
AbSciCon
2019

1
00:00:00,790 --> 00:00:07,320
[Music]

2
00:00:11,310 --> 00:00:08,700
[Applause]

3
00:00:14,010 --> 00:00:11,320
I think when we conceived of this

4
00:00:16,080 --> 00:00:14,020
session we thought that we would I

5
00:00:17,970 --> 00:00:16,090
really wanted to call it weird life but

6
00:00:19,530 --> 00:00:17,980
we got kind of merged with some other

7
00:00:21,210 --> 00:00:19,540
sessions and so we had to make a more

8
00:00:24,450 --> 00:00:21,220
general term and so you guys have

9
00:00:26,520 --> 00:00:24,460
already heard about Hot Springs and sea

10
00:00:29,040 --> 00:00:26,530
floors and so I want to kind of

11
00:00:30,480 --> 00:00:29,050
transition oh and maybe even Mars and so

12
00:00:32,430 --> 00:00:30,490
I wanted to transition to some other

13
00:00:36,180 --> 00:00:32,440

locations that we could think of life

14
00:00:37,970 --> 00:00:36,190
beginning and this has been borne out of

15
00:00:40,560 --> 00:00:37,980
a project from the ideas lab which

16
00:00:43,950 --> 00:00:40,570
stemmed from can we have oil-based life

17
00:00:45,960 --> 00:00:43,960
so scientists generally think that we

18
00:00:48,180 --> 00:00:45,970
are looking for liquid water when we

19
00:00:51,060 --> 00:00:48,190
look for exoplanets and the question is

20
00:00:54,000 --> 00:00:51,070
is that a good assumption and can we get

21
00:00:58,319 --> 00:00:54,010
any interesting behaviors from polymers

22
00:01:00,119 --> 00:00:58,329
in a non-polar phase so is hydrogen

23
00:01:04,469 --> 00:01:00,129
bonding really necessary for our liquids

24
00:01:06,510 --> 00:01:04,479
and so I would like to just start by

25
00:01:08,790 --> 00:01:06,520
thanking my collaborators and that's

26
00:01:10,920 --> 00:01:08,800
Lauren Williams from Georgia Tech Paul

27
00:01:13,800 --> 00:01:10,930
bratter from University Saint Louis

28
00:01:16,080 --> 00:01:13,810
University Chris butch is at LC Tokyo

29
00:01:18,149 --> 00:01:16,090
and Mike travisano is at the University

30
00:01:20,219 --> 00:01:18,159
of Minnesota and they have all been

31
00:01:23,820 --> 00:01:20,229
instrumental in kind of shaping these

32
00:01:26,580 --> 00:01:23,830
ideas and then I work at a predominantly

33
00:01:28,320 --> 00:01:26,590
undergraduate institution so I have a

34
00:01:30,060 --> 00:01:28,330
kind of team of undergraduates who have

35
00:01:32,700 --> 00:01:30,070
participated in this research and

36
00:01:34,770 --> 00:01:32,710
evolved it to where it is today and I

37
00:01:37,920 --> 00:01:34,780
think that it's really important to

38
00:01:39,870 --> 00:01:37,930

recognize specifically brooke thompson

39
00:01:42,240 --> 00:01:39,880
who did a large amount of the amino acid

40
00:01:45,210 --> 00:01:42,250
work and then Tanner Brawl who's working

41
00:01:47,609 --> 00:01:45,220
on some of the results that I'm not

42
00:01:49,760 --> 00:01:47,619
really showing here and of course I'd

43
00:01:52,230 --> 00:01:49,770
like to thank our benevolent overlords

44
00:01:57,060 --> 00:01:52,240
NSF and NASA for supporting these

45
00:02:00,630 --> 00:01:57,070
projects so the idea of how do you even

46
00:02:03,060 --> 00:02:00,640
test if oil phases are good for life is

47
00:02:06,420 --> 00:02:03,070
is a challenging topic right how do you

48
00:02:09,749 --> 00:02:06,430
evaluate if this is possible and our

49
00:02:12,479 --> 00:02:09,759
solution was to say if we can get any

50
00:02:14,220 --> 00:02:12,489
kind of polymer into an oil phase and

51
00:02:17,670 --> 00:02:14,230
have it interact with another polymer

52
00:02:19,380 --> 00:02:17,680
that might be considered functionality

53
