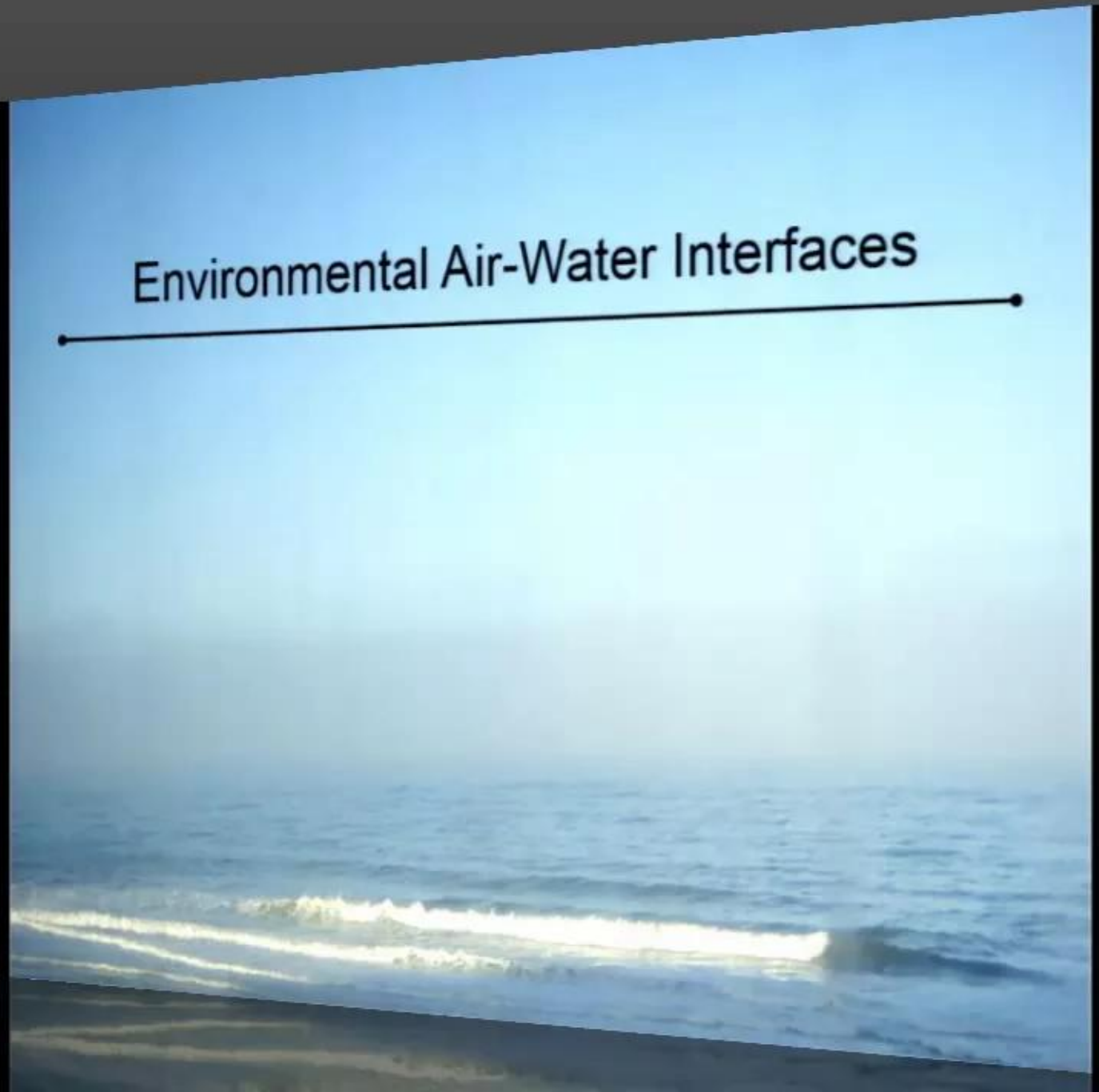
Environmental Air-Water Interfaces

1
00:00:11,790 --> 00:00:08,970
so we're going to step back a little bit

2
00:00:13,049 --> 00:00:11,800
in time and talk about I don't know

3
00:00:14,789 --> 00:00:13,059
whatever timeline you want to talk about

4
00:00:18,150 --> 00:00:14,799
but we're talking about prebiotic

5
00:00:19,290 --> 00:00:18,160
chemistry so before life and I'm going

6
00:00:21,540 --> 00:00:19,300
to be talking today a little bit about

7
00:00:22,919 --> 00:00:21,550
how we generate molecular complexity and

8
00:00:24,660 --> 00:00:22,929
when I'm talking about generating

9
00:00:26,130 --> 00:00:24,670
molecular complexity I mean going from

10
00:00:28,200 --> 00:00:26,140
the simple molecules that we know how to

11
00:00:32,010 --> 00:00:28,210
make either on meteorites or in space or

12
00:00:33,420 --> 00:00:32,020
with Yuri Miller discharges to going

13
00:00:37,860 --> 00:00:33,430

towards these more functional

14
00:00:40,410 --> 00:00:37,870
biomolecules so making proteins or RNA

15
00:00:43,740 --> 00:00:40,420
but also importantly these membrane

16
00:00:47,880 --> 00:00:43,750
components and so modern cells are

17
00:00:50,430 --> 00:00:47,890
really complex and the membranes that

18
00:00:51,990 --> 00:00:50,440
compose them are also really complex so

19
00:00:55,650 --> 00:00:52,000
enclosures we recognize that they're

20
00:00:58,170 --> 00:00:55,660
important for life and modern cells tend

21
00:01:00,450 --> 00:00:58,180
to use phospholipid molecules as their

22
00:01:03,060 --> 00:01:00,460
membrane components some such as die

23
00:01:05,789 --> 00:01:03,070
palmitoyl phosphatidyl choline which is

24
00:01:07,050 --> 00:01:05,799
a typical lung surfactant and so it's a

25
00:01:08,670 --> 00:01:07,060
really complicated molecule but

26
00:01:11,430 --> 00:01:08,680
importantly it's got a phosphate group

27
00:01:14,010 --> 00:01:11,440
and it has two long hydrocarbon tails

28
00:01:16,320 --> 00:01:14,020
but if we want to start modeling these

29
00:01:17,730 --> 00:01:16,330
things prebiotic lee we want to come up

30
00:01:20,160 --> 00:01:17,740
with a simpler model and so people

31
00:01:22,110 --> 00:01:20,170
usually talk about vesicles so vesicles

32
00:01:24,899 --> 00:01:22,120
this is obviously not just you can

33
00:01:29,149 --> 00:01:24,909
encapsulate some water and then they

34
00:01:31,830 --> 00:01:29,159
have a bilayer of membranes so you have

35
00:01:33,210 --> 00:01:31,840
oops head groups and things like that so

36
00:01:35,300 --> 00:01:33,220
you have surfactant molecules on the

37
00:01:37,500 --> 00:01:35,310
outside and water on the inside and so

38
00:01:39,600 --> 00:01:37,510

membrane components are amplifiers

39
00:01:42,780 --> 00:01:39,610
they're surfactants and so they usually

40
00:01:44,760 --> 00:01:42,790
have a polar head group and a nonpolar

41
00:01:46,980 --> 00:01:44,770
tail and that means that if you're in

42
00:01:49,080 --> 00:01:46,990
water the polar head group is

43
00:01:50,640 --> 00:01:49,090
hydrophilic it likes water and the tail

44
00:01:52,020 --> 00:01:50,650
group is hydrophobic so these things

45
00:01:54,780 --> 00:01:52,030
