AbGradCon 2018

1
00:00:00,260 --> 00:00:12,670
[Music]

2
00:00:16,970 --> 00:00:15,080
where's Michael Morrison I'm kind of

3
00:00:19,040 --> 00:00:16,980
gonna go back to it doctor to Lucas was

4
00:00:21,680 --> 00:00:19,050
kind of talking about at lunch with

5
00:00:24,770 --> 00:00:21,690
doing experiments that we kind of do on

6
00:00:27,500 --> 00:00:24,780
the ground but in a low orbit

7
00:00:29,210 --> 00:00:27,510
environment to kind of see how this

8
00:00:30,650 --> 00:00:29,220
microgravity environment affects what

9
00:00:32,540 --> 00:00:30,660
we're doing however instead of doing

10
00:00:35,330 --> 00:00:32,550
protein crystals I'm actually looking at

11
00:00:37,250 --> 00:00:35,340
how bacteria grow and adapt in this

12
00:00:40,430 --> 00:00:37,260
unique environment that can't be found

13
00:00:43,370 --> 00:00:40,440

on earth I'm instead of some background

14
00:00:45,200 --> 00:00:43,380
on how life adapts to space probably the

15
00:00:48,530 --> 00:00:45,210
best studied organism that we know of

16
00:00:50,000 --> 00:00:48,540
for her space are humans we've had a

17
00:00:52,819 --> 00:00:50,010
continuous presence in space for the

18
00:00:54,050 --> 00:00:52,829
last 70 and a half years and that's just

19
00:00:55,550 --> 00:00:54,060
if you consider the International Space

20
00:00:58,970 --> 00:00:55,560
Station before that there was a Space

21
00:01:00,470 --> 00:00:58,980
Station mer Skylab Apollo Vostok and so

22
00:01:02,780 --> 00:01:00,480
we've had about sixty years of studying

23
00:01:04,579 --> 00:01:02,790
how humans adapt to spaceflight and what

24
00:01:06,590 --> 00:01:04,589
we found as he pointed out was that

25
00:01:08,810 --> 00:01:06,600
astronauts lose bone density and muscle

26
00:01:10,910 --> 00:01:08,820
mass in space but they also experience

27
00:01:13,190 --> 00:01:10,920
this fluid redistribution because we've

28
00:01:15,710 --> 00:01:13,200
evolved with gravity constantly pulling

29
00:01:17,750 --> 00:01:15,720
down on our bodies so we have mechanisms

30
00:01:19,370 --> 00:01:17,760
mechanisms in our bodies to help push

31
00:01:21,830 --> 00:01:19,380
this fluid back up to kind of keep our

32
00:01:24,920 --> 00:01:21,840
blood circulating and everything kind of

33
00:01:27,920 --> 00:01:24,930
working in a nice harmonious manner and

34
00:01:29,180 --> 00:01:27,930
this dysregulation we are fluids when

35
00:01:30,380 --> 00:01:29,190
you get into space because gravity is no

36
00:01:32,750 --> 00:01:30,390
longer pointing down you can stress the

37
00:01:34,460 --> 00:01:32,760
body out which can cause this regulation

38
00:01:36,260 --> 00:01:34,470

of the immune system which has been seen

39
00:01:37,880 --> 00:01:36,270
in astronauts coming back from space as

40
00:01:41,179 --> 00:01:37,890
flare-ups of different dormant viruses

41
00:01:43,490 --> 00:01:41,189
such as epstein-barr and herpes and

42
00:01:45,980 --> 00:01:43,500
these astronauts we send up there are

43
00:01:48,560 --> 00:01:45,990
you know very active healthy individuals

44
00:01:54,800 --> 00:01:48,570
that we send up there for example right

45
00:01:57,649 --> 00:01:54,810
this photo right here is of this Oh what

46
00:02:00,410 --> 00:01:57,659
is it click okay well little the top

47
00:02:02,870 --> 00:02:00,420
button okay so this is a astronaut tim

48
00:02:05,539 --> 00:02:02,880
peake and this photo he was competing in

49
00:02:07,700 --> 00:02:05,549
the London Marathon where he actually

50
00:02:11,179 --> 00:02:07,710
set the record for the fastest off world

51
00:02:14,210 --> 00:02:11,189
marathon time at 3 at 3 hours and 35

52
00:02:16,100 --> 00:02:14,220
minutes and 12 seconds and so if we're

53
00:02:18,110 --> 00:02:16,110
you know seeing these effects and

54
00:02:21,020 --> 00:02:18,120
astronauts who are really physically fit

55
00:02:23,150 --> 00:02:21,030
