502
00:23:11,330 --> 00:23:06,690
say three billion years are they the

503
00:23:14,080 --> 00:23:11,340
same difference the work is getting and

504
00:23:18,010 --> 00:23:14,090
it is definitely interesting because we

505
00:23:22,070 --> 00:23:18,020
this is why there's no box outside the

506
00:23:27,920 --> 00:23:22,080
box and and the comfort zone doesn't

507
00:23:30,020 --> 00:23:27,930
exist anymore so luckily astrobiology

508
00:23:34,070 --> 00:23:30,030
and extremely you know multidisciplinary

509
00:23:36,080 --> 00:23:34,080
cross-disciplinary science so be talking

510
00:23:38,600 --> 00:23:36,090
to an oceanographer talking to an

511
00:23:41,570 --> 00:23:38,610
astronomer at planetary scientists and

512
00:23:44,660 --> 00:23:41,580
norm for us we learned the language so

513
00:23:46,070 --> 00:23:44,670

to speak over these years and we sort of

514

00:23:47,920 --> 00:23:46,080

get together and try to take all these

515

00:23:51,140 --> 00:23:47,930

problems together

516

00:23:53,090 --> 00:23:51,150

so from this pigmentation of life in the

517

00:23:55,250 --> 00:23:53,100

oceans this is really important for the

518

00:23:56,990 --> 00:23:55,260

remote detection of life on potential

519

00:23:59,240 --> 00:23:57,000

other worlds tell us a little bit about

520

00:24:00,620 --> 00:23:59,250

how your science ties to the world of

521

00:24:04,130 --> 00:24:00,630

exoplanets that you've been mentioning

522

00:24:06,230 --> 00:24:04,140

it is not I should point out that our

523

00:24:07,790 --> 00:24:06,240

technology that will allow us to even

524

00:24:09,800 --> 00:24:07,800

take a picture of another planet

525

00:24:11,960 --> 00:24:09,810

outside of our solar system if you're

526
00:24:14,360 --> 00:24:11,970
not there yet right so we cannot do that

527
00:24:15,980 --> 00:24:14,370
right now so be but is it gloom I guess

528
00:24:17,930 --> 00:24:15,990
we are preparing for the time that

529
00:24:20,750 --> 00:24:17,940
because that will come it may take us

530
00:24:22,370 --> 00:24:20,760
two decades to entirely understand what

531
00:24:24,710 --> 00:24:22,380
it planted outside of our solar system

532
00:24:26,570 --> 00:24:24,720
what the actual color might be but we

533
00:24:28,790 --> 00:24:26,580
will get there so once we are there I

534
00:24:31,340 --> 00:24:28,800
want the research that we produced to be

535
00:24:33,410 --> 00:24:31,350
useful so we are sort of investing in a

536
00:24:36,470 --> 00:24:33,420
decade from now where we will be able to

537
00:24:38,510 --> 00:24:36,480
detect and observe planets outside of

538
00:24:42,800 --> 00:24:38,520

our solar system even better than being

539

00:24:46,130 --> 00:24:42,810

said we are sort of getting ready for a

540

00:24:48,260 --> 00:24:46,140

planet that may be present but again the

541

00:24:50,120 --> 00:24:48,270

whole premise here is that we are

542

00:24:53,300 --> 00:24:50,130

looking for alien life but our own

543

00:24:55,190 --> 00:24:53,310

planets past is and I think biologists

544

00:24:57,890 --> 00:24:55,200

we need more biologists to study these

545

00:25:00,110 --> 00:24:57,900

problems we you know we don't I think

546

00:25:02,810 --> 00:25:00,120

truly appreciates in the education of

547

00:25:04,520 --> 00:25:02,820

molecular biology and I get this a lot

548

00:25:08,690 --> 00:25:04,530

because I'm teaching molecular G to

549

00:25:10,490 --> 00:25:08,700

undergrads and appreciate that we are

550

00:25:13,010 --> 00:25:10,500

products of billions of years of

551
00:25:15,050 --> 00:25:13,020
evolution at the end and and if we

552
00:25:19,550 --> 00:25:15,060
really want to find life outside of our

553
00:25:21,370 --> 00:25:19,560
solar system or out there it to

554
00:25:26,590 --> 00:25:21,380
understand two main things we need to

555
00:25:32,420 --> 00:25:29,660
occupied our entire planet but we also

556
00:25:34,790 --> 00:25:32,430
understand how life originated I am

557
00:25:36,290 --> 00:25:34,800
likely that without solving the original

558
00:25:39,500 --> 00:25:36,300
five problem we will never be able to

559
00:25:41,390 --> 00:25:39,510
fight back we have to find and make we

560
00:25:44,030 --> 00:25:41,400
need to make life and you know emerge

561
00:25:47,000 --> 00:25:44,040
it's our towels I think that's it

562
00:25:50,300 --> 00:25:47,010
I think I say that and understand the

563
00:25:52,220 --> 00:25:50,310

conditions that can Harbor life okay so

564

00:25:55,070 --> 00:25:52,230

we I think for a long time we thought

565

00:25:57,020 --> 00:25:55,080

that we will be able to do it I think

566

00:25:58,880 --> 00:25:57,030

about all the you know we've been asking

567

00:26:01,520 --> 00:25:58,890

the complex started and already alone in

568

00:26:04,670 --> 00:26:01,530

this universe sport as long as we gained

569

00:26:08,150 --> 00:26:04,680

consciousness as humanity Videl force

570

00:26:10,520 --> 00:26:08,160

Aristotle I look at how things changing

571

00:26:12,440 --> 00:26:10,530

how the evolution happens and then it

572

00:26:15,170 --> 00:26:12,450

comes you know we stole the structure of

573

00:26:17,990 --> 00:26:15,180

DNA right it rosalind Franklin taking

574

00:26:21,450 --> 00:26:18,000

picture showing us how molecules inside

575

00:26:24,779 --> 00:26:21,460

the cell very code that

576

00:26:28,799 --> 00:26:24,789

the entire structure possible it's the

577

00:26:31,019 --> 00:26:28,809

entire world around us had looks like

578

00:26:33,299 --> 00:26:31,029

maybe took these pictures and that comes

579

00:26:37,620 --> 00:26:33,309

Miller and Urey they're very able to

580

00:26:40,169 --> 00:26:37,630

spark electric and heat and and simulate

581

00:26:43,320 --> 00:26:40,179

an environment that made that maybe like

582

00:26:46,139 --> 00:26:43,330

ancient planet and able to make on

583

00:26:48,570 --> 00:26:46,149

questions that are very founders of the

584

00:26:51,299 --> 00:26:48,580

cells the building blocks and I think we

585

00:26:53,789 --> 00:26:51,309

thought okay we got this can we can we

586

00:26:57,630 --> 00:26:53,799

can you know how change happens we

587

00:27:00,690 --> 00:26:57,640

understand that complexity works maybe a

588

00:27:03,860 --> 00:27:00,700

little bit it's not to speculate we can

589

00:27:10,700 --> 00:27:03,870

take picture we can do look at DNA

590

00:27:19,470 --> 00:27:16,110

I think we got today

591

00:27:24,120 --> 00:27:19,480

we didn't right so it really reeks it

592

00:27:25,889 --> 00:27:24,130

was 60s we have an East we have a fate

593

00:27:29,399 --> 00:27:25,899

like with over 50 years now you're stuck

594

00:27:32,730 --> 00:27:29,409

there too it's important to realize that

595

00:27:36,029 --> 00:27:32,740

it's literally hundreds of years of

596

00:27:40,169 --> 00:27:36,039

thinking and thinking and doing that

597

00:27:42,029 --> 00:27:40,179

enabled us to finally come to 2020 and

598

00:27:44,130 --> 00:27:42,039

you argue that we are so close to

599

00:27:47,340 --> 00:27:44,140

solving the problem of version of life I

600

00:27:49,440 --> 00:27:47,350

think we are really close but I think

601
00:27:51,690 --> 00:27:49,450
we're a bit flip ourselves that we

602
00:27:55,080 --> 00:27:51,700
thought this would be easy and now we

603
00:27:56,700 --> 00:27:55,090
know it's far from it's it's not only

604
00:27:58,950 --> 00:27:56,710
understanding how those prebiotic

605
00:28:00,450 --> 00:27:58,960
molecules came to be and how they

606
00:28:02,279 --> 00:28:00,460
transition to become biological

607
00:28:05,940 --> 00:28:02,289
molecules but also in what environment

608
00:28:07,470 --> 00:28:05,950
did they interact in to allow that

609
00:28:09,419 --> 00:28:07,480
communication and sharing of information

610
00:28:11,039 --> 00:28:09,429
which is fascinating and I wish we had

611
00:28:13,860 --> 00:28:11,049
more time to talk about this I do want

612
00:28:15,690 --> 00:28:13,870
to transition to one of the aspects that

613
00:28:17,880 --> 00:28:15,700

makes you stand out as the scientist is

614

00:28:19,799 --> 00:28:17,890

that you are also very passionate about

615

00:28:21,720 --> 00:28:19,809

public engagement about communicating

616

00:28:24,120 --> 00:28:21,730

science to the public after all you're a

617

00:28:25,289 --> 00:28:24,130

co-founder of signator org the platform

618

00:28:27,210 --> 00:28:25,299

on which you are currently live

619

00:28:29,820 --> 00:28:27,220

streaming so it's fantastic to have you