will partition to the surface of water

46
00:01:56,610 --> 00:01:54,790
and orient themselves and concentrate

47
00:01:58,320 --> 00:01:56,620
and lap and we can measure these this

48
00:01:59,940 --> 00:01:58,330
surface activity using a langmuir trough

49
00:02:02,010 --> 00:01:59,950
which is just a really simple Teflon

50
00:02:03,420 --> 00:02:02,020
dish you put an aqueous substrate down

51
00:02:05,219 --> 00:02:03,430
and then you can deposit a monolayer of

52
00:02:07,200 --> 00:02:05,229
surfactant on top and then you have

53
00:02:08,940 --> 00:02:07,210
these little Teflon barriers and you can

54
00:02:11,039 --> 00:02:08,950
squeeze the monolayer on the top and

55
00:02:12,750 --> 00:02:11,049
measure the surface tension and by doing

56
00:02:14,729 --> 00:02:12,760
that you can get a lot of the surface

57
00:02:16,679 --> 00:02:14,739
thermodynamics an orientation of the

58
00:02:17,300 --> 00:02:16,689
packing of the membrane in sort of a

59
00:02:18,890 --> 00:02:17,310
two-dimensional

60
00:02:21,410 --> 00:02:18,900
nonsense so that would be a mano later

61
00:02:24,400 --> 00:02:21,420
but these molecules also form

62
00:02:26,839 --> 00:02:24,410
three-dimensional structures they form

63
00:02:29,089 --> 00:02:26,849

especially once you get above a higher

64
00:02:32,000 --> 00:02:29,099
constant light enough concentration so

65
00:02:34,250 --> 00:02:32,010
perhaps the simplest is a micelle where

66
00:02:37,130 --> 00:02:34,260
you have the polar head groups on the

67
00:02:39,979 --> 00:02:37,140
outside and the nonpolar tails on the

68
00:02:41,390 --> 00:02:39,989
inside and that makes and that is

69
00:02:43,430 --> 00:02:41,400
soluble so it can float around in

70
00:02:45,979 --> 00:02:43,440
material you can also get the vesicles

71
00:02:48,920 --> 00:02:45,989
as I said where you have a bilayer with

72
00:02:50,539 --> 00:02:48,930
the soluble head groups on the outside

73
00:02:52,340 --> 00:02:50,549
and the tails in the middle and you can

74
00:02:54,020 --> 00:02:52,350
also get things like reverse micelles or

75
00:02:55,309 --> 00:02:54,030
oil droplets where the heads are on the

76
00:02:56,960 --> 00:02:55,319
inside the tails running out and that

77
00:03:02,690 --> 00:02:56,970
will face separate rather than be

78
00:03:05,300 --> 00:03:02,700
soluble and so modern biology uses a lot

79
00:03:07,039 --> 00:03:05,310
of phospholipids and they readily form

80
00:03:08,259 --> 00:03:07,049
these three-dimensional structures and

81
00:03:10,430 --> 00:03:08,269
vesicles even at fairly low

82
00:03:12,410 --> 00:03:10,440
concentrations and they have relatively

83
00:03:13,430 --> 00:03:12,420
simple phase behavior they're not in

84
00:03:14,960 --> 00:03:13,440
equilibrium with the monomer and

85
00:03:17,750 --> 00:03:14,970
solution there kinetically trapped

86
00:03:19,820 --> 00:03:17,760
structures but as I said these are not

87
00:03:21,650 --> 00:03:19,830
very prebiotic irrelevant so how do we

88
00:03:23,979 --> 00:03:21,660

get to a model that is more prebiotic

89
00:03:26,300 --> 00:03:23,989
irrelevance so one of the most popular

90
00:03:27,949 --> 00:03:26,310
models that people have used have been

91
00:03:30,319 --> 00:03:27,959