00:02:22,289 --> 00:02:19,390
and you know that actually turned out to

54
00:02:24,660 --> 00:02:22,299
be a pretty lofty goal and so first we

55
00:02:27,600 --> 00:02:24,670
started with analyzing how biological

56
00:02:29,940 --> 00:02:27,610
polymers enter oil phases and I wanted

57
00:02:31,530 --> 00:02:29,950
to answer the question can they and also

58
00:02:34,349 --> 00:02:31,540
when they enter those phases do they

59
00:02:35,640 --> 00:02:34,359
have any interesting structures so the

60
00:02:37,710 --> 00:02:35,650
biomolecules that I'm looking at and

61
00:02:40,890 --> 00:02:37,720
that I'm showing you here are amino

62
00:02:44,490 --> 00:02:40,900
acids and proteins specifically we have

63
00:02:46,380 --> 00:02:44,500

some amino acids and we evaluate them

64
00:02:48,149 --> 00:02:46,390
both in the acidic the neutral and the

65
00:02:50,220 --> 00:02:48,159
basic form because you can see the

66
00:02:51,930 --> 00:02:50,230
charge changes so in the acidic form we

67
00:02:55,589 --> 00:02:51,940
have a positive charge on our ammonia

68
00:02:57,449 --> 00:02:55,599
and a neutral carboxylic acid in the

69
00:02:59,699 --> 00:02:57,459
neutral form we have as whitter ionic

70
00:03:03,420 --> 00:02:59,709
situation where both the base and the

71
00:03:06,860 --> 00:03:03,430
acid are charged and then in our basic

72
00:03:10,259 --> 00:03:06,870
system our ammonia deprotonates and our

73
00:03:13,710 --> 00:03:10,269
carboxylate is deep charged negatively

74
00:03:17,009 --> 00:03:13,720
charged and we tested one charged amino

75
00:03:20,160 --> 00:03:17,019
acid glutamic acid it has a carboxylate

76
00:03:21,839 --> 00:03:20,170
on its side chain we also tested glycine

77
00:03:24,119 --> 00:03:21,849
and of course phenylalanine and

78
00:03:26,819 --> 00:03:24,129
phenylalanine was our initial choice

79
00:03:27,960 --> 00:03:26,829
because it is a little more hydrophobic

80
00:03:31,229 --> 00:03:27,970
and so we're hoping that would force

81
00:03:34,619 --> 00:03:31,239
things into our oil phase we have also

82
00:03:37,020 --> 00:03:34,629
looked at polymers oh and so we have

83
00:03:39,059 --> 00:03:37,030
looked at dye glycine and tri glycine

84
00:03:41,430 --> 00:03:39,069
and we've tried two different proteins

85
00:03:43,550 --> 00:03:41,440
so we tried BSA because it's cheap and

86
00:03:45,629 --> 00:03:43,560
it's in my lab and then we've tried

87
00:03:49,550 --> 00:03:45,639
tackle race and we were thinking that

88
00:03:51,719 --> 00:03:49,560

maybe tack would have more

89
00:03:53,849 --> 00:03:51,729
conformational stability in weird

90
00:03:55,259 --> 00:03:53,859
environments because of how it folds and

91
00:03:59,490 --> 00:03:55,269
how it stabilizes for high temperatures

92
00:04:01,439 --> 00:03:59,500
and so how we do our phase partitioning

93
00:04:02,759 --> 00:04:01,449
it's essentially I know that you might

94
00:04:05,699 --> 00:04:02,769
think this must have already been done

95
00:04:08,250 --> 00:04:05,709
by someone but we actually are cheating

96
00:04:10,680 --> 00:04:08,260
because we add something to

97
00:04:13,439 --> 00:04:10,690
counterbalance our charges so we have a

98
00:04:16,349 --> 00:04:13,449
Dessel sulfate that is in our water

99
00:04:17,370 --> 00:04:16,359
phase to counterbalance the positive

100
00:04:22,379 --> 00:04:17,380
charge on our amines

101
00:04:24,210 --> 00:04:22,389
and we have a desk dido Dessel dimethyl

102
00:04:26,820 --> 00:04:24,220
ammonium bromide so quaternary amine

103
00:04:28,330 --> 00:04:26,830
that balances the negative charge on our

104
00:04:31,450 --> 00:04:28,340
carboxylates

105