620

00:28:32,490 --> 00:28:29,830

as a guest on the program and you've

621

00:28:42,100 --> 00:28:32,500

been involved for for this and as far as

622

00:28:48,370 --> 00:28:45,730

I am a product of public engagements

623

00:28:49,720 --> 00:28:48,380

myself right so when I the program that

624

00:28:51,310 --> 00:28:49,730

I applied to his laundry grade was

625

00:28:55,120 --> 00:28:51,320

founded by Harvard Hughes Medical

626
00:28:58,840 --> 00:28:55,130
Institute and and it enabled me to spend

627
00:29:02,919 --> 00:28:58,850
a summer in a lab and do research at

628
00:29:04,960 --> 00:29:02,929
that time I was trying to synthesize go

629
00:29:06,880 --> 00:29:04,970
back there isn't a lot specifically

630
00:29:09,370 --> 00:29:06,890
riboflavin analogs and I quickly

631
00:29:12,700 --> 00:29:09,380
realized that I respect organic chemists

632
00:29:15,129 --> 00:29:12,710
but it's not for me I can't do it so but

633
00:29:17,919 --> 00:29:15,139
but it was a product of public outreach

634
00:29:20,379 --> 00:29:17,929
that gave me the sense of what I can or

635
00:29:22,090 --> 00:29:20,389
cannot do and make me feel that feel

636
00:29:27,250 --> 00:29:22,100
like I belong and I have a place in

637
00:29:30,220 --> 00:29:27,260
science I think that sort of deals and

638
00:29:32,350 --> 00:29:30,230

it saddens me that still you know ten

639

00:29:35,049 --> 00:29:32,360

years since then maybe actually more

640

00:29:37,889 --> 00:29:35,059

than that 16 years we are still hearing

641

00:29:40,930 --> 00:29:37,899

from young scholars that they have this

642

00:29:45,190 --> 00:29:40,940

inability to imagine themselves as a

643

00:29:50,169 --> 00:29:45,200

part of scientific rigor if you are

644

00:29:58,470 --> 00:29:53,299

so

645

00:30:00,810 --> 00:29:58,480

science and science scientists might be

646

00:30:03,930 --> 00:30:00,820

doesn't matter it's their problem not

647

00:30:07,470 --> 00:30:03,940

yours right so I am a product of that

648

00:30:09,390 --> 00:30:07,480

sort of grassroots outreach its Emory

649

00:30:12,360 --> 00:30:09,400

and I think we all have some person that

650

00:30:14,700 --> 00:30:12,370

changed the way we think but pet

651
00:30:18,240 --> 00:30:14,710
Patricia Marsteller she was the leading

652
00:30:19,260 --> 00:30:18,250
a person for this group and even though

653
00:30:22,470 --> 00:30:19,270
she was coming from another country

654
00:30:24,450 --> 00:30:22,480
right I'm Turkish she's from Georgia

655
00:30:27,000 --> 00:30:24,460
Atlanta you know right completely

656
00:30:29,460 --> 00:30:27,010
different part of the world I deleted to

657
00:30:31,350 --> 00:30:29,470
her and it was fascinating to me that

658
00:30:33,780 --> 00:30:31,360
there are things that are beyond the

659
00:30:37,950 --> 00:30:33,790
languages and cultures and our futures

660
00:30:40,530 --> 00:30:37,960
that connect us as humanity and because

661
00:30:43,080 --> 00:30:40,540
I think I was very aware that my

662
00:30:45,390 --> 00:30:43,090
presence in science is a product of my

663
00:30:49,220 --> 00:30:45,400

engagements and outreach

664

00:30:52,470 --> 00:30:49,230

I never even thought about it being a

665

00:30:55,770 --> 00:30:52,480

job or a task it's a natural thing for

666

00:30:58,890 --> 00:30:55,780

that I feel that it's my job now to give

667

00:31:02,130 --> 00:30:58,900

back so I always did voluntary

668

00:31:04,140 --> 00:31:02,140

activities in in calling it's a graduate

669

00:31:06,840 --> 00:31:04,150

school as a graduate students I was

670

00:31:07,919 --> 00:31:06,850

teaching in Decatur Georgia there was a

671

00:31:10,140 --> 00:31:07,929

high school there indicator of high

672

00:31:11,790 --> 00:31:10,150

school so I did I was partnered to be

673

00:31:14,370 --> 00:31:11,800

the high school teacher the thoughts

674

00:31:16,520 --> 00:31:14,380

physics and chemistry for one year which

675

00:31:19,620 --> 00:31:16,530

changed a lot of things for me

676

00:31:23,000 --> 00:31:19,630

understand I

677

00:31:26,550 --> 00:31:23,010

was mind blown to see kids who live in

678

00:31:29,160 --> 00:31:26,560

Atlanta Georgia cannot show me by Canada

679

00:31:31,230 --> 00:31:29,170

that that was a very eye-opening

680

00:31:34,080 --> 00:31:31,240

experience for me and all these things

681

00:31:36,930 --> 00:31:34,090

made me realize that I belong here even

682

00:31:40,290 --> 00:31:36,940

more that I have a job a mission and

683

00:31:43,320 --> 00:31:40,300

that is to teach science and instead is

684

00:31:49,380 --> 00:31:43,330

a product of death honey that we started

685

00:31:51,600 --> 00:31:49,390

this I think 2011 and it was me being

686

00:31:53,220 --> 00:31:51,610

away from my own home country I don't

687

00:31:55,820 --> 00:31:53,230

want to do get this right I realized

688

00:31:58,230 --> 00:31:55,830

that they're only in Turkey wants to

689

00:32:00,330 --> 00:31:58,240

watch astrobiology meetings but they

690

00:32:03,320 --> 00:32:00,340

have no way of doing that so we started

691

00:32:05,760 --> 00:32:03,330

an online group to bring science to

692

00:32:08,880 --> 00:32:05,770

everybody and look at where we are now

693

00:32:11,450 --> 00:32:08,890

it's really amazing there's so many more

694

00:32:16,039 --> 00:32:14,570

stop being selfish and open up the floor

695

00:32:18,260 --> 00:32:16,049

to the questions which is my one of my

696

00:32:19,580 --> 00:32:18,270

favorite part of the show so let's head

697

00:32:20,960 --> 00:32:19,590

and get started thank you all so much

698

00:32:23,360 --> 00:32:20,970

for submitting your questions please

699

00:32:25,549 --> 00:32:23,370

keep them coming use hashtag ask as for

700

00:32:27,230 --> 00:32:25,559

bio on Twitter or put them on the chat

701
00:32:28,610 --> 00:32:27,240
on Signet org if you're watching on

702
00:32:29,899 --> 00:32:28,620
Facebook live put them down in the

703
00:32:32,090 --> 00:32:29,909
comments we're listening we're hearing

704
00:32:35,779 --> 00:32:32,100
you and okay b2 so are you ready

705
00:32:38,600 --> 00:32:35,789
the first question comes from @astro

706
00:32:40,460 --> 00:32:38,610
sociology gym pass on twitter and he

707
00:32:42,590 --> 00:32:40,470
asks what are your thoughts about how

708
00:32:44,840 --> 00:32:42,600
social scientists can participate more

709
00:32:46,250 --> 00:32:44,850
extensively in astrobiology research so

710
00:32:47,899 --> 00:32:46,260
that the societal implications of

711
00:32:50,779 --> 00:32:47,909
astrobiology and SETI can become more

712
00:32:56,419 --> 00:32:50,789
mainstream considerations alongside stem

713
00:32:59,720 --> 00:32:56,429

issues my field so I wouldn't know with

714

00:33:02,060 --> 00:32:59,730

the goal of it or social science would

715

00:33:06,289 --> 00:33:02,070

be to in fact increase the awareness of

716

00:33:08,330 --> 00:33:06,299

science studies or just keep a record of

717

00:33:12,620 --> 00:33:08,340

what's what has been happening so I'm

718

00:33:15,260 --> 00:33:12,630

familiar with studies of dr. Sophia

719

00:33:18,950 --> 00:33:15,270

roost she is an anthropology professor

720

00:33:21,289 --> 00:33:18,960

and so she wrote really remarkable

721

00:33:25,610 --> 00:33:21,299

articles about how astrobiologists go to

722

00:33:28,789 --> 00:33:25,620

field sites and study life and so there

723

00:33:32,269 --> 00:33:28,799

there's been some efforts towards so

724

00:33:34,639 --> 00:33:32,279

documenting what astrobiologists do that

725

00:33:36,560 --> 00:33:34,649

being said I think we need definitely

726

00:33:39,470 --> 00:33:36,570

definitely we need social scientists to

727

00:33:42,019 --> 00:33:39,480

that that a newbie presence with us

728

00:33:44,320 --> 00:33:42,029

right now and you know are saying I

729

00:33:47,630 --> 00:33:44,330

didn't know who is in Turkey right now

730

00:33:50,060 --> 00:33:47,640

has also been sort out studying how

731

00:33:51,710 --> 00:33:50,070

astrobiologists communicate and

732

00:33:53,720 --> 00:33:51,720

collaborate but I think the question is

733

00:33:55,760 --> 00:33:53,730

a bit broader than this and I think it's

734

00:33:57,799 --> 00:33:55,770

deeper that the question is you know how

735

00:34:00,830 --> 00:33:57,809

so said that whether the social studies

736

00:34:02,779 --> 00:34:00,840

can be even more recognized part of the

737

00:34:06,049 --> 00:34:02,789

Austral biology studies and I will say

738