these fatty acids and specifically like

92
00:03:34,280 --> 00:03:30,329
decanoic acid and so you've got a single

93
00:03:36,380 --> 00:03:34,290
hydrocarbon tail instead of the double

94
00:03:39,440 --> 00:03:36,390
tail and just a very simple carboxylic

95
00:03:41,210 --> 00:03:39,450
acid head group and they've been used to

96
00:03:42,740 --> 00:03:41,220
great effect as modeling protocells you

97
00:03:44,930 --> 00:03:42,750
can encapsulate RNA you can do all of

98
00:03:46,190 --> 00:03:44,940
these things with that but there's a

99
00:03:48,170 --> 00:03:46,200
fair amount about the face behavior I

100
00:03:50,539 --> 00:03:48,180
would argue that we still don't know so

101
00:03:52,849 --> 00:03:50,549
the generally accepted picture of the

102
00:03:54,890 --> 00:03:52,859
decanoic acid phase behavior almost

103
00:03:57,500 --> 00:03:54,900
entirely relies on the protonation state

104
00:03:59,509 --> 00:03:57,510
of that carboxylic head group and so if

105
00:04:01,759 --> 00:03:59,519
you're below some critical concentration

106
00:04:03,379 --> 00:04:01,769
which is referred to as critical vesicle

107
00:04:04,910 --> 00:04:03,389
concentration and critical aggregation

108
00:04:06,590 --> 00:04:04,920
concentration or critical by layer

109
00:04:08,240 --> 00:04:06,600
concentration you're just going to have

110
00:04:10,309 --> 00:04:08,250
the monomer floating around in solution

111
00:04:13,400 --> 00:04:10,319
but when you get above that critical

112
00:04:14,930 --> 00:04:13,410
concentration it really depends on the

113
00:04:17,360 --> 00:04:14,940

head group and so if you're at a really

114
00:04:19,250 --> 00:04:17,370
high pH where all your carboxylic acid

115
00:04:20,930 --> 00:04:19,260
head groups are deprotonated those are

116
00:04:23,990 --> 00:04:20,940
going to repel and you're going to end

117
00:04:26,000 --> 00:04:24,000
up getting my cells and if you're at a

118
00:04:27,980 --> 00:04:26,010
really low pH where you're not at all

119
00:04:29,480 --> 00:04:27,990
where everything is protonated the head

120
00:04:31,070 --> 00:04:29,490
groups won't repel so you'll tend to get

121
00:04:34,249 --> 00:04:31,080
phase separation into reverse

122
00:04:35,929 --> 00:04:34,259
my cells and you get the vesicles in

123
00:04:37,429 --> 00:04:35,939
this sort of sweet spot in between the

124
00:04:39,200 --> 00:04:37,439
two when roughly half the head groups

125
00:04:41,300 --> 00:04:39,210
are protonated half pick head groups rd

126
00:04:42,800 --> 00:04:41,310
protonated and these are also considered

127
00:04:44,300 --> 00:04:42,810
to be equilibrium structures so you're

128
00:04:46,760 --> 00:04:44,310
always at equilibrium with a monomer in

129
00:04:49,040 --> 00:04:46,770
solution so that's the so that's the

130
00:04:51,170 --> 00:04:49,050
general picture and sort of one of the

131
00:04:54,170 --> 00:04:51,180
downsides to these is that you require a

132
00:04:55,429 --> 00:04:54,180
fairly high concentration but if you

133
00:04:56,899 --> 00:04:55,439
look at the literature a little bit and

134
00:04:59,570 --> 00:04:56,909
you try to quantify this more in a phase

135
00:05:01,879 --> 00:04:59,580
diagram picture than a schematic you run