00:04:33,670 --> 00:04:31,460
and the reason that we choose DDA be is

106
00:04:36,040 --> 00:04:33,680
because it's a transaction agent so it

107
00:04:38,290 --> 00:04:36,050
can be used to pull DNA into cells and

108
00:04:39,820 --> 00:04:38,300
so it seems like you know if it can help

109
00:04:43,270 --> 00:04:39,830
permeate a cell membrane maybe it'll

110
00:04:45,760 --> 00:04:43,280
help enter an elf ace and so what

111
00:04:50,379 --> 00:04:45,770
happens when we look at just glycine or

112
00:04:52,090 --> 00:04:50,389
our monomeric amino acids oh so how this

113
00:04:54,280 --> 00:04:52,100

works is and how we how we do the

114
00:04:57,070 --> 00:04:54,290
experiment is we just vortex the water

115
00:04:59,439 --> 00:04:57,080
phase with our oil phase and we kind of

116
00:05:01,840 --> 00:04:59,449
hope that some of our biomolecules enter

117
00:05:04,540 --> 00:05:01,850
into the oil phase we also expect that

118
00:05:07,060 --> 00:05:04,550
there is some like monomer or sorry mono

119
00:05:09,550 --> 00:05:07,070
layer forming where our amphiphiles may

120
00:05:12,490 --> 00:05:09,560
actually partially partition into our

121
00:05:15,010 --> 00:05:12,500
oil phase we may have some interaction

122
00:05:18,730 --> 00:05:15,020
here and so to prevent that we actually

123
00:05:21,450 --> 00:05:18,740
separate out our molecules using HPLC so

124
00:05:24,550 --> 00:05:21,460
we're really just trying to look at our

125
00:05:26,920 --> 00:05:24,560
biomolecules and not the other products

126
00:05:28,810 --> 00:05:26,930
using HPLC and we actually use charged

127
00:05:30,430 --> 00:05:28,820
aerosol detection which is a universal

128
00:05:33,370 --> 00:05:30,440
detector so we haven't derivatives our

129
00:05:36,219 --> 00:05:33,380
amino acids at all and what we see is

130
00:05:38,260 --> 00:05:36,229
that glutamic acid has it has three

131
00:05:41,320 --> 00:05:38,270
charged States right it has the aming it

132
00:05:43,629 --> 00:05:41,330
has two carboxylates and we see that

133
00:05:46,930 --> 00:05:43,639
it's actually pretty bad at entering oil

134
00:05:49,060 --> 00:05:46,940
phases this is the just directly from

135
00:05:50,920 --> 00:05:49,070
the HPLC you can see that we get a large

136
00:05:53,110 --> 00:05:50,930
amount detected in the water phase and a

137
00:05:55,960 --> 00:05:53,120
really tiny amount regardless of our

138
00:05:57,940 --> 00:05:55,970

four PHS that we've tried and we pick

139
00:06:00,219 --> 00:05:57,950
these PHS because they are in between

140
00:06:04,770 --> 00:06:00,229
the PKS so we would expect the majority

141
00:06:08,010 --> 00:06:04,780
of our charge to be in that single state

142
00:06:11,110 --> 00:06:08,020
and so what we see with glycine is that

143
00:06:13,810 --> 00:06:11,120
at low pH we have almost no glycine in

144
00:06:15,969 --> 00:06:13,820
our oil phase but as we increase the pH

145
00:06:18,370 --> 00:06:15,979
we actually drive the glycine into the

146
00:06:21,550 --> 00:06:18,380
oil phase which is really promising it's

147
00:06:23,050 --> 00:06:21,560
possible that the Dessel sulfate that

148
00:06:24,969 --> 00:06:23,060
we're using is just not hydrophobic

149
00:06:27,339 --> 00:06:24,979
enough to cause this effect where the

150
00:06:30,070 --> 00:06:27,349
DDA B has those two hydrocarbon tails

151
00:06:32,230 --> 00:06:30,080
and so it's more effective but this begs

152
00:06:35,020 --> 00:06:32,240
the question you know we don't see any

153
00:06:37,270 --> 00:06:35,030
in our water phase at pH 10 and so

154
00:06:39,130 --> 00:06:37,280
is actually happening to the glycine

155