00:34:08,690 --> 00:34:06,059

yes there are a lot of new astrobiology

739

00:34:10,190 --> 00:34:08,700

centers being formed right now it's an

740

00:34:11,990 --> 00:34:10,200

interesting you know a very exciting

741

00:34:15,050 --> 00:34:12,000

time for astrobiology field as a whole

742

00:34:16,280 --> 00:34:15,060

so if you're interested in so there's

743

00:34:18,649 --> 00:34:16,290

more social sciences part of

744

00:34:21,710 --> 00:34:18,659

astrobiology I recommend that you get in

745

00:34:23,480 --> 00:34:21,720

touch with scientists who are needy who

746

00:34:24,440 --> 00:34:23,490

are participating in these NASA notes

747

00:34:26,540 --> 00:34:24,450

and

748

00:34:29,000 --> 00:34:26,550

pitch time your idea I think we could we

749

00:34:30,470 --> 00:34:29,010

could all use someone who is definitely

750

00:34:32,149 --> 00:34:30,480

thinking there could be than us

751

00:34:33,770 --> 00:34:32,159

not even as a scientist with the

752

00:34:37,069 --> 00:34:33,780

broadest Ehrman as a part of social

753

00:34:39,859 --> 00:34:37,079

sciences so definitely is thank you

754

00:34:44,119 --> 00:34:39,869

the next question comes from a peer ekk

755

00:34:47,480 --> 00:34:44,129

who tweets as at Duke McCollum's and he

756

00:34:54,740 --> 00:34:47,490

or she asks who was or what was your

757

00:34:59,150 --> 00:34:54,750

biggest inspiration for me to pin it to

758

00:35:02,079 --> 00:34:59,160

a certain person but I would say that it

759

00:35:04,190 --> 00:35:02,089

was more about what's happened around me

760

00:35:09,079 --> 00:35:04,200

collectively I grew up in an environment

761

00:35:11,180 --> 00:35:09,089

by remembrance given the privilege and I

762

00:35:14,440 --> 00:35:11,190

will argue that it is a privilege to

763

00:35:17,930 --> 00:35:14,450

receive education and not everybody can

764

00:35:20,510 --> 00:35:17,940

receive it really 91 top level but in

765

00:35:22,790 --> 00:35:20,520

education it's still a problem in our

766

00:35:25,400 --> 00:35:22,800

world unfortunately so I think seeing

767

00:35:32,300 --> 00:35:25,410

what was not given to them and drove me

768

00:35:34,280 --> 00:35:32,310

to get get it all I was women in my

769

00:35:36,920 --> 00:35:34,290

family they did not have any diploma so

770

00:35:39,920 --> 00:35:36,930

I always joked that I I acquired enough

771

00:35:41,270 --> 00:35:39,930

diploma for everybody for all the people

772

00:35:44,300 --> 00:35:41,280

that couldn't go to school I have a

773

00:35:47,030 --> 00:35:44,310

degree so I was just really driven to

774

00:35:50,809 --> 00:35:47,040

have my own life my own path is a woman

775

00:35:52,640 --> 00:35:50,819

and I so education is the only way to

776

00:35:56,359 --> 00:35:52,650

achieve that for myself thank you for

777

00:35:58,010 --> 00:35:56,369

the question using that article that you

778

00:35:59,569 --> 00:35:58,020

were featured in by UN women you have

779

00:36:01,790 --> 00:35:59,579

another good quote in there that says

780

00:36:03,859 --> 00:36:01,800

your armor your knowledge is your armor

781

00:36:07,640 --> 00:36:03,869

and that ties very well to that answer

782

00:36:09,290 --> 00:36:07,650

thank you again and Sarah had set Jen on

783

00:36:11,780 --> 00:36:09,300

say Gannett asks what are you taking

784

00:36:14,210 --> 00:36:11,790

your experimental evolution research and

785

00:36:22,040 --> 00:36:14,220

placing those cells in a paleo

786

00:36:25,430 --> 00:36:22,050

environmental setting the quick answer

787

00:36:29,150 --> 00:36:25,440

is yes we are simulating ancient earth

788

00:36:32,510 --> 00:36:29,160

conditions while once we open the lab

789

00:36:35,690 --> 00:36:32,520

again the goal is to see how the

790

00:36:37,339 --> 00:36:35,700

bacteria engineer ancient components

791

00:36:39,410 --> 00:36:37,349

respond to the environment

792

00:36:43,849 --> 00:36:39,420

that means minute ancient conditions as

793

00:36:46,460 --> 00:36:43,859

well thank you the next question comes

794

00:36:49,609 --> 00:36:46,470

from Marian Denton who tweets as at

795

00:36:51,920 --> 00:36:49,619

Astro underscore limb no and she asks

796

00:36:56,329 --> 00:36:51,930

whether finding a piece of genetic code

797

00:36:58,460 --> 00:36:56,339

RNA or DNA or structure like it be

798

00:37:01,309 --> 00:36:58,470

considered on another world would it be

799

00:37:03,739 --> 00:37:01,319

considered as an evidence of life that's

800

00:37:07,099 --> 00:37:03,749

a very good question and so I will

801
00:37:09,859 --> 00:37:07,109
response by quoting Prasad ami who

802
00:37:12,859 --> 00:37:09,869
studies not by them on many other things

803
00:37:15,079 --> 00:37:12,869
he talks about finding a screwdriver on

804
00:37:18,680 --> 00:37:15,089
Mars right so if you find a screwdriver

805
00:37:21,200 --> 00:37:18,690
on Mars will you be convinced that there

806
00:37:25,249 --> 00:37:21,210
was life or is life on this planet so to

807
00:37:26,710 --> 00:37:25,259
me finding DNA or RNA or any molecule

808
00:37:30,529 --> 00:37:26,720
that is familiar to us inside a

809
00:37:32,719 --> 00:37:30,539
biological cell on planet Earth is like

810
00:37:34,190 --> 00:37:32,729
finding a screwdriver on somewhere else

811
00:37:37,339 --> 00:37:34,200
how did it get here

812
00:37:39,799 --> 00:37:37,349
it isn't it's so hard to synthesize

813
00:37:41,569 --> 00:37:39,809

these these molecules let alone use them

814

00:37:44,029 --> 00:37:41,579

as an information system that we see in

815

00:37:47,390 --> 00:37:44,039

the cell today so I will argue that yes

816

00:37:49,430 --> 00:37:47,400

finding piece DNA or RNA it's definitely

817

00:37:51,979 --> 00:37:49,440

gonna be we will be really close to

818

00:37:54,140 --> 00:37:51,989

finding what if you find DNA somewhere

819

00:37:58,729 --> 00:37:54,150

else regardless of the context that it

820

00:38:00,829 --> 00:37:58,739

is it is in our planet bring it there

821

00:38:02,029 --> 00:38:00,839

it's like finding a hard drive in

822

00:38:03,589 --> 00:38:02,039

another world right the density of

823

00:38:05,900 --> 00:38:03,599

information that's in these molecules

824

00:38:07,609 --> 00:38:05,910

are just it has to be something more

825

00:38:08,749 --> 00:38:07,619

than just a natural setting but who

826

00:38:10,089 --> 00:38:08,759

knows right I don't think our

827

00:38:12,140 --> 00:38:10,099

imagination is broad enough to

828

00:38:13,670 --> 00:38:12,150

categorize all the different

829

00:38:15,680 --> 00:38:13,680

possibilities anyway so the next

830

00:38:18,890 --> 00:38:15,690

question comes from Allah and on Twitter

831

00:38:20,269 --> 00:38:18,900

who tweets us at they say is Ibrahim and

832

00:38:22,099 --> 00:38:20,279

we were talking about sign a big

833

00:38:25,039 --> 00:38:22,109

bacteria and how their parent parts of

834

00:38:27,049 --> 00:38:25,049

plants today and so he or she asks are

835

00:38:33,739 --> 00:38:27,059

they are there any plant species that

836

00:38:35,539 --> 00:38:33,749

can be grown in space International

837

00:38:39,890 --> 00:38:35,549

Space Station that's also in space or

838

00:38:40,609 --> 00:38:39,900

any planet so for the ISS absolutely I

839

00:38:43,400 --> 00:38:40,619

don't see why not

840

00:38:45,109 --> 00:38:43,410

and but poor and there are studies

841

00:38:47,870 --> 00:38:45,119

towards this and there are work again

842

00:38:49,729 --> 00:38:47,880

towards understanding the conditions

843

00:38:50,900 --> 00:38:49,739

that we need to create if you were to

844

00:38:54,170 --> 00:38:50,910

grow plan

845

00:38:55,579 --> 00:38:54,180

different plants there are not just

846

00:38:57,049 --> 00:38:55,589

scientific by the way I know a lot of

847

00:38:59,000 --> 00:38:57,059

artists are also thinking about these

848

00:39:05,510 --> 00:38:59,010

things there's a really fascinating

849

00:39:08,000 --> 00:39:05,520

group United Kingdom that are creating

850

00:39:08,599 --> 00:39:08,010

exhibition is about sort of imagining

851
00:39:11,990 --> 00:39:08,609
the future

852
00:39:13,940 --> 00:39:12,000
imagining plants on different planets so

853
00:39:15,529 --> 00:39:13,950
yes that there now may be possibilities

854
00:39:20,720 --> 00:39:15,539
but we are not there yet

855
00:39:23,630 --> 00:39:20,730
I thank you the next question comes from

856
00:39:26,299 --> 00:39:23,640
Murphy and dad on say Gannett who asks

857