136
00:05:03,409 --> 00:05:01,889
into a few issues and so it's sort of

137
00:05:05,570 --> 00:05:03,419
the same idea you've got my cells at

138
00:05:07,189 --> 00:05:05,580

high ph oil droplets at low pH and

139
00:05:08,959 --> 00:05:07,199
there's this really narrow range where

140
00:05:10,809 --> 00:05:08,969
you have stable vesicles which may be

141
00:05:13,760 --> 00:05:10,819
limits some of the prebiotic

142
00:05:15,740 --> 00:05:13,770
applications perhaps a little bit and

143
00:05:18,589 --> 00:05:15,750
then there also if you look in the

144
00:05:20,300 --> 00:05:18,599
literature several different critical

145
00:05:22,339 --> 00:05:20,310
vesicle concentrations that are reported

146
00:05:23,659 --> 00:05:22,349
anywhere from 10 to 40 millimolar for

147
00:05:26,480 --> 00:05:23,669
decanoic acid which is a pretty big

148
00:05:28,249 --> 00:05:26,490
range and when you're making these

149
00:05:30,290 --> 00:05:28,259
vesicles you usually make them in with

150
00:05:31,879 --> 00:05:30,300
some salt and some buffer and that's not

151
00:05:33,769 --> 00:05:31,889
always very well characterized so

152
00:05:35,689 --> 00:05:33,779
there's a little bit more in the phase

153
00:05:38,089 --> 00:05:35,699
behavior that I think people tend to

154
00:05:40,369 --> 00:05:38,099
accept and there's also this range where

155
00:05:43,339 --> 00:05:40,379
there's this critical vesicle

156
00:05:45,350 --> 00:05:43,349
concentration but the CRC solubility is

157
00:05:47,240 --> 00:05:45,360
only about 1 millivolt so there's

158
00:05:48,680 --> 00:05:47,250
clearly aggregation happening in between

159
00:05:50,510 --> 00:05:48,690
these two but that's sort of a

160
00:05:54,079 --> 00:05:50,520
disconnect that people don't necessarily

161
00:05:56,360 --> 00:05:54,089
talk about that much either yeah and so

162
00:05:57,439 --> 00:05:56,370
the role of salt and pH perhaps maybe we

163
00:05:59,959 --> 00:05:57,449

should be talking more about ionic

164
00:06:01,279 --> 00:05:59,969
strength rather than straight up ph for

165
00:06:03,350 --> 00:06:01,289
how these things are going to do and

166
00:06:06,379 --> 00:06:03,360
then just as an additional complication

167
00:06:10,279 --> 00:06:06,389
I said the CRC solubility was about 1

168
00:06:11,570 --> 00:06:10,289
millon of it at point eight millimolar

169
00:06:14,540 --> 00:06:11,580
you end up with a nice crystal at the

170
00:06:18,619 --> 00:06:14,550
bottom so there's a lot of a lot of

171
00:06:20,059 --> 00:06:18,629
complications here and so we sort of had

172
00:06:21,800 --> 00:06:20,069
these two options we've got the fatty

173
00:06:23,390 --> 00:06:21,810
acids which can make these things but

174
00:06:25,129 --> 00:06:23,400
they're relatively fragile they require

175
00:06:26,809 --> 00:06:25,139
very specific environmental conditions

176
00:06:29,240 --> 00:06:26,819
and if you have too much salt they'll

177
00:06:31,070 --> 00:06:29,250
fall apart phospholipids on the other

178
00:06:32,719 --> 00:06:31,080
hand are very robust but they're almost

179
00:06:34,909 --> 00:06:32,729
too robust because if you don't have the

180
00:06:36,129 --> 00:06:34,919
biological inclusions of modern life