what would we see in it were humans

56
00:02:27,199 --> 00:02:23,160
myself who a marathon would probably

57
00:02:29,090 --> 00:02:27,209
kill so this is kind of astronauts kind

58
00:02:31,460 --> 00:02:29,100
of idea but you know these are macro you

59
00:02:33,710 --> 00:02:31,470
know big organisms my focus is more on

60
00:02:35,270 --> 00:02:33,720
the prokaryotes because we see keep

61
00:02:36,530 --> 00:02:35,280
sending humans to space but prokaryotes

62
00:02:38,150 --> 00:02:36,540
go with us everywhere we go they're

63
00:02:40,580 --> 00:02:38,160

central for our immune system our

64
00:02:42,410 --> 00:02:40,590
digestion and does it affect these

65
00:02:45,050 --> 00:02:42,420
prokaryotes and it actually does what

66
00:02:46,910 --> 00:02:45,060
we've observed is that prokaryotes have

67
00:02:48,620 --> 00:02:46,920
faster growth rates in space and it can

68
00:02:51,050 --> 00:02:48,630
reach fine cell density higher final

69
00:02:53,240 --> 00:02:51,060
cell densities they some experiments

70
00:02:55,100 --> 00:02:53,250
also suggest that antibiotic resistance

71
00:02:57,350 --> 00:02:55,110
increases in space as well as appearance

72
00:02:59,600 --> 00:02:57,360
and there's not things you want if the

73
00:03:01,850 --> 00:02:59,610
immune system becomes dysregulated big

74
00:03:04,009 --> 00:03:01,860
concern for NASA for sending astronauts

75
00:03:05,720 --> 00:03:04,019
past low-earth orbit because if you send

76
00:03:07,160 --> 00:03:05,730
them out there they're halfway to Mars

77
00:03:09,170 --> 00:03:07,170
they get sick you can't bring them back

78
00:03:11,570 --> 00:03:09,180
you said we have to figure this out kind

79
00:03:13,490 --> 00:03:11,580
of thing and last what they what kind of

80
00:03:16,250 --> 00:03:13,500
prokaryotes is this alteration and

81
00:03:18,559 --> 00:03:16,260
biofilm formation biofilms do have some

82
00:03:20,930 --> 00:03:18,569
role in chronic infections and

83
00:03:23,090 --> 00:03:20,940
antibiotic resistance but NASA's noticed

84
00:03:24,979 --> 00:03:23,100
that they affect the systems on the

85
00:03:26,870 --> 00:03:24,989
space station as well such as the space

86
00:03:28,759 --> 00:03:26,880
station mer it actually clogged the

87
00:03:29,990 --> 00:03:28,769
water reclaiming system with a biofilm

88
00:03:32,330 --> 00:03:30,000

and they had it completely read change

89
00:03:34,370 --> 00:03:32,340
out the entire system and also they find

90
00:03:36,830 --> 00:03:34,380
biofilms on the surface of this capsules

91
00:03:37,910 --> 00:03:36,840
which can actually corrode material and

92
00:03:39,740 --> 00:03:37,920
that's not something you want again

93
00:03:41,690 --> 00:03:39,750
pathway to space all sudden your machine

94
00:03:42,199 --> 00:03:41,700
you're starting to corrode what you can

95
00:03:44,449 --> 00:03:42,209
do about it

96
00:03:45,979 --> 00:03:44,459
so this is something that NASA is very

97
00:03:47,509 --> 00:03:45,989
interested in and that's kind of what my

98
00:03:49,520 --> 00:03:47,519
lab wants to look into kind of figuring

99
00:03:53,000 --> 00:03:49,530
out what's going on here and some kind

100
00:03:58,160 --> 00:03:53,010
of molecular like responses we can kind

101
00:03:59,539 --> 00:03:58,170
of predict and kind of treat so as the

102
00:04:01,430 --> 00:03:59,549
Lucas kind of point out spaceflight

103
00:04:03,440 --> 00:04:01,440
hardware is important so for us we use

104
00:04:05,569 --> 00:04:03,450
the biological research in canisters or

105
00:04:07,729 --> 00:04:05,579
brick space flight hardware they contain

106
00:04:10,370 --> 00:04:07,739
the petri dish that we air deposited

107
00:04:12,259 --> 00:04:10,380
vasila settler spores which are a soil

108
00:04:14,660 --> 00:04:12,269
bacteria that are non pathogenic know

109
00:04:16,670 --> 00:04:14,670
which astronauts whatsoever and the