00:39:28,339 --> 00:39:26,309
is it possible to create the Jima genome

858
00:39:35,510 --> 00:39:28,349
of the simplest cell that can survive

859
00:39:37,760 --> 00:39:35,520
I'm in silico only okay so there are

860
00:39:39,920 --> 00:39:37,770
studies that are done by craig Venter

861
00:39:43,490 --> 00:39:39,930
for example student ecologists that try

862
00:39:44,650 --> 00:39:43,500
to create methods to synthesize genomes

863
00:39:47,839 --> 00:39:44,660

bunk

864

00:39:49,730 --> 00:39:47,849

yes yes I want to say scratch but it's

865

00:39:51,920 --> 00:39:49,740

not necessarily scratch right because

866

00:39:54,849 --> 00:39:51,930

reliant on other organisms genome is a

867

00:39:57,740 --> 00:39:54,859

tablet that means that there are many

868

00:39:59,809 --> 00:39:57,750

facets to this question number one is

869

00:40:01,789 --> 00:39:59,819

that what is the simplest organism are

870

00:40:04,010 --> 00:40:01,799

you talking about the simplest microbe

871

00:40:06,230 --> 00:40:04,020

that we have like a micro plasma or

872

00:40:07,730 --> 00:40:06,240

something like that we have today or are

873

00:40:10,240 --> 00:40:07,740

you be talking about engineering

874

00:40:13,069 --> 00:40:10,250

organism that will have the minimal

875

00:40:16,460 --> 00:40:13,079

components that will give rise to any

876

00:40:19,609 --> 00:40:16,470

living cell yes the minimal components

877

00:40:21,260 --> 00:40:19,619

so if the if the aspect is number two we

878

00:40:23,450 --> 00:40:21,270

are not there yet and the problem is

879

00:40:26,450 --> 00:40:23,460

don't quite understand what exactly

880

00:40:29,150 --> 00:40:26,460

needs to be in this bag and by that I

881

00:40:31,819 --> 00:40:29,160

mean that the cell itself that will be

882

00:40:34,010 --> 00:40:31,829

minimal but still gave life give rise to

883

00:40:35,539 --> 00:40:34,020

life what is it that we're trying to see

884

00:40:38,150 --> 00:40:35,549

so there's a lot of work towards

885

00:40:39,200 --> 00:40:38,160

protocells in that aspect we are not

886

00:40:42,710 --> 00:40:39,210

there yet right we didn't make any

887

00:40:44,859 --> 00:40:42,720

evolving life like protocell a system

888

00:40:48,650 --> 00:40:44,869

that has information in itself

889

00:40:50,930 --> 00:40:48,660

encapsulated however there is definitely

890

00:40:53,630 --> 00:40:50,940

work towards creating

891

00:40:55,670 --> 00:40:53,640

early cells that are that don't have

892

00:40:57,260 --> 00:40:55,680

genomes that are not like what we see

893

00:40:58,760 --> 00:40:57,270

today by the way I don't think it's

894

00:41:02,269 --> 00:40:58,770

gonna be like but bacteria has you're

895

00:41:03,460 --> 00:41:02,279

talking a lot simpler maybe that's a

896

00:41:14,420 --> 00:41:03,470

couple hundred

897

00:41:17,440 --> 00:41:14,430

Jeanne's is very different so thank you

898

00:41:20,480 --> 00:41:17,450

the next question comes from Twitter

899

00:41:22,640 --> 00:41:20,490

freaking Kenobi as at space engineer

900

00:41:24,200 --> 00:41:22,650

asks the following question and he asked

901
00:41:26,480 --> 00:41:24,210
it in Turkish and I would say a big

902
00:41:28,160 --> 00:41:26,490
thank you to a professor our sivaiah

903
00:41:30,080 --> 00:41:28,170
Dino blue who has helped us translating

904
00:41:32,330 --> 00:41:30,090
live these questions if you're watching

905
00:41:35,750 --> 00:41:32,340
our server thank you very much and and

906
00:41:37,790 --> 00:41:35,760
thank you he so at space engineer asks

907
00:41:45,440 --> 00:41:37,800
what steps should a person who wants to

908
00:41:47,870 --> 00:41:45,450
become an astrobiologist follow because

909
00:41:49,850 --> 00:41:47,880
I get that question a lot so first of

910
00:41:52,570 --> 00:41:49,860
all there are resources there are posted

911
00:41:55,040 --> 00:41:52,580
by NASA Astrobiology Institute online

912
00:41:56,930 --> 00:41:55,050
that shows different paths that can take

913
00:42:00,080 --> 00:41:56,940

you to study astrobiology but I'll give

914

00:42:02,090 --> 00:42:00,090

the broadest answer possible that you

915

00:42:04,010 --> 00:42:02,100

don't need to replicate someone else's

916

00:42:06,500 --> 00:42:04,020

trajectory if you do what you want to do

917

00:42:07,730 --> 00:42:06,510

at the end so that means that because I

918

00:42:09,560 --> 00:42:07,740

studied chemistry and I need

919

00:42:11,000 --> 00:42:09,570

biochemistry and then in your biology

920

00:42:13,060 --> 00:42:11,010

you don't need to necessarily follow

921

00:42:16,670 --> 00:42:13,070

these steps to study the questions that

922

00:42:19,280 --> 00:42:16,680

we do if you are interested in a basic

923

00:42:22,220 --> 00:42:19,290

scientific field physics geology

924

00:42:25,490 --> 00:42:22,230

astronomy chemistry whatever it might

925

00:42:26,840 --> 00:42:25,500

not be do that and then you will find

926

00:42:28,610 --> 00:42:26,850

that there are questions that you can

927

00:42:30,860 --> 00:42:28,620

answer that are related to astrobiology

928

00:42:34,460 --> 00:42:30,870

that are embedded in these basic areas

929

00:42:36,650 --> 00:42:34,470

of research I think one aspect that kids

930

00:42:39,860 --> 00:42:36,660

are maybe you're not emphasizing it's

931

00:42:43,160 --> 00:42:39,870

not a disaster biologists that you need

932

00:42:45,620 --> 00:42:43,170

to have a home discipline and excelled

933

00:42:47,600 --> 00:42:45,630

in that so whatever you do if it is

934

00:42:50,050 --> 00:42:47,610

biochemistry I need to be an excellent

935

00:42:52,730 --> 00:42:50,060

biochemist and then build astrobiology

936

00:42:55,310 --> 00:42:52,740

so you need to have a core area of

937

00:42:57,590 --> 00:42:55,320

research could be microbiology you know

938

00:42:59,180 --> 00:42:57,600

could be geology you could be paleo

939

00:43:01,730 --> 00:42:59,190

biology whatever it may be

940

00:43:04,040 --> 00:43:01,740

excel in that and then apply your

941

00:43:06,170 --> 00:43:04,050

technique and your methods to questions

942

00:43:08,720 --> 00:43:06,180

related to astrobiology because

943

00:43:10,910 --> 00:43:08,730

Australia is not necessarily a major

944

00:43:12,830 --> 00:43:10,920

right right now nobody offers that we

945

00:43:16,320 --> 00:43:12,840

may do it here anyway but you're not

946

00:43:17,730 --> 00:43:16,330

there yet so follow the

947

00:43:21,180 --> 00:43:17,740

area that you are really passionate

948

00:43:22,800 --> 00:43:21,190

about and then apply what you make or

949

00:43:24,870 --> 00:43:22,810

iron your skills and your knowledge

950

00:43:26,400 --> 00:43:24,880

towards questions related to

951
00:43:28,950 --> 00:43:26,410
astrobiology because there is room for

952
00:43:31,950 --> 00:43:28,960
everybody in this field we are not

953
00:43:33,810 --> 00:43:31,960
running short of questions we have so

954
00:43:36,690 --> 00:43:33,820
much to figure out altogether and we

955
00:43:37,920 --> 00:43:36,700
will need all of you yeah big enough to

956
00:43:39,090 --> 00:43:37,930
buy out this is really about the

957
00:43:41,250 --> 00:43:39,100
questions you ask

958
00:43:43,830 --> 00:43:41,260
not necessarily the science you do so a

959
00:43:45,660 --> 00:43:43,840
great answer vitriol thank you the next

960
00:43:48,960 --> 00:43:45,670
question comes from hello Smithers on

961
00:43:50,670 --> 00:43:48,970
Twitter who who asks I am in school

962
00:43:52,140 --> 00:43:50,680
right now for environmental science and

963
00:43:55,170 --> 00:43:52,150

research with a concentration on

964

00:43:57,060 --> 00:43:55,180

genetics what types of jobs or research

965

00:43:59,580 --> 00:43:57,070

would I be able to do and I graduate and

966

00:44:09,270 --> 00:43:59,590

want to work for NASA and organization

967

00:44:11,400 --> 00:44:09,280

like it I believe so you check out the

968

00:44:14,310 --> 00:44:11,410

internship programs that are offered

969

00:44:15,840 --> 00:44:14,320

directly by NASA centers or you could

970

00:44:18,150 --> 00:44:15,850

write to professors that are not

971

00:44:22,860 --> 00:44:18,160

necessarily working at NASA centers but

972

00:44:25,050 --> 00:44:22,870

are working through NASA funded programs

973

00:44:27,420 --> 00:44:25,060

and you can directly get in touch with

974

00:44:29,270 --> 00:44:27,430

them and ask to work with them even

975

00:44:33,090 --> 00:44:29,280

though it's just over this summer

976