181
00:06:38,360 --> 00:06:36,139
you're not going to get much

182
00:06:41,360 --> 00:06:38,370
permeability and no exchange with

183
00:06:42,559 --> 00:06:41,370
information in the environment and so we

184
00:06:44,350 --> 00:06:42,569
kind of want to look for something

185
00:06:46,089 --> 00:06:44,360
that's an intermedia

186
00:06:47,350 --> 00:06:46,099
solution between the two so we want to

187
00:06:49,600 --> 00:06:47,360
balance between robustness and

188
00:06:51,339 --> 00:06:49,610

permeability and we want a lower

189
00:06:53,589 --> 00:06:51,349
aggregation concentration than the fatty

190
00:06:55,270 --> 00:06:53,599
acids had and so to do that we have to

191
00:06:58,029 --> 00:06:55,280
come up with prebiotic chemical

192
00:07:00,010 --> 00:06:58,039
synthesis and so when you're thinking

193
00:07:01,659 --> 00:07:00,020
about making things prebiotic Li you

194
00:07:03,309 --> 00:07:01,669
need and especially if you want them to

195
00:07:05,850 --> 00:07:03,319
self-assemble into a vesicle or a

196
00:07:08,860 --> 00:07:05,860
membrane or an enclosure you need

197
00:07:12,040 --> 00:07:08,870
favourable conditions for both synthesis

198
00:07:13,749 --> 00:07:12,050
and self-assembly and so people use an

199
00:07:16,149 --> 00:07:13,759
energy source hydrothermal vents are

200
00:07:18,939 --> 00:07:16,159
very popular we've used the Sun we use

201
00:07:20,469 --> 00:07:18,949
photochemistry and environments people

202
00:07:22,510 --> 00:07:20,479
talk a lot about clays and mineral

203
00:07:23,860 --> 00:07:22,520
surfaces we tend to use the air water

204
00:07:25,420 --> 00:07:23,870
interface because they were widely

205
00:07:29,679 --> 00:07:25,430
available in our relatively gentle

206
00:07:32,439 --> 00:07:29,689
environments and so air water interfaces

207
00:07:35,100 --> 00:07:32,449
there on the ocean surface lakes rivers

208
00:07:37,540 --> 00:07:35,110
but also atmospheric aerosols the

209
00:07:39,550 --> 00:07:37,550
surface area of aqueous atmospheric

210
00:07:41,469 --> 00:07:39,560
aerosols is about two orders of

211
00:07:43,269 --> 00:07:41,479
magnitude bigger than the surface area

212
00:07:46,089 --> 00:07:43,279
of the ocean so it's an important thing

213
00:07:47,800 --> 00:07:46,099

to remember um and when we're talking

214
00:07:50,230 --> 00:07:47,810
about photochemistry we've talked about

215
00:07:51,790 --> 00:07:50,240
how the early Sun had more UV radiation

216
00:07:53,890 --> 00:07:51,800
even though it was less luminous and

217
00:07:56,589 --> 00:07:53,900
there was no ozone shield so people

218
00:07:58,119 --> 00:07:56,599
often think about the UV radiation being

219
00:08:00,610 --> 00:07:58,129
destructive but we would argue that it's

220
00:08:03,279 --> 00:08:00,620
not always destructive pyruvic acid for

221
00:08:05,409 --> 00:08:03,289
instance is a common molecule in today's

222
00:08:08,140 --> 00:08:05,419
atmosphere as well as being pyruvate

223
00:08:10,689 --> 00:08:08,150
metabolites and it absorbs light within

224
00:08:12,670 --> 00:08:10,699
the solar spectrum and we know the

225
00:08:15,429 --> 00:08:12,680
aqueous phase photochemistry really

226
00:08:17,619 --> 00:08:15,439