110
00:04:18,920 --> 00:04:16,680
spores are dormant and so when we send

111
00:04:20,930 --> 00:04:18,930
them up we can inject media into them

112
00:04:22,640 --> 00:04:20,940
they become you know viable growing

113
00:04:24,350 --> 00:04:22,650

cells and so we can affect of what they

114
00:04:26,450 --> 00:04:24,360
do just in space without having to worry

115
00:04:27,800 --> 00:04:26,460
about the launch and the return and down

116
00:04:29,510 --> 00:04:27,810
here there's an actual chamber for the

117
00:04:31,940 --> 00:04:29,520
media that can be stored in until we're

118
00:04:34,759 --> 00:04:31,950
ready to inoculate the petri dish and we

119
00:04:37,939 --> 00:04:34,769
used a rich media TS

120
00:04:39,949 --> 00:04:37,949
that has protein and glucose as carbon

121
00:04:41,029 --> 00:04:39,959
sources as well as about twenty ten

122
00:04:42,889 --> 00:04:41,039
percent glycerol so we could actually

123
00:04:44,749 --> 00:04:42,899
freeze our samples and bring them back

124
00:04:47,359 --> 00:04:44,759
to earth and they would still be in this

125
00:04:48,739 --> 00:04:47,369
kind of state of hey we're still in

126
00:04:51,769 --> 00:04:48,749
space even though they're on the ground

127
00:04:53,509 --> 00:04:51,779
white when we follow them and so the

128
00:04:55,219 --> 00:04:53,519
actual timeline for our mission which

129
00:04:59,209 --> 00:04:55,229
became known as Brook 21 because it was

130
00:05:02,479 --> 00:04:59,219
the 21st brick mission launched in April

131
00:05:04,429 --> 00:05:02,489
2015 dr. the National Space Station they

132
00:05:08,119 --> 00:05:04,439
inoculated the samples in space right

133
00:05:09,499 --> 00:05:08,129
here and they roiled to grow at ambient

134
00:05:12,229 --> 00:05:09,509
space station temperature approximately

135
00:05:13,819 --> 00:05:12,239
23 degrees Celsius for about 25 hours

136
00:05:16,609 --> 00:05:13,829
after which they were frozen in minus 80

137
00:05:18,529 --> 00:05:16,619
degrees and shipped back to earth where

138
00:05:19,579 --> 00:05:18,539

you know me and my lab were able to get

139
00:05:22,549 --> 00:05:19,589
our hands on and I saw actually

140
00:05:24,169 --> 00:05:22,559
processing the samples and because space

141
00:05:24,469 --> 00:05:24,179
is limited we wanted to do a lot with a

142
00:05:26,989 --> 00:05:24,479
little

143
00:05:28,819 --> 00:05:26,999
and so this is kind of everything we

144
00:05:29,749 --> 00:05:28,829
wanted to do with them and you can kind

145
00:05:31,399 --> 00:05:29,759
of see we've kind of looked at the

146
00:05:32,600 --> 00:05:31,409
antibiotic profiles and the mutation

147
00:05:34,549 --> 00:05:32,610
rates and everything I'm going to focus

148
00:05:37,129 --> 00:05:34,559
mostly on the transcriptome how they're

149
00:05:39,499 --> 00:05:37,139
actually adapting today but I guess it's

150
00:05:40,909 --> 00:05:39,509
a little late but Josh Lee had a student

151
00:05:41,689 --> 00:05:40,919
in our lab was actually giving a poster

152
00:05:43,339 --> 00:05:41,699
on this yesterday

153
00:05:45,139 --> 00:05:43,349
pretty sure if you still are interested

154
00:05:46,819 --> 00:05:45,149
in that Josh Ling Han would be happy to

155
00:05:47,929 --> 00:05:46,829
talk to you about mutation frequencies

156
00:05:50,119 --> 00:05:47,939
in space so they're my little plug for

157
00:05:52,189 --> 00:05:50,129
him but from here on I'm mostly talking

158
00:05:56,839 --> 00:05:52,199
about the transcriptome and how the gene

159
00:05:59,719 --> 00:05:56,849
expression is affected by space so how

160
00:06:01,819 --> 00:05:59,729
do we do transcriptomics we get the

161
00:06:03,559 --> 00:06:01,829
samples back they're frozen we thaw them

162
00:06:05,569 --> 00:06:03,569
in the lab and we immediately extract

163
00:06:09,679 --> 00:06:05,579

the RNA so we have all the RNA that was