00:44:35,340 --> 00:44:33,100

because so I think to get to the job you

977

00:44:36,900 --> 00:44:35,350

need to get to it first you I think it's

978

00:44:38,370 --> 00:44:36,910

a scientist beepers it will be very

979

00:44:41,160 --> 00:44:38,380

useful for us to understand about our

980

00:44:43,800 --> 00:44:41,170

interests are and and this is a tricky

981

00:44:45,510 --> 00:44:43,810

part about finding your interests you

982

00:44:47,310 --> 00:44:45,520

need to sometimes do things that don't

983

00:44:49,470 --> 00:44:47,320

interest you and that's the only way you

984

00:44:52,680 --> 00:44:49,480

will find what you like through doing

985

00:44:54,540 --> 00:44:52,690

things that you don't like and and also

986

00:44:56,760 --> 00:44:54,550

finding that the thing that you thought

987

00:45:00,090 --> 00:44:56,770

you would like doesn't interest you as

988

00:45:01,710 --> 00:45:00,100

much so it's it's I encourage that don't

989

00:45:04,320 --> 00:45:01,720

overthink these things if you like a

990

00:45:07,050 --> 00:45:04,330

program if it's sort of sparks something

991

00:45:09,650 --> 00:45:07,060

in you write to the professor write to

992

00:45:12,000 --> 00:45:09,660

the NASA Center seek these internships

993

00:45:14,670 --> 00:45:12,010

and then try to get your foot in the

994

00:45:17,430 --> 00:45:14,680

door in one of these labs and you will

995

00:45:21,090 --> 00:45:17,440

walk up from there but most importantly

996

00:45:23,010 --> 00:45:21,100

also create an internship for you that

997

00:45:26,070 --> 00:45:23,020

have your interests your best interests

998

00:45:27,600 --> 00:45:26,080

in heart and these could be people in

999

00:45:30,500 --> 00:45:27,610

your level your ear

1000

00:45:33,090 --> 00:45:30,510

these could be people with a mix of both

1001
00:45:36,090 --> 00:45:33,100
build your network and your mentorship

1002
00:45:38,910 --> 00:45:36,100
network early on and surround yourself

1003
00:45:42,030 --> 00:45:38,920
with people who will inspire you who

1004
00:45:45,090 --> 00:45:42,040
will share your dreams and who will join

1005
00:45:47,010 --> 00:45:45,100
them with you that's I think very

1006
00:45:51,600 --> 00:45:47,020
important for young scientists find a

1007
00:45:53,340 --> 00:45:51,610
good group that's yeah not feeling shy

1008
00:45:56,010 --> 00:45:53,350
knocking on doors and finding a mentor

1009
00:45:57,480 --> 00:45:56,020
is is essential none of us who are

1010
00:45:59,910 --> 00:45:57,490
professional astrobiologists did it on

1011
00:46:01,700 --> 00:45:59,920
our own why we all rely on mentors to

1012
00:46:04,880 --> 00:46:01,710
help us along the way

1013
00:46:07,680 --> 00:46:04,890

you mean I think we are we think that

1014

00:46:10,560 --> 00:46:07,690

successful people are always successful

1015

00:46:13,710 --> 00:46:10,570

but that's that's not very realistic you

1016

00:46:16,500 --> 00:46:13,720

know we we are there's a lot of pain and

1017

00:46:18,960 --> 00:46:16,510

suffering and heartache and blood and

1018

00:46:22,080 --> 00:46:18,970

sweat behind any success story that you

1019

00:46:24,150 --> 00:46:22,090

see so so if you hear answer is a no

1020

00:46:26,670 --> 00:46:24,160

don't take it personally just keep keep

1021

00:46:30,600 --> 00:46:26,680

keep at it don't give up on your dreams

1022

00:46:34,200 --> 00:46:30,610

never I couldn't say it in it a better

1023

00:46:36,450 --> 00:46:34,210

way the next question comes from at

1024

00:46:38,730 --> 00:46:36,460

próxima airball on twitter as well who

1025

00:46:40,740 --> 00:46:38,740

asks is it possible for a life form with

1026

00:46:42,330 --> 00:46:40,750

right-handed proteins in different

1027

00:46:45,470 --> 00:46:42,340

planets so as to do is the opposite

1028

00:46:48,210 --> 00:46:45,480

chirality as we have today on earth

1029

00:46:50,160 --> 00:46:48,220

interesting question there are there are

1030

00:46:52,310 --> 00:46:50,170

little Studies on that there's there is

1031

00:46:55,080 --> 00:46:52,320

we don't really understand why certain

1032

00:46:58,730 --> 00:46:55,090

chirality that we see today on earth is

1033

00:47:03,360 --> 00:46:58,740

selected what's worthy sort of drivers

1034

00:47:08,130 --> 00:47:03,370

or those selection I know what I know HD

1035

00:47:09,600 --> 00:47:08,140

on this topic Sarah poker and the quick

1036

00:47:12,390 --> 00:47:09,610

answer is we don't know exactly what's

1037

00:47:14,010 --> 00:47:12,400

orientation molecules that we see today

1038

00:47:14,970 --> 00:47:14,020

and whether they need to be necessary to

1039

00:47:18,660 --> 00:47:14,980

make for them to have the same

1040

00:47:22,400 --> 00:47:18,670

arrangement for them to be price to buy

1041

00:47:26,040 --> 00:47:22,410

for is create the conditions asking

1042

00:47:27,210 --> 00:47:26,050

thank you so many questions is fantastic

1043

00:47:28,170 --> 00:47:27,220

thank you so much everybody for a

1044

00:47:30,150 --> 00:47:28,180

syndrome

1045

00:47:33,090 --> 00:47:30,160

the next one comes from at stray

1046

00:47:34,830 --> 00:47:33,100

ologists who asks what subjects should

1047

00:47:37,350 --> 00:47:34,840

an individual be confident in for

1048

00:47:39,480 --> 00:47:37,360

studying ancient genes

1049

00:47:42,080 --> 00:47:39,490

interesting so

1050

00:47:44,370 --> 00:47:42,090

I would say because we start the

1051

00:47:48,690 --> 00:47:44,380

creation of th same genes in the lab

1052

00:47:51,210 --> 00:47:48,700

through pilot phylogenetics primarily my

1053

00:47:54,390 --> 00:47:51,220

PP want to understand the phylogeny

1054

00:47:57,750 --> 00:47:54,400

so the students that join regardless of

1055

00:48:00,210 --> 00:47:57,760

their background and be sort of work

1056

00:48:02,070 --> 00:48:00,220

with these Asian teams in one level its

1057

00:48:04,380 --> 00:48:02,080

engineering or not but if they are

1058

00:48:06,950 --> 00:48:04,390

interested in making these things in the

1059

00:48:09,780 --> 00:48:06,960

lab I would say evolutionary biology

1060

00:48:11,790 --> 00:48:09,790

phylogenetics and there's an excellent

1061

00:48:16,530 --> 00:48:11,800

workshop it moves whole marine

1062

00:48:18,810 --> 00:48:16,540

biological labs beeps it's called

1063

00:48:22,130 --> 00:48:18,820

molecular evolution and I think there is

1064

00:48:25,140 --> 00:48:22,140

a sister workshop in Greece in Europe

1065

00:48:27,560 --> 00:48:25,150

that also it takes place during the

1066

00:48:30,630 --> 00:48:27,570

summer probably not this summer I

1067

00:48:33,000 --> 00:48:30,640

encourage you to attend these workshops

1068

00:48:35,580 --> 00:48:33,010

they are usually two to three weeks

1069

00:48:38,850 --> 00:48:35,590

it's very intense but about ten day ten

1070

00:48:40,770 --> 00:48:38,860

hours a day you could and you learn how

1071

00:48:44,220 --> 00:48:40,780

trees are constructed and all the

1072

00:48:45,540 --> 00:48:44,230

algorithms behind it it's many times but

1073

00:48:48,410 --> 00:48:45,550

you get so much out of it in a very

1074

00:48:51,770 --> 00:48:48,420

short amount of time so I recommend

1075

00:48:56,640 --> 00:48:51,780

shops for anyone interested in

1076

00:49:00,349 --> 00:48:56,650

reconstructing accessible thank you so

1077

00:49:03,120 --> 00:49:00,359

next question by Anna Roop mohanty who

1078

00:49:04,880 --> 00:49:03,130

book asks the same question with

1079

00:49:06,780 --> 00:49:04,890

focusing on the technology around

1080

00:49:08,520 --> 00:49:06,790

reconstruction case indigenes what what

1081

00:49:15,330 --> 00:49:08,530

what toy is he used in the lab to do

1082

00:49:17,910 --> 00:49:15,340

that sequences he then send them into

1083

00:49:20,810 --> 00:49:17,920

these sequences to synthetic biology

1084

00:49:23,160 --> 00:49:20,820

companies so if you are in the end of

1085

00:49:28,500 --> 00:49:23,170

more biotechnology you could have your

1086

00:49:30,750 --> 00:49:28,510

own biology company and it's us and make

1087

00:49:32,250 --> 00:49:30,760

these genes for us right so there are I

1088

00:49:34,349 --> 00:49:32,260

think right now four or five main

1089

00:49:35,190 --> 00:49:34,359

companies that we work with in the

1090

00:49:38,730 --> 00:49:35,200

United States

1091

00:49:42,030 --> 00:49:38,740

once we infer in silico but these

1092

00:49:44,099 --> 00:49:42,040

sequences are or might be if it an order

1093