clearly you're excited goes to a triplet

227
00:08:20,290 --> 00:08:17,629
and pi star state other stuff but the

228
00:08:21,730 --> 00:08:20,300
main thing is you can make dimethyl

229
00:08:23,409 --> 00:08:21,740
tartaric acid so you've gone from a

230
00:08:25,240 --> 00:08:23,419
three carbon molecule to a six carbon

231
00:08:27,879 --> 00:08:25,250
molecule you've made a carbon-carbon

232
00:08:30,760 --> 00:08:27,889
bond which is important and so if we use

233
00:08:34,209 --> 00:08:30,770
a longer tailed analog of this to Oxbow

234
00:08:36,639 --> 00:08:34,219
octanoic acid we can then go and do the

235
00:08:38,589 --> 00:08:36,649
same photo chemistry and make a double

236
00:08:41,889 --> 00:08:38,599
tailed surfactant die hexyl tartaric

237
00:08:43,630 --> 00:08:41,899
acid and so with water sun and this

238
00:08:45,579 --> 00:08:43,640

molecule we've made a double tailed

239
00:08:47,829 --> 00:08:45,589
surfactant which is generally hard to do

240
00:08:50,110 --> 00:08:47,839
not a phospholipid but a double tailed

241
00:08:54,130 --> 00:08:50,120
molecule and we do see that it's quite a

242
00:08:56,980 --> 00:08:54,140
bit more surface active after em after a

243
00:08:58,240 --> 00:08:56,990
fatalis asst which is good or at least

244
00:08:59,890 --> 00:08:58,250
not at all so proud

245
00:09:02,380 --> 00:08:59,900
because if you have more hydrocarbon

246
00:09:06,520 --> 00:09:02,390
tails it should be more surface active

247
00:09:08,350 --> 00:09:06,530
and yes so the sort of schematic is as

248
00:09:09,400 --> 00:09:08,360
we're doing the photochemistry these

249
00:09:10,600 --> 00:09:09,410
molecules are going to start

250
00:09:15,520 --> 00:09:10,610
partitioning more and more to the

251
00:09:17,620 --> 00:09:15,530
surface and without sort of our solution

252
00:09:19,030 --> 00:09:17,630
starts off clear there no my cells were

253
00:09:20,950 --> 00:09:19,040
below all the critical micelle

254
00:09:22,990 --> 00:09:20,960
concentration and as fatalis asst

255
00:09:25,600 --> 00:09:23,000
proceeds without any further aggregation

256
00:09:27,790 --> 00:09:25,610
or whatever and the solution becomes

257
00:09:30,040 --> 00:09:27,800
cloudy so we're forming self-assembling

258
00:09:33,010 --> 00:09:30,050
three-dimensional structures during our

259
00:09:35,170 --> 00:09:33,020
Fatah lysis and we've worked on

260
00:09:37,150 --> 00:09:35,180
characterizing these and they're quite

261
00:09:38,350 --> 00:09:37,160
monodisperse in size their spherical

262
00:09:40,240 --> 00:09:38,360
which we can see by phase contrast

263
00:09:43,030 --> 00:09:40,250

microscopy they're small they're only

264
00:09:45,400 --> 00:09:43,040
about 200 nanometers in diameter but

265
00:09:48,160 --> 00:09:45,410
they're too big to be my cells and so

266
00:09:49,900 --> 00:09:48,170
and they're very stable with time and so

267
00:09:52,330 --> 00:09:49,910
we've tentatively characterize them as

268
00:09:53,800 --> 00:09:52,340
vesicles electron microscopy will tell

269
00:09:56,170 --> 00:09:53,810
us more we're currently working on that

270
00:09:59,140 --> 00:09:56,180
but in any case they're self-assembling

271
00:10:02,680 --> 00:09:59,150
without further perturbation and so for