164
00:06:11,419 --> 00:06:09,689
up in space before it's degraded as well

165
00:06:13,309 --> 00:06:11,429
as the ground samples that we flew are

166
00:06:14,719 --> 00:06:13,319
that we didn't fly that we're sitting at

167
00:06:17,509 --> 00:06:14,729
NASA while the ground all the

168
00:06:19,609 --> 00:06:17,519
spaceflight samples were flying and we

169
00:06:21,229 --> 00:06:19,619
then sequenced that RNA to get it you

170
00:06:22,939 --> 00:06:21,239
know figure out what the actual code is

171
00:06:26,089 --> 00:06:22,949
and then we can do differential

172
00:06:28,159 --> 00:06:26,099
expression analysis on those sequences

173
00:06:30,679 --> 00:06:28,169
so differential expression analysis I

174
00:06:31,999 --> 00:06:30,689
take the reads and I filter them for

175
00:06:33,499 --> 00:06:32,009
quality making sure that you know we

176
00:06:35,569 --> 00:06:33,509
actually have good reads or reads aren't

177
00:06:36,919 --> 00:06:35,579
you know messed up or anything and then

178
00:06:38,899 --> 00:06:36,929
I line them to the genome and every

179
00:06:41,389 --> 00:06:38,909
single sample we had had about 50

180
00:06:43,909 --> 00:06:41,399
million reads per sample and we had in

181
00:06:46,670 --> 00:06:43,919
equals 3 for Brick 21 so that's total of

182
00:06:47,790 --> 00:06:46,680
6 samples 3 per condition and we use a

183
00:06:49,170 --> 00:06:47,800
machine to do this because I

184
00:06:51,809 --> 00:06:49,180
you want to graduate eventually and not

185
00:06:54,149 --> 00:06:51,819
have film and then once we align them to

186
00:06:55,860 --> 00:06:54,159
the genome we count how many sequences

187
00:06:57,839 --> 00:06:55,870
are there for every single gene so we

188
00:06:59,640 --> 00:06:57,849

can get kind of a quantitative number of

189
00:07:01,379 --> 00:06:59,650
how much was this gene being expressed

190
00:07:03,570 --> 00:07:01,389
in space compare and you know compared

191
00:07:05,580 --> 00:07:03,580
to on the ground and then we statistics

192
00:07:09,809 --> 00:07:05,590
we use actually two packages Lima into

193
00:07:12,300 --> 00:07:09,819
ec2 to determine if it's you know higher

194
00:07:13,260 --> 00:07:12,310
or lower in space compared to ground in

195
00:07:14,820 --> 00:07:13,270
order for a gene to be consider

196
00:07:16,439 --> 00:07:14,830
differentially expressed it had to have

197
00:07:17,909 --> 00:07:16,449
at least a two-fold change in the number

198
00:07:20,580 --> 00:07:17,919
of counts and between flight and ground

199
00:07:21,719 --> 00:07:20,590
with a p-value of point zero one and

200
00:07:24,180 --> 00:07:21,729
since we were looking about four

201
00:07:25,709 --> 00:07:24,190
thousand four hundred transcripts we did

202
00:07:27,300 --> 00:07:25,719
correct from local testing bias using

203
00:07:29,670 --> 00:07:27,310
Benjamin Hochberg and all that stuff and

204
00:07:31,050 --> 00:07:29,680
so we're pretty confident with our you

205
00:07:32,399 --> 00:07:31,060
know genes we get and then we do

206
00:07:33,749 --> 00:07:32,409
functional analysis to kind of figure

207
00:07:35,640 --> 00:07:33,759
out what are those genes actually doing

208
00:07:37,770 --> 00:07:35,650
and do they kind of group into different

209
00:07:41,339 --> 00:07:37,780
pathways so we can kind of try to target

210
00:07:44,490 --> 00:07:41,349
pathways not just individual genes so we

211
00:07:45,540 --> 00:07:44,500
did this on Brick 21 and we found 293

212
00:07:47,640 --> 00:07:45,550
genes that were differentially expressed

213
00:07:49,920 --> 00:07:47,650

between flight and ground so there's

214
00:07:52,379 --> 00:07:49,930
about 177 that were higher in space

215
00:07:55,019 --> 00:07:52,389
flight and about 116 that were higher in

216
00:07:56,339 --> 00:07:55,029
the ground samples and from this we did

217
00:07:57,959 --> 00:07:56,349