00:06:41,650 --> 00:06:39,140
it's possible that it's organizing at

156
00:06:44,140 --> 00:06:41,660
the interface which we're not testing or

157
00:06:45,670 --> 00:06:44,150
it's possible that it is precipitating

158
00:06:47,800 --> 00:06:45,680
out with maybe charge-charge

159
00:06:50,470 --> 00:06:47,810
interactions or something so we still

160
00:06:53,140 --> 00:06:50,480
have further testing to do and then with

161
00:06:54,550 --> 00:06:53,150
phenylalanine we see that at low pH and

162
00:06:56,620 --> 00:06:54,560
at high pH we get pretty good

163
00:06:59,170 --> 00:06:56,630

partitioning phenylalanine is pretty

164
00:07:00,670 --> 00:06:59,180
hydrophobic but then when it's doubly

165
00:07:02,440 --> 00:07:00,680
charged so at both a negative and a

166
00:07:06,100 --> 00:07:02,450
positive charge we see much less

167
00:07:08,200 --> 00:07:06,110
partitioning at the pH 7 and so I think

168
00:07:09,700 --> 00:07:08,210
you know this is a little bit predictive

169
00:07:11,410 --> 00:07:09,710
that you can kind of see that the more

170
00:07:13,090 --> 00:07:11,420
hydrophobic something is the more likely

171
00:07:17,890 --> 00:07:13,100
it is to enter an oil phase with the

172
00:07:21,100 --> 00:07:17,900
help of a phase transfer agent we also

173
00:07:23,500 --> 00:07:21,110
looked at how changing the amount of our

174
00:07:25,420 --> 00:07:23,510
phase transfer agent will change our

175
00:07:27,550 --> 00:07:25,430
partitioning so this is the

176
00:07:29,380 --> 00:07:27,560
concentration of Dessel sulfate the

177
00:07:31,510 --> 00:07:29,390
concentration of Desa salts fate indeed

178
00:07:33,550 --> 00:07:31,520
EAB or the concentration of DD a be

179
00:07:36,130 --> 00:07:33,560
alone at each of our PHS for

180
00:07:39,750 --> 00:07:36,140
phenylalanine specifically and we can

181
00:07:42,940 --> 00:07:39,760
see that as we increase our amount of

182
00:07:45,760 --> 00:07:42,950
phase transfer agent when we have equal

183
00:07:48,040 --> 00:07:45,770
molar amounts we have a about 40 percent

184
00:07:50,950 --> 00:07:48,050
partitioning but it does seem that it is

185
00:07:52,930 --> 00:07:50,960
going to reach a plateau right so this

186
00:07:55,170 --> 00:07:52,940
is not an unlimited amount that we can

187
00:07:59,740 --> 00:07:55,180
partition into an oil phase it's limited

188
00:08:01,510 --> 00:07:59,750

and interestingly at the pH 7 it

189
00:08:03,100 --> 00:08:01,520
plateaus that have really low value it's

190
00:08:08,590 --> 00:08:03,110
about 14 percent of our molecules

191
00:08:10,600 --> 00:08:08,600
actually partitioning so we also looked

192
00:08:12,490 --> 00:08:10,610
at polymers because obviously amino

193
00:08:14,920 --> 00:08:12,500
acids alone aren't super exciting and

194
00:08:18,040 --> 00:08:14,930
when we look at polymers what we see is

195
00:08:19,930 --> 00:08:18,050
that the glycine so this is just the

196
00:08:21,490 --> 00:08:19,940
data kind of reimagined from that first

197
00:08:24,640 --> 00:08:21,500
slide right so low pH we have almost

198
00:08:28,630 --> 00:08:24,650
nothing mid pH we have a small portion

199
00:08:31,420 --> 00:08:28,640
and then the high pH we see 50% of our

200
00:08:33,010 --> 00:08:31,430
starting material in the oil phase as we

201
00:08:34,510 --> 00:08:33,020
increase the length of our polymers we

202
00:08:37,630 --> 00:08:34,520
actually see that those would or ionic

203
00:08:40,360 --> 00:08:37,640
molecules are not there and you know the

204
00:08:42,640 --> 00:08:40,370
HPLC is really flat in this region it

205
00:08:44,650 --> 00:08:42,650
really seems like there are no no

206