272
00:10:04,120 --> 00:10:02,690
us we're quite interested in how the

273
00:10:06,850 --> 00:10:04,130
role of the surface and what is the

274
00:10:08,590 --> 00:10:06,860
mechanism of the self-assembly so the

275
00:10:12,130 --> 00:10:08,600
role of pH is we saw with the fatty

276
00:10:13,750 --> 00:10:12,140
acids where we're more interested in the

277
00:10:15,340 --> 00:10:13,760
protonation state our fatalis this

278
00:10:17,890 --> 00:10:15,350
mixture right now is quite acidic

279
00:10:19,540 --> 00:10:17,900
because it's just no buffer no nothing

280
00:10:22,870 --> 00:10:19,550
and so it's about pH two and a half

281
00:10:25,390 --> 00:10:22,880
which perhaps not realistic and but if

282
00:10:28,060 --> 00:10:25,400
anything if you believe the model of the

283
00:10:31,870 --> 00:10:28,070
fatty acid face behavior working at a

284
00:10:34,060 --> 00:10:31,880
higher pH ought to be more conducive to

285
00:10:36,820 --> 00:10:34,070
forming vesicles the role of salt is

286
00:10:38,880 --> 00:10:36,830
also really important and just looking

287
00:10:42,640 --> 00:10:38,890
at how these guys self-assemble into

288
00:10:44,860 --> 00:10:42,650

these structures and conceivably if the

289
00:10:47,290 --> 00:10:44,870
photo chemistry goes better at acidic pH

290
00:10:49,630 --> 00:10:47,300
is atmospheric aerosols are quite a bit

291
00:10:51,579 --> 00:10:49,640
more acidic than the ocean and so maybe

292
00:10:55,090 --> 00:10:51,589
the photo chemistry is going to be more

293
00:10:56,740 --> 00:10:55,100
favorable in the aerosol but then it

294
00:10:58,960 --> 00:10:56,750
would get deposited into the ocean and

295
00:11:00,610 --> 00:10:58,970
self-assemble into these vesicles so

296
00:11:02,200 --> 00:11:00,620
there are a lot of open questions about

297
00:11:04,510 --> 00:11:02,210
this but it's kind of a cool model

298
00:11:08,170 --> 00:11:04,520
system that's somewhere in between the

299
00:11:17,090 --> 00:11:08,180
two general pictures and so that like to

300
00:11:24,660 --> 00:11:23,070
questions great I get asked fun so you

301
00:11:26,850 --> 00:11:24,670
said one of the places I followed this

302
00:11:29,040 --> 00:11:26,860
that these can form is in aerosols and

303
00:11:31,470 --> 00:11:29,050
then they drop out of the sky and into

304
00:11:33,210 --> 00:11:31,480
the ocean is that instead I follow that

305
00:11:35,520 --> 00:11:33,220
correctly the photochemistry could

306
00:11:36,870 --> 00:11:35,530
certainly happen there um you do see a

307
00:11:38,580 --> 00:11:36,880
lot of organic matter and aqueous

308
00:11:40,890 --> 00:11:38,590
aerosols that will partition to the

309
00:11:43,560 --> 00:11:40,900
surface usually think about that more as

310
00:11:48,150 --> 00:11:43,570
being a mono layer partitioning to the

311
00:11:50,250 --> 00:11:48,160
surface but the aerosols are usually

312
00:11:52,320 --> 00:11:50,260
micron-sized so it's possible these guys

313
00:11:54,690 --> 00:11:52,330

are small enough you might have a

314
00:11:56,130 --> 00:11:54,700
soluble guy in there as well I mean

315
00:11:57,210 --> 00:11:56,140
that's the speculation but it's just

316
00:11:59,550 --> 00:11:57,220