you know our functional annotation try

218
00:07:59,700 --> 00:07:57,969
figure out what was going on and we

219
00:08:01,890 --> 00:07:59,710
found about 10 enriched KEGG pathways

220
00:08:03,689 --> 00:08:01,900
KEGG pathways are just kind of submitted

221
00:08:05,600 --> 00:08:03,699
but pathways such as biotin metabolism

222
00:08:07,890 --> 00:08:05,610
arginine we actually had a couple of

223
00:08:09,899 --> 00:08:07,900
non-ribosomal peptide biosynthesis

224
00:08:11,610 --> 00:08:09,909
pathways going on and it's an actually

225
00:08:14,670 --> 00:08:11,620
metabolism just to kinda name a few but

226
00:08:16,980 --> 00:08:14,680
while we were analyzing this data nasa

227
00:08:18,689 --> 00:08:16,990
was generous enough to let our lab kind

228
00:08:20,339 --> 00:08:18,699
of participate on a second space flight

229
00:08:22,499 --> 00:08:20,349
experiment which became those brook 23

230
00:08:24,540 --> 00:08:22,509
where we flew the exact same hardware

231
00:08:26,730 --> 00:08:24,550
exact same strain exact same media and

232
00:08:29,730 --> 00:08:26,740
this was very important because to this

233
00:08:32,430 --> 00:08:29,740
point no transcriptome for bacteria has

234
00:08:33,750 --> 00:08:32,440
ever been duplicated in space so this

235
00:08:35,639 --> 00:08:33,760
was kind of a nice idea to say can we

236
00:08:36,990 --> 00:08:35,649
see the same results if we duplicate the

237
00:08:41,389 --> 00:08:37,000
sensation of the gold standard of

238
00:08:44,130 --> 00:08:41,399

science and however adhering the kind of

239
00:08:46,500 --> 00:08:44,140
development and planning stage instead

240
00:08:48,240 --> 00:08:46,510
of rowing it for 20-25 hours we they

241
00:08:49,350 --> 00:08:48,250
grew these for 26 hours that's the only

242
00:08:52,410 --> 00:08:49,360
difference between these two we actually

243
00:08:53,579 --> 00:08:52,420
wanted to look at stationary phase which

244
00:08:55,500 --> 00:08:53,589
the first one for an exponential phase

245
00:08:57,329 --> 00:08:55,510
to kind of see like differences in fit

246
00:09:00,180 --> 00:08:57,339
growth phases but if there's an effect

247
00:09:01,540 --> 00:09:00,190
by spaceflight we should still see genes

248
00:09:03,550 --> 00:09:01,550
up regardless of what

249
00:09:05,769 --> 00:09:03,560
Faye's it's in so can we kind of use

250
00:09:07,509 --> 00:09:05,779
these two different phases to pull out

251
00:09:11,800 --> 00:09:07,519
genes that spaceflight effects

252
00:09:15,040 --> 00:09:11,810
continuously and so these flew about a

253
00:09:16,720 --> 00:09:15,050
year after the first ones and then so we

254
00:09:18,370 --> 00:09:16,730
did you know transcriptome profiling the

255
00:09:19,900 --> 00:09:18,380
same way as the first one and I love

256
00:09:22,360 --> 00:09:19,910
this photo because these are actually

257
00:09:27,100 --> 00:09:22,370
our samples in space and they're

258
00:09:30,400 --> 00:09:27,110
floating I love looking at there's no

259
00:09:33,130 --> 00:09:30,410
strings attached and so we found about

260
00:09:35,590 --> 00:09:33,140
255 genes in the 23 samples that were

261
00:09:37,030 --> 00:09:35,600
differentially expressed so feel a few

262
00:09:38,680 --> 00:09:37,040
less than brick 20 where I'm about the

263
00:09:40,480 --> 00:09:38,690

same number and we found about seven and

264
00:09:44,980 --> 00:09:40,490
rich pathways

265
00:09:46,449 --> 00:09:44,990
among these 255 genes this is all great

266
00:09:47,829 --> 00:09:46,459
and everything but you know how do they

267
00:09:49,150 --> 00:09:47,839
compare to one another that was the you

268
00:09:50,259 --> 00:09:49,160
know the big question and so I want to

269
00:09:52,389 --> 00:09:50,269
know what the variation between the

270
00:09:53,860 --> 00:09:52,399
different samples were you know do are

271
00:09:55,720 --> 00:09:53,870