00:49:45,630 --> 00:49:44,109

these genes so at that point we moved

1094

00:49:48,270 --> 00:49:45,640

from reconstruction which is

1095

00:49:51,520 --> 00:49:48,280

computational to resurrection which is

1096

00:49:53,440 --> 00:49:51,530

more experimental so the

1097

00:49:55,270 --> 00:49:53,450

this is multiple levels because we also

1098

00:49:58,450 --> 00:49:55,280

engineered genomes and we use different

1099

00:50:00,400 --> 00:49:58,460

systems to engineer microbial genomes if

1100

00:50:04,120 --> 00:50:00,410

you're gonna do biochemistry usually

1101

00:50:06,190 --> 00:50:04,130

order down the circular gene or

1102

00:50:07,750 --> 00:50:06,200

expression what not so the person who is

1103

00:50:09,850 --> 00:50:07,760

asking this might be familiar with these

1104

00:50:11,620 --> 00:50:09,860

applications if it is for genome

1105

00:50:13,870 --> 00:50:11,630

engineering depending on the method that

1106

00:50:15,040 --> 00:50:13,880

we use we order linear DNA or again

1107

00:50:18,720 --> 00:50:15,050

circular

1108

00:50:22,660 --> 00:50:18,730

you know constructed we are going to be

1109

00:50:24,160 --> 00:50:22,670

using later on so so the key is then to

1110

00:50:26,440 --> 00:50:24,170

know exactly what your application is

1111

00:50:28,630 --> 00:50:26,450

maybe and it's also important to note

1112

00:50:30,430 --> 00:50:28,640

that we optimize these sequences for the

1113

00:50:33,940 --> 00:50:30,440

organism that people use these organ

1114

00:50:35,800 --> 00:50:33,950

these sequences for so say if you're

1115

00:50:38,590 --> 00:50:35,810

gonna use coli these are the gene

1116

00:50:41,950 --> 00:50:38,600

sequences are optimized for e.coli what

1117

00:50:43,870 --> 00:50:41,960

in its mmm-hmm thank you the next

1118

00:50:48,550 --> 00:50:43,880

question comes from Julia the marina's

1119

00:50:50,050 --> 00:50:48,560

Sun cigarette yes who asks what was the

1120

00:50:52,630 --> 00:50:50,060

most challenging part about

1121

00:51:00,820 --> 00:50:52,640

reconstructing reconstructing ancestral

1122

00:51:05,370 --> 00:51:00,830

DNA in e.coli that was not down deep or

1123

00:51:10,770 --> 00:51:08,710

genome itself will communicate with this

1124

00:51:13,750 --> 00:51:10,780

ancient gene I am putting in so to speak

1125

00:51:16,660 --> 00:51:13,760

so that was difficult for me but I I

1126
00:51:18,520 --> 00:51:16,670
think any engineer knows this and I did

1127
00:51:20,170 --> 00:51:18,530
this is biological level that you will

1128
00:51:21,820 --> 00:51:20,180
try a million things and one of them

1129
00:51:24,070 --> 00:51:21,830
will work in your jobs to find out one

1130
00:51:28,450 --> 00:51:24,080
thing that works so I would say there

1131
00:51:32,260 --> 00:51:28,460
was a for mental aspect to know okay am

1132
00:51:34,690 --> 00:51:32,270
I just sort of in Turkey we say you're

1133
00:51:37,710 --> 00:51:34,700
only in your boat on a on a rock you

1134
00:51:41,050 --> 00:51:37,720
know like just am I just imagining this

1135
00:51:43,330 --> 00:51:41,060
just never work or did I not try the

1136
00:51:46,870 --> 00:51:43,340
right method yet so it took me about a

1137
00:51:48,760 --> 00:51:46,880
year and a half to do it which is long

1138
00:51:50,890 --> 00:51:48,770

if you think that that's all I did I did

1139

00:51:54,220 --> 00:51:50,900

not take any weekends off I was in the

1140

00:51:56,050 --> 00:51:54,230

lab entire time and again switching from

1141

00:51:58,480 --> 00:51:56,060

biochemistry to microbiology and

1142

00:52:00,240 --> 00:51:58,490

genomics may have something to do with

1143

00:52:02,530 --> 00:52:00,250

this because it's a completely new skill

1144

00:52:05,019 --> 00:52:02,540

but at the end of the day I told myself

1145

00:52:08,140 --> 00:52:05,029

you know I had a giant Muhammad Ali

1146

00:52:10,120 --> 00:52:08,150

posture in the lab that's that not only

1147

00:52:13,719 --> 00:52:10,130

I knocked the mouth but I picked around

1148

00:52:16,419 --> 00:52:13,729

and and I thought you know I keep it up

1149

00:52:18,759 --> 00:52:16,429

like this is it I'll do it and it worked

1150

00:52:20,620 --> 00:52:18,769

and now you're doing it in material

1151

00:52:23,289 --> 00:52:20,630

engineering it engineering is ancient

1152

00:52:25,809 --> 00:52:23,299

genes and in e.coli now so the bacteria

1153

00:52:28,899 --> 00:52:25,819

the cyanobacteria you know you name it

1154

00:52:32,140 --> 00:52:28,909

we get it to work is that poster in your

1155

00:52:33,699 --> 00:52:32,150

grad students lab now no no you know

1156

00:52:38,739 --> 00:52:33,709

that poster is in a box somewhere

1157

00:52:42,130 --> 00:52:38,749

because I'm still unpacking Tom Caruso

1158

00:52:44,140 --> 00:52:42,140

on Facebook asks at at last summer's

1159

00:52:47,439 --> 00:52:44,150

conference at the earth Life Science

1160

00:52:50,199 --> 00:52:47,449

Institute at Tokyo they addressed moving

1161

00:52:51,519 --> 00:52:50,209

from a disordered system to an ordered

1162

00:52:54,909 --> 00:52:51,529

functioning state so moving from

1163

00:52:56,679 --> 00:52:54,919

geochemistry to biochemistry how does

1164

00:53:00,009 --> 00:52:56,689

your research connect moving from jus

1165

00:53:01,899 --> 00:53:00,019

chemistry to biochemistry and a topic of

1166

00:53:03,579 --> 00:53:01,909

molecular signaling between system

1167

00:53:08,380 --> 00:53:03,589

components responding to a change in the

1168

00:53:09,489 --> 00:53:08,390

environment we don't necessarily refer

1169

00:53:12,489 --> 00:53:09,499

to these systems as wholly clear

1170

00:53:15,909 --> 00:53:12,499

signaling but I will say that we have

1171

00:53:18,219 --> 00:53:15,919

this whole emerging area of work in my

1172

00:53:20,769 --> 00:53:18,229

group and I worked exact Atlantis

1173

00:53:23,169 --> 00:53:20,779

primarily that's all the things I told

1174

00:53:25,299 --> 00:53:23,179

you about so far focused on life right

1175

00:53:26,890 --> 00:53:25,309

life life life even the simplest form is

1176

00:53:30,189 --> 00:53:26,900

all about life but then if you think

1177

00:53:32,709 --> 00:53:30,199

about our planet is about 4.5 billions

1178

00:53:34,989 --> 00:53:32,719

of years old and like I say all this is

1179

00:53:38,849 --> 00:53:34,999

3.8 depending on which data are you

1180

00:53:42,939 --> 00:53:38,859

trusting 2.81 5.1 somewhere out there so

1181

00:53:44,769 --> 00:53:42,949

before life happened there is a state

1182

00:53:46,449 --> 00:53:44,779

that is completely abiotic these

1183

00:53:48,399 --> 00:53:46,459

chemicals are still around us but we

1184

00:53:50,739 --> 00:53:48,409

also have life on top of that so we want

1185

00:53:53,859 --> 00:53:50,749

to know how that abiotic system

1186

00:53:55,689 --> 00:53:53,869

transitions into a biological system and

1187

00:53:57,729 --> 00:53:55,699

the biological system that we think

1188

00:53:59,829 --> 00:53:57,739

about is beyond genomes it's beyond

1189

00:54:01,989 --> 00:53:59,839

replication it's beyond basically

1190

00:54:04,539 --> 00:54:01,999

anything that we can see in the right

1191

00:54:08,919 --> 00:54:04,549

now but it's more about organization and

1192

00:54:11,880 --> 00:54:08,929

and maintenance as a secondary component

1193

00:54:14,859 --> 00:54:11,890

in this organized system structure so I

1194

00:54:18,700 --> 00:54:14,869

published a paper in complexity about

1195

00:54:21,550 --> 00:54:18,710

last year that we described

1196

00:54:24,370 --> 00:54:21,560

how the Velarde complex the components

1197

00:54:26,830 --> 00:54:24,380

that we need to detect and observe in

1198

00:54:29,620 --> 00:54:26,840

early chemical environments for them to

1199

00:54:31,870 --> 00:54:29,630

be pinned as biological right so that's

1200

00:54:35,050 --> 00:54:31,880

the that's the real question here that

1201
00:54:39,040 --> 00:54:35,060
how do you take a suit that is just

1202
00:54:40,630 --> 00:54:39,050
chemistry and then infer or predict

1203
00:54:42,610 --> 00:54:40,640
whether there's gonna be life coming out

1204
00:54:44,650 --> 00:54:42,620
of this and by life I don't mean you

1205
00:54:47,040 --> 00:54:44,660
know if dinosaur poking out of your test

1206
00:54:49,510 --> 00:54:47,050
tube I'm talking about you know a

1207
00:54:51,610 --> 00:54:49,520
biological organization so that's the

1208
00:54:54,310 --> 00:54:51,620
work we're doing right now you're

1209