00:08:46,450 --> 00:08:44,660
polymers entering the phase and again

207
00:08:47,210 --> 00:08:46,460
this could be a partitioning into the

208
00:08:50,210 --> 00:08:47,220
interface

209
00:08:51,890 --> 00:08:50,220
be a precipitating out of solution but

210
00:08:54,830 --> 00:08:51,900
we don't see it fully in the oil phase

211
00:08:56,900 --> 00:08:54,840
either or in the water phase either and

212
00:08:58,670 --> 00:08:56,910
a high pH we actually see that we get

213
00:09:01,970 --> 00:08:58,680

some of these polymers to enter into the

214
00:09:05,630 --> 00:09:01,980
oil phase and this may suggest that that

215
00:09:07,550 --> 00:09:05,640
the a mean is more more prone to

216
00:09:09,950 --> 00:09:07,560
preventing partitioning right when the

217
00:09:13,040 --> 00:09:09,960
it's an ammonium State it's less likely

218
00:09:14,780 --> 00:09:13,050
to partition into our oil phase and I

219
00:09:17,720 --> 00:09:14,790
have not fully characterized our

220
00:09:20,360 --> 00:09:17,730
proteins yet but we do know that we get

221
00:09:23,600 --> 00:09:20,370
some partitioning into an oil phase with

222
00:09:25,490 --> 00:09:23,610
both BSA and TAC so with BSA we try to

223
00:09:27,950 --> 00:09:25,500
have an absorbance of about 1 in our

224
00:09:30,260 --> 00:09:27,960
water phase and the difference between

225
00:09:37,160 --> 00:09:30,270
this dotted line which seems to be light

226
00:09:39,140 --> 00:09:37,170
scattering versus our BSA about 0.8 so I

227
00:09:41,150 --> 00:09:39,150
would say that we have about 50% of our

228
00:09:43,730 --> 00:09:41,160
protein looks like it actually can enter

229
00:09:46,400 --> 00:09:43,740
an oil phase and this is done with UV

230
00:09:49,160 --> 00:09:46,410
vis not with HPLC because the proteins

231
00:09:51,260 --> 00:09:49,170
are so large and if we really want to

232
00:09:52,790 --> 00:09:51,270
push it we can put a lot of tack into

233
00:09:54,860 --> 00:09:52,800
our water phase so here we're maxing out

234
00:09:58,550 --> 00:09:54,870
our detector and we see that we can get

235
00:10:01,010 --> 00:09:58,560
a pretty large tack peak we have run CV

236
00:10:02,930 --> 00:10:01,020
on these so circular dichroism can

237
00:10:05,390 --> 00:10:02,940
predict secondary structure and we

238
00:10:08,660 --> 00:10:05,400

actually see that we have no secondary

239
00:10:09,860 --> 00:10:08,670
structure in our oil phase it's likely

240
00:10:11,390 --> 00:10:09,870
that the proteins are just kind of

241
00:10:13,940 --> 00:10:11,400
turning inside out that the hydrophobic

242
00:10:16,820 --> 00:10:13,950
core is being inverted and we're losing

243
00:10:19,220 --> 00:10:16,830
all of our protein structure so I guess

244
00:10:22,070 --> 00:10:19,230
that's a downside of this this

245
00:10:24,190 --> 00:10:22,080
experiment but a result nonetheless and

246
00:10:26,840 --> 00:10:24,200
I would just like to give a brief

247
00:10:29,660 --> 00:10:26,850
preview to some of the other things that

248
00:10:31,940 --> 00:10:29,670
I've been working on so I have very

249
00:10:33,140 --> 00:10:31,950
similar to Dave Deemer and Nita so hi

250
00:10:36,200 --> 00:10:33,150
have been talking about have been using

251
00:10:37,760 --> 00:10:36,210
pH is for electron transfer and in this

252
00:10:40,940 --> 00:10:37,770
we're actually our goal is to reduce

253
00:10:43,160 --> 00:10:40,950
carbon dioxide into formate and we

254
00:10:45,920 --> 00:10:43,170
actually see that we get a pH change

255
00:10:47,960 --> 00:10:45,930
when we turn on the light so as you turn

256
00:10:51,380 --> 00:10:47,970
on the light you get an increase in pH