their samples clustered together are

272
00:09:57,370 --> 00:09:55,730
they completely over the map and so I

273
00:09:59,110 --> 00:09:57,380
ran a principal component analysis and

274
00:10:01,060 --> 00:09:59,120
what you can kind of see is if you look

275
00:10:02,230 --> 00:10:01,070
at the first principal component you see

276
00:10:05,860 --> 00:10:02,240
that the sample is kind of clustered

277
00:10:07,630 --> 00:10:05,870
between brick 21 and brick 23 and have

278
00:10:10,329 --> 00:10:07,640
about 51 percent of variation between

279
00:10:12,460 --> 00:10:10,339
all the samples and because we grew them

280
00:10:13,810 --> 00:10:12,470
at different state growth phases this

281
00:10:16,120 --> 00:10:13,820
isn't uncommon because they should have

282
00:10:17,440 --> 00:10:16,130
completely different gene expressions

283
00:10:18,880 --> 00:10:17,450
when they're you know rapidly growing an

284
00:10:20,740 --> 00:10:18,890
exponential phase that's when they're

285
00:10:22,660 --> 00:10:20,750
dormant in stationary phase but if you

286
00:10:24,579 --> 00:10:22,670
look over at the second principal

287
00:10:26,590 --> 00:10:24,589
component you see that about 21 percent

288
00:10:28,449 --> 00:10:26,600

of the variants between all the genes

289
00:10:30,340 --> 00:10:28,459
can be explained by grouping the ground

290
00:10:33,910 --> 00:10:30,350
samples together and the flight samples

291
00:10:37,240 --> 00:10:33,920
together so we do see this effect of

292
00:10:38,470 --> 00:10:37,250
spaceflight even though our examples

293
00:10:39,910 --> 00:10:38,480
were going to this different face so we

294
00:10:41,590 --> 00:10:39,920
can actually pull out maybe some

295
00:10:44,710 --> 00:10:41,600
effective spaceflight even though it's

296
00:10:47,889 --> 00:10:44,720
it's not the dominant source of our

297
00:10:49,540 --> 00:10:47,899
variants and so we then want to see can

298
00:10:50,769 --> 00:10:49,550
we actually see this at the actual gene

299
00:10:52,800 --> 00:10:50,779
level do we have new genes that are

300
00:10:55,449 --> 00:10:52,810
differentially expressed in both

301
00:10:56,500 --> 00:10:55,459
experiments and we found 91 genes that

302
00:11:00,610 --> 00:10:56,510
were differentially expressed in both

303
00:11:02,110 --> 00:11:00,620
experiments so yeah about put and so 55

304
00:11:04,480 --> 00:11:02,120
of these genes were upregulated in

305
00:11:06,759 --> 00:11:04,490
spaceflight which include our biotin

306
00:11:09,430 --> 00:11:06,769
metabolism biotin uptake genes as well

307
00:11:10,569 --> 00:11:09,440
as our biofilm biosynthesis genes as I

308
00:11:11,980 --> 00:11:10,579
mentioned before you know NASA is very

309
00:11:15,250 --> 00:11:11,990
interested in these biofilm by since the

310
00:11:17,260 --> 00:11:15,260
scheme and then we found 36 that

311
00:11:19,030 --> 00:11:17,270
regulating the ground control and these

312
00:11:21,550 --> 00:11:19,040
are national metabolism into component

313
00:11:23,590 --> 00:11:21,560

systems an actually metabolism is a bit

314
00:11:25,960 --> 00:11:23,600
of a misleading because it was really

315
00:11:27,610 --> 00:11:25,970
just the nitrate reductase genes which

316
00:11:29,920 --> 00:11:27,620
are expressed in low oxygen conditions

317
00:11:31,450 --> 00:11:29,930
and this is we also saw some other

318
00:11:33,700 --> 00:11:31,460
fermentation genes that are also

319
00:11:35,410 --> 00:11:33,710
expressed in low oxygen conditions so we

320
00:11:37,330 --> 00:11:35,420
think most of the genes it looks like

321
00:11:39,610 --> 00:11:37,340
most the genes that are down regulated

322
00:11:43,060 --> 00:11:39,620
were due to maybe a difference in oxygen

323
00:11:44,680 --> 00:11:43,070
between the flight and ground sample but

324
00:11:46,360 --> 00:11:44,690
the flight samples going back to those

325