00:54:57,610 --> 00:54:54,320
looking at hierarchical structures of

1210
00:55:00,040 --> 00:54:57,620
early chemical components and how they

1211
00:55:02,500 --> 00:55:00,050
may be arranging themselves for for them

1212
00:55:05,770 --> 00:55:02,510
to be pins as a biological organism at

1213
00:55:07,180 --> 00:55:05,780

the crux of the very transition and I

1214

00:55:09,910 --> 00:55:07,190

don't know who asked this but send me an

1215

00:55:11,920 --> 00:55:09,920

email because your question was me I was

1216

00:55:13,300 --> 00:55:11,930

Tom Caruso on Facebook thank you

1217

00:55:17,080 --> 00:55:13,310

real great answer to a great question

1218

00:55:18,550 --> 00:55:17,090

next question comes from @cr a car on

1219

00:55:21,100 --> 00:55:18,560

twitter who asks perhaps more

1220

00:55:26,790 --> 00:55:21,110

fundamentally as an organism needs to

1221

00:55:32,680 --> 00:55:30,880

without which nothing that's we need to

1222

00:55:33,940 --> 00:55:32,690

constrain our search for life in our

1223

00:55:36,730 --> 00:55:33,950

definition for life in the universe

1224

00:55:41,040 --> 00:55:36,740

based on what we see on planet earth and

1225

00:55:45,460 --> 00:55:41,050

the planetary life is depending on water

1226

00:55:47,290 --> 00:55:45,470

is it required I'm gonna say no because

1227

00:55:48,700 --> 00:55:47,300

I want to believe right I want to

1228

00:55:50,200 --> 00:55:48,710

believe in different possibilities and

1229

00:55:51,700 --> 00:55:50,210

there are different there could be

1230

00:55:53,830 --> 00:55:51,710

different alternatives to these people

1231

00:55:55,900 --> 00:55:53,840

been proposing for my chemistry or I

1232

00:55:57,850 --> 00:55:55,910

recommend you read look into those

1233

00:56:00,040 --> 00:55:57,860

papers they're very interesting but so

1234

00:56:04,570 --> 00:56:00,050

far is life as we know it depends on

1235

00:56:07,390 --> 00:56:04,580

water and we need to rely on what we

1236

00:56:10,050 --> 00:56:07,400

have right now primarily when we look

1237

00:56:13,540 --> 00:56:10,060

for life elsewhere in the universe

1238

00:56:16,390 --> 00:56:13,550

thank you Andrew planet on say Gannett

1239

00:56:19,890 --> 00:56:16,400

asks is it possible that the exchange of

1240

00:56:23,680 --> 00:56:19,900

genetic information evolves or happened

1241

00:56:29,440 --> 00:56:23,690

before asexual reproduction oh is it the

1242

00:56:31,450 --> 00:56:29,450

other way around so there are many

1243

00:56:32,349 --> 00:56:31,460

things happening in the early life right

1244

00:56:33,819 --> 00:56:32,359

even though the

1245

00:56:36,220 --> 00:56:33,829

the focus of life happened there is no

1246

00:56:37,809 --> 00:56:36,230

life life happens but there's a lot of

1247

00:56:40,269 --> 00:56:37,819

things happening beats me it was a big

1248

00:56:41,739 --> 00:56:40,279

dramatic time and the main thing about

1249

00:56:43,930 --> 00:56:41,749

these major transitions in their

1250

00:56:46,479 --> 00:56:43,940

emergence of you know either

1251

00:56:49,809 --> 00:56:46,489

evolution of sex or major transitions

1252

00:56:51,849 --> 00:56:49,819

you know multicellularity and all that I

1253

00:56:54,940 --> 00:56:51,859

think we sort of don't think about the

1254

00:56:57,609 --> 00:56:54,950

transitions that's where predated life

1255

00:56:59,769 --> 00:56:57,619

there's transitions there too that's how

1256

00:57:01,539 --> 00:56:59,779

I think about it so we think about

1257

00:57:05,680 --> 00:57:01,549

classic Universal common ancestor and

1258

00:57:07,269 --> 00:57:05,690

what it was capable of right it was a it

1259

00:57:09,640 --> 00:57:07,279

being able to create some sort of

1260

00:57:11,019 --> 00:57:09,650

ecosystem with its surroundings but we

1261

00:57:13,059 --> 00:57:11,029

are more interested in understanding

1262

00:57:15,999 --> 00:57:13,069

what happened before the last Universal

1263

00:57:18,569 --> 00:57:16,009

common ancestor so I will say that yes

1264

00:57:21,099 --> 00:57:18,579

life has to exchange information

1265

00:57:23,410 --> 00:57:21,109

probably in the form of genetics as we

1266

00:57:25,720 --> 00:57:23,420

see today but I argue that problem was

1267

00:57:29,589 --> 00:57:25,730

much simpler but that doesn't mean

1268

00:57:37,420 --> 00:57:29,599

simple before Luca and before all the

1269

00:57:39,420 --> 00:57:37,430

production that we see later on so

1270

00:57:41,650 --> 00:57:39,430

there's a big jump in complexity between

1271

00:57:43,870 --> 00:57:41,660

reconstructing ancient genes and

1272

00:57:46,539 --> 00:57:43,880

recreating Jurassic Park right but

1273

00:57:48,609 --> 00:57:46,549

nonetheless Rohan's shirodkar great

1274

00:57:50,829 --> 00:57:48,619

question on Sagan and asks using this

1275

00:57:52,359 --> 00:57:50,839

tool of paleogenetics will you be

1276

00:58:00,509 --> 00:57:52,369

interested in working on a project to

1277

00:58:03,849 --> 00:58:00,519

bring back the woolly mammoth No right

1278

00:58:08,769 --> 00:58:06,819

the next question is by Graham Lau my

1279

00:58:11,380 --> 00:58:08,779

co-host here on ask an astrobiologist

1280

00:58:13,539 --> 00:58:11,390

and he asked the following question you

1281

00:58:16,989 --> 00:58:13,549

teach a class of the science of Star

1282

00:58:18,880 --> 00:58:16,999

Trek can you speak to how science

1283

00:58:24,370 --> 00:58:18,890

fiction gets the science right or wrong

1284

00:58:25,960 --> 00:58:24,380

with regard to your own research I

1285

00:58:27,849 --> 00:58:25,970

should have seen this coming

1286

00:58:30,400 --> 00:58:27,859

so yes I teach a molecular biology of

1287

00:58:34,029 --> 00:58:30,410

Star Trek course and I will be teaching

1288

00:58:35,739 --> 00:58:34,039

it again in his 2021 so the reason why I

1289

00:58:37,989 --> 00:58:35,749

picked Star Trek is that it's not just

1290

00:58:40,989 --> 00:58:37,999

in science fiction and Graham knows this

1291

00:58:43,830 --> 00:58:40,999

as well that's there is a lot of ethical

1292

00:58:48,020 --> 00:58:43,840

conundrum involved there's a lot of also

1293

00:58:50,900 --> 00:58:48,030

Acuras I think Star Trek all the sci-fi

1294

00:58:53,580 --> 00:58:50,910

TV series or movies that I watched got

1295

00:58:57,000 --> 00:58:53,590

science so accurately despite the fact

1296

00:58:59,400 --> 00:58:57,010

that it was decades ago so I picked Star

1297

00:59:02,850 --> 00:58:59,410

Trek primarily to expose molecular

1298

00:59:04,740 --> 00:59:02,860

biology freshman students to original

1299

00:59:06,270 --> 00:59:04,750

pipe in Astro well the questions and I

1300

00:59:08,520 --> 00:59:06,280

think it's actually worked out fine

1301
00:59:10,590 --> 00:59:08,530
because again Star Trek I think does a

1302
00:59:12,330 --> 00:59:10,600
really good job of synthesizing a lot of

1303
00:59:15,780 --> 00:59:12,340
different components could talk about

1304
00:59:18,630 --> 00:59:15,790
what life is and and we were talking

1305
00:59:21,090 --> 00:59:18,640
about whether data is life or not

1306
00:59:23,940 --> 00:59:21,100
whether we have the right to an Istanbul

1307
00:59:26,370 --> 00:59:23,950
data even though it's an AI right so

1308
00:59:28,650 --> 00:59:26,380
it's this really I think was interesting

1309
00:59:30,870 --> 00:59:28,660
for the students so I find a lot of

1310
00:59:34,440 --> 00:59:30,880
similarities a lot of inspiration like I

1311
00:59:37,350 --> 00:59:34,450
seek inspiration from sci-fi when I do

1312
00:59:40,530 --> 00:59:37,360
my work as well but I also separates

1313
00:59:42,540 --> 00:59:40,540

science fiction pro science very sharply

1314

00:59:45,980 --> 00:59:42,550

I think it's very important that we

1315

00:59:48,330 --> 00:59:45,990

don't treat a scientific field

1316

00:59:51,600 --> 00:59:48,340

even though maybe here because of the

1317

00:59:52,860 --> 00:59:51,610

size sci-fi inspiration and etc but I

1318

00:59:54,810 --> 00:59:52,870

think it's very important that we

1319

00:59:57,330 --> 00:59:54,820

appreciate and recognize science men

1320

00:59:58,830 --> 00:59:57,340

seeds and especially for the future of

1321

01:00:02,220 --> 00:59:58,840

our fields we need to make that

1322

01:00:03,540 --> 01:00:02,230

distinction very very clear could a

1323

01:00:05,280 --> 01:00:03,550

fist-sized more science fiction is a

1324

01:00:09,390 --> 01:00:05,290

great way to get inspired to do science

1325