interesting that you would get these

317
00:12:01,230 --> 00:11:59,560
different environments so yes my real

318
00:12:03,360 --> 00:12:01,240
question is how do you have any idea of

319
00:12:05,340 --> 00:12:03,370
how photo stable these are once they're

320
00:12:07,260 --> 00:12:05,350
in the aerosol and exposed to the

321
00:12:09,990 --> 00:12:07,270
harsher environment of early earth

322
00:12:13,500 --> 00:12:10,000
before they get shielded by the ocean so

323
00:12:16,770 --> 00:12:13,510
um the good news I mean I guess I don't

324
00:12:18,810 --> 00:12:16,780
know if you were had really high UV but

325
00:12:21,600 --> 00:12:18,820
you've lost all your chroma force here

326
00:12:24,000 --> 00:12:21,610
okay you're not going to so the key so

327
00:12:26,160 --> 00:12:24,010
it's this alpha keto acid that's the key

328
00:12:29,640 --> 00:12:26,170
and so it absorbs at about 320

329
00:12:32,430 --> 00:12:29,650
nanometers but um but here you've just

330
00:12:35,130 --> 00:12:32,440
got alcohols and acids and so it's not a

331
00:12:37,080 --> 00:12:35,140
photo chemically active molecule I mean

332
00:12:41,070 --> 00:12:37,090
probably lyman-alpha I mean you could

333
00:12:48,400 --> 00:12:41,080
smash it with something but yeah other

334
00:12:55,519 --> 00:12:51,980
if you had other organic molecules in

335
00:12:58,100 --> 00:12:55,529
this mixture to would that inhibit the

336
00:12:59,569 --> 00:12:58,110
formation of these vesicles they get in

337
00:13:01,160 --> 00:12:59,579
the way or that's a really good question

338
00:13:03,829 --> 00:13:01,170

so with fatty acids you can often

339
00:13:05,059 --> 00:13:03,839
stabilize the vesicle formation if you

340
00:13:06,559 --> 00:13:05,069
have a mixture so even if you have a

341
00:13:08,239 --> 00:13:06,569
mixture of like a shorter tailed fatty

342
00:13:12,530 --> 00:13:08,249
acid that won't form vesicles on its own

343
00:13:14,090 --> 00:13:12,540
it will stabilize it and certainly

344
00:13:16,790 --> 00:13:14,100
mixtures are going to be more probiotic

345
00:13:18,590 --> 00:13:16,800
ly relevant okay um it depends a little

346
00:13:20,449 --> 00:13:18,600
bit so some people talk about shape

347
00:13:22,160 --> 00:13:20,459
parameter and so if you have things that

348
00:13:24,949 --> 00:13:22,170
are of a different shape parameter for

349
00:13:26,989 --> 00:13:24,959
the self-assembly that might be bad if

350
00:13:28,340 --> 00:13:26,999
they're not contributed but one of the

351
00:13:30,679 --> 00:13:28,350
other cool things were interested in

352
00:13:32,749 --> 00:13:30,689
doing so it's pyruvic acid it forms this

353
00:13:36,139 --> 00:13:32,759
radical in the mechanism that I didn't

354
00:13:38,090 --> 00:13:36,149
go over and it can actually be used as a

355
00:13:41,660 --> 00:13:38,100
driver to react with another molecule so

356
00:13:43,519 --> 00:13:41,670
it's possible to perhaps use the radical

357
00:13:45,470 --> 00:13:43,529
formed with the two octanoic acid and

358
00:13:47,389 --> 00:13:45,480
react with another lipid and then get

359
00:13:49,429 --> 00:13:47,399
even more a mixed double tailed molecule

360
00:13:56,210 --> 00:13:49,439
or something like so there are a lot of