00:11:47,920 --> 00:11:46,370
you know we didn't see this biofilm

326
00:11:49,420 --> 00:11:47,930
bison for this gene which we're kind of

327
00:11:51,580 --> 00:11:49,430
like wanting to dive in a bit more into

328
00:11:53,410 --> 00:11:51,590
like okay we see them up masses kind of

329
00:11:55,780 --> 00:11:53,420
interest in these you know what do we

330
00:11:56,980 --> 00:11:55,790
actually see with our gene counts and I

331
00:11:58,210 --> 00:11:56,990
know probably most of you do not

332
00:12:00,490 --> 00:11:58,220
understand what these four little

333
00:12:02,920 --> 00:12:00,500
radiations are so I will be I will kind

334
00:12:05,800 --> 00:12:02,930
of dive into that all these genes are

335
00:12:07,360 --> 00:12:05,810
the genes required to make biofilms in

336
00:12:09,670 --> 00:12:07,370
bacillus unless the organism that we're

337
00:12:12,340 --> 00:12:09,680
using so any available that aren't

338
00:12:14,350 --> 00:12:12,350

familiar with biofilms the most simple

339
00:12:16,390 --> 00:12:14,360
and probably when you associate with the

340
00:12:18,520 --> 00:12:16,400
most is plaque on your teeth it's a

341
00:12:21,820 --> 00:12:18,530
community of cells that kind of grouped

342
00:12:23,290 --> 00:12:21,830
together in a protein sugar matrix that

343
00:12:25,570 --> 00:12:23,300
kind of shared nutrients kind of help

344
00:12:27,760 --> 00:12:25,580
each other out and this protects them

345
00:12:29,200 --> 00:12:27,770
from invaders antibiotics and a bunch of

346
00:12:30,970 --> 00:12:29,210
other environmental stresses so you know

347
00:12:33,550 --> 00:12:30,980
bacteria love to grow in these biofilms

348
00:12:39,490 --> 00:12:33,560
and they're made up of like I said EXO

349
00:12:41,260 --> 00:12:39,500
polysaccharide or EPS sugars there's a

350
00:12:43,240 --> 00:12:41,270
biofilm surface layer protein and then

351
00:12:44,770 --> 00:12:43,250
you also have a protein scaffold that

352
00:12:47,470 --> 00:12:44,780
kind of holds them together as well

353
00:12:50,200 --> 00:12:47,480
within the sugar matrix so we have all

354
00:12:52,480 --> 00:12:50,210
of our genes here and if you look at you

355
00:12:54,010 --> 00:12:52,490
know this cut off of it this is a log to

356
00:12:56,380 --> 00:12:54,020
scale so this is a two-fold change

357
00:12:58,420 --> 00:12:56,390
there's only two genes that don't have a

358
00:13:01,150 --> 00:12:58,430
two-fold change between fly and grounds

359
00:13:03,670 --> 00:13:01,160
so almost all of our biofilm

360
00:13:05,290 --> 00:13:03,680
biosynthesis genes are upregulated in

361
00:13:07,620 --> 00:13:05,300
spaceflight and so this is the first

362
00:13:10,390 --> 00:13:07,630
molecular evidence that we have that

363
00:13:13,150 --> 00:13:10,400

points towards spaceflight you know

364
00:13:14,680 --> 00:13:13,160
promoting biofilm biosynthesis now we

365
00:13:16,750 --> 00:13:14,690
don't have a you know reason why this is

366
00:13:18,190 --> 00:13:16,760
right now but you know something that

367
00:13:21,730 --> 00:13:18,200
we're hoping to look into in the future

368
00:13:25,780 --> 00:13:21,740
with more spaceflight missions you know

369
00:13:27,910 --> 00:13:25,790
and more regular tests on regulations so

370
00:13:28,720 --> 00:13:27,920
it's kind of with that in the conclusion

371
00:13:30,460 --> 00:13:28,730
we

372
00:13:31,900 --> 00:13:30,470
fine about 91 genes that are

373
00:13:32,980 --> 00:13:31,910
differentially expressed and these 91

374
00:13:35,230 --> 00:13:32,990
genes we're gonna look further into

375
00:13:38,319 --> 00:13:35,240
because these could be good candidates

376
00:13:40,120 --> 00:13:38,329
for how space is affecting bacteria like

377
00:13:42,819 --> 00:13:40,130
what are these you know we'd knock out

378
00:13:44,170 --> 00:13:42,829
these 91 genes one of them how does it

379
00:13:46,620 --> 00:13:44,180