01:00:10,590 --> 01:00:09,400

but it is not science at all so can you

1326

01:00:12,180 --> 01:00:10,600

believe we've been talking for one hour

1327

01:00:13,980 --> 01:00:12,190

already and there's just so many

1328

01:00:15,180 --> 01:00:13,990

questions so if it's okay with you I

1329

01:00:18,150 --> 01:00:15,190

would like to take three more questions

1330

01:00:19,830 --> 01:00:18,160

and then we'll wrap things up thank you

1331

01:00:21,090 --> 01:00:19,840

so much really appreciate it really

1332

01:00:24,630 --> 01:00:21,100

grateful for your time I know you're

1333

01:00:27,330 --> 01:00:24,640

very busy so Gaurav Yadav on Facebook

1334

01:00:29,280 --> 01:00:27,340

asks can the lipid profile study of

1335

01:00:31,590 --> 01:00:29,290

extremophiles on earth be used to

1336

01:00:37,980 --> 01:00:31,600

identify bio signatures for past life on

1337

01:00:45,570 --> 01:00:37,990

extraterrestrial planets my colleague

1338

01:00:47,910 --> 01:00:45,580

the lender Stanford's paper came out few

1339

01:00:49,500 --> 01:00:47,920

months ago they are studying the

1340

01:00:52,650 --> 01:00:49,510

potential of lipids as bio signatures

1341

01:00:54,540 --> 01:00:52,660

and there's interest in that group and

1342

01:00:57,440 --> 01:00:54,550

also the group that she came from at MIT

1343

01:00:59,630 --> 01:00:57,450

rather some assume that studies

1344

01:01:01,700 --> 01:00:59,640

the potential of finding spire

1345

01:01:05,270 --> 01:01:01,710

signatures on Mars so I would like to

1346

01:01:06,770 --> 01:01:05,280

direct questions words that those

1347

01:01:09,230 --> 01:01:06,780

researchers that actually study these

1348

01:01:11,599 --> 01:01:09,240

things that researchers poll are we

1349

01:01:14,270 --> 01:01:11,609

lender is that Stanford University

1350

01:01:18,589 --> 01:01:14,280

next question is by Amit Carrie ke run

1351
01:01:21,290 --> 01:01:18,599
on Facebook who asks do does does life

1352
01:01:23,060 --> 01:01:21,300
need to be carbon-based what other

1353
01:01:27,650 --> 01:01:23,070
elements could could could we possibly

1354
01:01:29,270 --> 01:01:27,660
think of I've never met anyone who did

1355
01:01:30,680 --> 01:01:29,280
not watch Star Trek who could ask this

1356
01:01:34,550 --> 01:01:30,690
question right so this is why we one

1357
01:01:38,089 --> 01:01:34,560
side by the curiosity among this but I

1358
01:01:40,819 --> 01:01:38,099
also again this is my - similar question

1359
01:01:43,730 --> 01:01:40,829
to whether water is the absolute need if

1360
01:01:46,940 --> 01:01:43,740
life is you know is only possible based

1361
01:01:50,180 --> 01:01:46,950
on elements that we detect and find and

1362
01:01:51,890 --> 01:01:50,190
Carmela soprano so so far that's that's

1363
01:01:53,599 --> 01:01:51,900

what at least we'll be able to find

1364

01:01:58,250 --> 01:01:53,609

between technologies and techniques that

1365

01:02:02,210 --> 01:01:58,260

you're developing here looking like my

1366

01:02:03,770 --> 01:02:02,220

words I'll be surprised yeah thank you

1367

01:02:06,650 --> 01:02:03,780

great questions thank you very much

1368

01:02:09,200 --> 01:02:06,660

so last question is by a microphone on

1369

01:02:11,720 --> 01:02:09,210

Twitter who treats us as McCoy who asks

1370

01:02:14,900 --> 01:02:11,730

you spoke about how a single molecule

1371

01:02:16,880 --> 01:02:14,910

can have planetary scale impacts we're

1372

01:02:18,859 --> 01:02:16,890

seeing something like that today was the

1373

01:02:21,140 --> 01:02:18,869

virus right now is there a way to

1374

01:02:23,720 --> 01:02:21,150

predict which small pieces of

1375

01:02:29,200 --> 01:02:23,730

information can or cannot have huge

1376

01:02:31,760 --> 01:02:29,210

effects on a system like a planet hmm so

1377

01:02:35,210 --> 01:02:31,770

always very fascinating that's also the

1378

01:02:37,160 --> 01:02:35,220

video card so we are not there lot of

1379

01:02:40,660 --> 01:02:37,170

studies word prediction in multiple

1380

01:02:43,040 --> 01:02:40,670

levels especially resistance

1381

01:02:46,460 --> 01:02:43,050

scientists who study the resistance of

1382

01:02:50,510 --> 01:02:46,470

exports antibiotics have been thinking

1383

01:02:53,380 --> 01:02:50,520

and building systems that may answer the

1384

01:02:55,670 --> 01:02:53,390

predictability component of life and I

1385

01:02:58,010 --> 01:02:55,680

may be familiar with Stephen Jay Gould

1386

01:02:59,599 --> 01:02:58,020

playing a table I have experiments

1387

01:03:03,050 --> 01:02:59,609

whether it be people be ending it the

1388

01:03:04,579 --> 01:03:03,060

same at the same biota that we see

1389

01:03:07,040 --> 01:03:04,589

around us today if B Bert repeats

1390

01:03:08,630 --> 01:03:07,050

everything that happens on earth so that

1391

01:03:10,340 --> 01:03:08,640

there's a predictability component there

1392

01:03:13,730 --> 01:03:10,350

that you may appreciate it it's embedded

1393

01:03:15,890 --> 01:03:13,740

there that being said does there's a lot

1394

01:03:20,120 --> 01:03:15,900

of computational needs and we need to

1395

01:03:23,450 --> 01:03:20,130

first of all understand Li what sort of

1396

01:03:24,980 --> 01:03:23,460

circumstances give rise to the sort of

1397

01:03:27,410 --> 01:03:24,990

invasions right we need to understand

1398

01:03:31,010 --> 01:03:27,420

the past so to speak if we were to

1399

01:03:33,140 --> 01:03:31,020

understand or come close to predicting

1400

01:03:35,060 --> 01:03:33,150

what may happen the challenge with the

1401

01:03:37,550 --> 01:03:35,070

prediction is that environment changes

1402

01:03:39,320 --> 01:03:37,560

right environment evolves so you need to

1403

01:03:41,710 --> 01:03:39,330

predict the environment which is really

1404

01:03:45,140 --> 01:03:41,720

really hard

1405

01:03:48,110 --> 01:03:45,150

thank you are there any more questions

1406

01:03:49,790 --> 01:03:48,120

they are but how to be respectful of

1407

01:03:51,500 --> 01:03:49,800

your time I thank you that you thank you

1408

01:03:52,460 --> 01:03:51,510

so much for for chatting with us there

1409

01:03:55,010 --> 01:03:52,470

it's been an incredible incredible

1410

01:03:57,980 --> 01:03:55,020

conversation of yours have turned out in

1411

01:03:59,900 --> 01:03:57,990

large numbers in supporting you and and

1412

01:04:02,090 --> 01:03:59,910

being fascinated by what your research

1413

01:04:04,790 --> 01:04:02,100

thank you so much um so for those of you

1414

01:04:06,230 --> 01:04:04,800

are watching we've before we call it out

1415

01:04:08,360 --> 01:04:06,240

for those of you are watching remember

1416

01:04:09,680 --> 01:04:08,370

that about the astrobiology graphics

1417

01:04:11,860 --> 01:04:09,690

series that I was talking about in the

1418

01:04:14,270 --> 01:04:11,870

beginning of the episode so there is a

1419

01:04:17,450 --> 01:04:14,280

short premiere happening this Thursday

1420

01:04:19,520 --> 01:04:17,460

that it's graphic novel that dr. Aaron

1421

01:04:21,050 --> 01:04:19,530

gold wrong style is writing is there

1422

01:04:23,390 --> 01:04:21,060

behind the scene look at what it takes

1423

01:04:25,490 --> 01:04:23,400

to make those those graphic novels and

1424

01:04:26,690 --> 01:04:25,500

the two features quite a bit in them so

1425

01:04:29,000 --> 01:04:26,700

make sure you check that out

1426

01:04:34,580 --> 01:04:29,010

I think it's on Thursday Mike will put

1427

01:04:36,770 --> 01:04:34,590

up a link for the moment and I don't

1428

01:04:40,430 --> 01:04:36,780

forget you can download all these these

1429

01:04:42,080 --> 01:04:40,440

for free so talk to say could a dating

1430

01:04:44,300 --> 01:04:42,090

material this is an incredible

1431

01:04:46,070 --> 01:04:44,310

conversation I'm really grateful for

1432

01:04:47,720 --> 01:04:46,080

those of you are watching thank you

1433

01:04:49,130 --> 01:04:47,730

again please shared ask an

1434

01:04:51,200 --> 01:04:49,140

astrobiologist your friends colleagues

1435

01:04:52,820 --> 01:04:51,210

and everybody that you that follows you

1436

01:04:54,830 --> 01:04:52,830

online this show could not be possible

1437

01:04:56,780 --> 01:04:54,840

without you so we look forward to

1438

01:04:58,760 --> 01:04:56,790

welcoming you next month when episode of

1439

01:05:02,650 --> 01:04:58,770

ask and astrobiologists and until then

1440

01:05:42,560 --> 01:05:02,660

stay curious but you'll thank you