257
00:10:54,800 --> 00:10:51,390
and we also see if we run mass spec that

258
00:10:57,800 --> 00:10:54,810
we have a very small in this yellow peak

259
00:10:59,430 --> 00:10:57,810
a very small formic acid peak so the

260
00:11:01,140 --> 00:10:59,440
gray is our standard

261
00:11:03,450 --> 00:11:01,150
and we're it seems like we're actually

262
00:11:05,640 --> 00:11:03,460
producing formic acid in this process

263
00:11:08,880 --> 00:11:05,650

and our electron source in these

264
00:11:12,720 --> 00:11:08,890
reactions is a iron two-plus that iron

265
00:11:17,370 --> 00:11:12,730
chloride and I'll be talking more about

266
00:11:18,780 --> 00:11:17,380
this at the GRC in galveston and finally

267
00:11:20,970 --> 00:11:18,790
I just like to promote something that I

268
00:11:23,370 --> 00:11:20,980
spent a lot of time on with the help of

269
00:11:26,160 --> 00:11:23,380
many of you in this room there's an

270
00:11:27,990 --> 00:11:26,170
origins of life MOOC and it's a free

271
00:11:31,530 --> 00:11:28,000
course so if you go to complexity

272
00:11:33,510 --> 00:11:31,540
explore org you can sign up for this you

273
00:11:35,790 --> 00:11:33,520
can see your own videos if you recorded

274
00:11:37,980 --> 00:11:35,800
any additionally you can see comments so

275
00:11:41,310 --> 00:11:37,990
it's a good idea to see how the general

276
00:11:44,580 --> 00:11:41,320
public receives our kind of our kind of

277
00:11:46,530 --> 00:11:44,590
science and if you have any students who

278
00:11:48,660 --> 00:11:46,540
are entering the field that maybe need

279
00:11:50,250 --> 00:11:48,670
more of a background you can recommend

280
00:11:52,950 --> 00:11:50,260
this course for them and it gives a good

281
00:11:55,890 --> 00:11:52,960
overview of the physics the planetary

282
00:11:57,750 --> 00:11:55,900
science the chemistry the biology of

283
00:12:02,520 --> 00:11:57,760
origins of life so it's a good kind of

284
00:12:05,070 --> 00:12:02,530
primer for origins I'd be happy to take

285
00:12:05,080 --> 00:12:08,259
[Music]

286
00:12:14,109 --> 00:12:11,429
Thank You Sara we have time just for one

287
00:12:16,210 --> 00:12:14,119
question and if our men will Canadian is

288
00:12:20,350 --> 00:12:16,220

in the room I think we may need your

289
00:12:24,009 --> 00:12:20,360
slides loaded for the last slot so with

290
00:12:26,470 --> 00:12:24,019
that question is that Palmer hi I'm a

291
00:12:28,269 --> 00:12:26,480
bit confused what pH means when you're

292
00:12:30,699 --> 00:12:28,279
dealing with non aqueous solvents

293
00:12:33,100 --> 00:12:30,709
because the concentration of the H+ in

294
00:12:35,019 --> 00:12:33,110
the water won't be the same as the non

295
00:12:37,449 --> 00:12:35,029
aqueous solvent and and the ionization

296
00:12:38,949 --> 00:12:37,459
state of a molecule like an amino acid

297
00:12:42,100 --> 00:12:38,959
will change if it goes into the other

298
00:12:44,739 --> 00:12:42,110
solvent so how do you think about those

299
00:12:46,480 --> 00:12:44,749
things so I was really referring to we

300
00:12:48,460 --> 00:12:46,490
dissolve everything in water first and

301
00:12:52,809 --> 00:12:48,470
so I was referring to the starting water

302
00:12:55,299 --> 00:12:52,819
pH I don't have a good metric or a good

303
00:12:58,530 --> 00:12:55,309
system for measuring pH in an oil phase

304
00:13:01,059 --> 00:12:58,540
and so I have not really addressed that

305
00:13:04,689 --> 00:13:01,069
but you're right there is definitely a

306
00:13:11,020 --> 00:13:04,699
change in in PKA as we change our

307
00:13:12,230 --> 00:13:11,030
solvents thank you Sara