affect space why does it have a effect

380
00:13:49,150 --> 00:13:46,630
at all you know kind of dive in further

381
00:13:51,250 --> 00:13:49,160
also look further into biofilm

382
00:13:53,079 --> 00:13:51,260
biosynthesis we do see the first

383
00:13:56,350 --> 00:13:53,089
molecular kind of evidence for this

384
00:13:58,629 --> 00:13:56,360
increased production in space and it

385
00:14:00,430 --> 00:13:58,639
appears that at least for the hardware

386
00:14:02,920 --> 00:14:00,440
we're using the available of nitrogen

387
00:14:04,090 --> 00:14:02,930
oxygen is different between flight and

388
00:14:06,400 --> 00:14:04,100

ground and that's something that we are

389
00:14:10,389 --> 00:14:06,410
discussing with NASA on kind of making

390
00:14:12,280 --> 00:14:10,399
adjustments to the hardware for that but

391
00:14:13,920 --> 00:14:12,290
you know science is in a one-man show so

392
00:14:17,019 --> 00:14:13,930
I have a lot of people I want to thank

393
00:14:18,430 --> 00:14:17,029
primarily my boss and Patricia Fajardo

394
00:14:20,079 --> 00:14:18,440
who actually helped with a lot of

395
00:14:21,220 --> 00:14:20,089
processing and integration the

396
00:14:23,650 --> 00:14:21,230
integration of the spaceflight

397
00:14:25,960 --> 00:14:23,660
experiments the BRIC 21 BRIC 23 teams

398
00:14:27,400 --> 00:14:25,970
who you know helped integration with the

399
00:14:29,350 --> 00:14:27,410
preparing of the samples and everything

400
00:14:31,810 --> 00:14:29,360
and the astronauts who actually ran my

401
00:14:35,650 --> 00:14:31,820
experiments in space that you know they

402
00:14:39,100 --> 00:14:35,660
wouldn't let me do and so with that

403
00:14:43,060 --> 00:14:39,110
oh and NASA for funding me and and with

404
00:14:47,620 --> 00:14:46,139
[Applause]

405
00:14:57,340 --> 00:14:47,630
thank you Michael

406
00:15:04,549 --> 00:15:02,569
do you have ideas about why biotin is

407
00:15:05,749 --> 00:15:04,559
upregulated is it a general stress

408
00:15:07,939 --> 00:15:05,759
response do you think there's a certain

409
00:15:10,609 --> 00:15:07,949
protein that is a cofactor that's

410
00:15:12,169 --> 00:15:10,619
hindered in some way like so yeah we're

411
00:15:14,389 --> 00:15:12,179
working fused about that little bit we

412
00:15:16,609 --> 00:15:14,399
don't know for sure because it's you

413
00:15:19,850 --> 00:15:16,619

it's a B vitamin it's used in the

414
00:15:22,100 --> 00:15:19,860
biosynthesis of some fatty acids and

415
00:15:24,169 --> 00:15:22,110
branched chain amino acids and buccaneer

416
00:15:25,729 --> 00:15:24,179
genesis but we looked at all the genes

417
00:15:27,710 --> 00:15:25,739
involved in those pathways and none of

418
00:15:35,780 --> 00:15:27,720
more differentially expressed so we have

419
00:15:38,660 --> 00:15:35,790
no clue why they're up regarding the

420
00:15:40,609 --> 00:15:38,670
about film production do you think that

421
00:15:43,160 --> 00:15:40,619
a my absolutely to do with form sensing

422
00:15:45,859 --> 00:15:43,170
signal regulation with volatility in the

423
00:15:48,259 --> 00:15:45,869
og so there is some thought about

424
00:15:50,509 --> 00:15:48,269
motility in space we didn't see any

425
00:15:52,639 --> 00:15:50,519
motility genes upregulated but we did

426
00:15:55,160 --> 00:15:52,649
see a quorum sensing gene surfactant

427
00:15:57,499 --> 00:15:55,170
that was up regulated in space so that

428
00:15:59,030 --> 00:15:57,509
probably one reason why we're seeing the

429
00:16:02,539 --> 00:15:59,040
increase in point of information but we

430
00:16:04,069 --> 00:16:02,549
don't necessarily know you know why that

431
00:16:06,309 --> 00:16:04,079
coursing gene would be higher in space

432
00:16:09,019 --> 00:16:06,319
but we did see one Qantas engine

433
00:16:11,970 --> 00:16:09,029
okay let's thank Michael again I don't