

Tony Jia

*Membraneless Polyester Microdroplets as
Primordial Compartments at the Origins of Life*

1
00:00:00,240 --> 00:00:10,890

[Music]

2
00:00:16,630 --> 00:00:14,490

hi everyone so my name is Tony Jaa I'm a

3
00:00:18,279 --> 00:00:16,640

researcher at the earth Life Science

4
00:00:22,000 --> 00:00:18,289

Institute at Tokyo Institute of

5
00:00:23,770 --> 00:00:22,010

Technology LC for short and I'm also an

6
00:00:25,600 --> 00:00:23,780

affiliated researcher with Blue Marble

7
00:00:27,400 --> 00:00:25,610

space Institute of science I'd like to

8
00:00:30,040 --> 00:00:27,410

thank Mike for such a great musical

9
00:00:32,019 --> 00:00:30,050

introduction and then I'd like to thank

10
00:00:34,240 --> 00:00:32,029

the organizers for giving me a chance to

11
00:00:36,370 --> 00:00:34,250

share my research thank all the audience

12
00:00:37,930 --> 00:00:36,380

for staying awake for this in the next

13
00:00:40,810 --> 00:00:37,940

talk there's two more great packs so

14

00:00:43,930 --> 00:00:40,820

keep it up and then I'd really like to

15

00:00:47,680 --> 00:00:43,940

thank all of my abundant YouTube and

16

00:00:52,540 --> 00:00:47,690

Facebook fans following online if there

17

00:00:53,740 --> 00:00:52,550

are any anyway so yeah so today I'm

18

00:00:56,410 --> 00:00:53,750

gonna be telling you a little bit about

19

00:00:58,840 --> 00:00:56,420

some research I've been doing at LC

20

00:01:01,990 --> 00:00:58,850

regarding polyester micro droplets and

21

00:01:03,520 --> 00:01:02,000

their role as compartments similar to

22

00:01:06,039 --> 00:01:03,530

AMA this actually was published

23

00:01:09,030 --> 00:01:06,049

yesterday so please read this online

24

00:01:12,550 --> 00:01:09,040

also afterwards if you have any interest

25

00:01:15,390 --> 00:01:12,560

so we make a very big generalization

26
00:01:18,370 --> 00:01:15,400
here so biology is very complicated and

27
00:01:21,280 --> 00:01:18,380
biology is made of cells and cells are

28
00:01:24,070 --> 00:01:21,290
very complicated cells have a ton of

29
00:01:26,800 --> 00:01:24,080
different functions and very specific

30
00:01:29,679 --> 00:01:26,810
organelles which have been tailored to

31
00:01:31,870 --> 00:01:29,689
perform very specific functions so many

32
00:01:34,390 --> 00:01:31,880
modern biologists and biochemists are

33
00:01:37,749 --> 00:01:34,400
really interested to study how exactly

34
00:01:41,020 --> 00:01:37,759
the cell functions and how exactly it

35
00:01:43,539 --> 00:01:41,030
formed I'm gonna again make a very gross

36
00:01:45,760 --> 00:01:43,549
oversimplification here and assume this

37
00:01:50,200 --> 00:01:45,770
is a modern cell all right it's not this

38
00:01:53,469 --> 00:01:50,210

simple but basically you have DNA

39

00:01:57,520 --> 00:01:53,479

genetic material that turns into RNA and

40

00:01:59,020 --> 00:01:57,530

RNA makes proteins which are you have

41

00:02:00,520 --> 00:01:59,030

enzymes you have very functional

42

00:02:05,380 --> 00:02:00,530

catalytic molecules and these are all

43

00:02:06,999 --> 00:02:05,390

enclosed within a lipid bilayer this is

44

00:02:10,330 --> 00:02:07,009

like the compartment that encloses all

45

00:02:13,720 --> 00:02:10,340

of these things what did an early cell

46

00:02:14,080 --> 00:02:13,730

look like so well we don't really know

47

00:02:16,589 --> 00:02:14,090

exactly

48

00:02:19,390 --> 00:02:16,599

actually how modern proteins could have

49

00:02:22,000 --> 00:02:19,400

evolved in assembled we don't really

50

00:02:24,490 --> 00:02:22,010

understand how DNA came about and so

51
00:02:28,360 --> 00:02:24,500
many people do believe that primitive

52
00:02:32,199 --> 00:02:28,370
cells are some type of lipid vesicles

53
00:02:33,640 --> 00:02:32,209
where with RNA inside I'm gonna skip the

54
00:02:35,289 --> 00:02:33,650
next part because Krishna did a really

55
00:02:38,890 --> 00:02:35,299
good job to explain the RNA world

56
00:02:42,550 --> 00:02:38,900
hypothesis and basically what what we we

57
00:02:45,190 --> 00:02:42,560
understand is because RNA was genetic

58
00:02:47,229 --> 00:02:45,200
information and could perform catalytic

59
00:02:49,270 --> 00:02:47,239
functions it's been proposed to be one

60
00:02:51,850 --> 00:02:49,280
of the first early biomolecules on the

61
00:02:53,620 --> 00:02:51,860
early Earth now furthermore though one

62
00:02:55,600 --> 00:02:53,630
one question that many researchers have

63
00:02:57,970 --> 00:02:55,610

had is you know how exactly did RNA

64

00:03:02,890 --> 00:02:57,980

replicate there's been a lot of research

65

00:03:05,650 --> 00:03:02,900

progress no in this field we still don't

66

00:03:08,589 --> 00:03:05,660

have a really concrete answer and we

67

00:03:11,770 --> 00:03:08,599

don't necessarily have a very concrete

68

00:03:14,890 --> 00:03:11,780

answer about how this lipid vesicle type

69

00:03:16,809 --> 00:03:14,900

bilayer vesicle form we don't even

70

00:03:19,870 --> 00:03:16,819

really have a concrete answer of how

71

00:03:23,550 --> 00:03:19,880

exactly RNA could have formed so you

72

00:03:26,289 --> 00:03:23,560

know what on earth happened whether you

73

00:03:28,330 --> 00:03:26,299

you know understand the RNA world to be

74

00:03:30,640 --> 00:03:28,340

correct or not we still need to

75

00:03:32,530 --> 00:03:30,650

understand you know even if it were

76

00:03:34,509 --> 00:03:32,540

correct what about before or such a

77

00:03:36,699 --> 00:03:34,519

world existed what happened on earth

78

00:03:38,500 --> 00:03:36,709

before vesicles what happened before RNA

79

00:03:40,720 --> 00:03:38,510

and so these are really interesting

80

00:03:43,390 --> 00:03:40,730

questions that I've been very I've been

81

00:03:47,140 --> 00:03:43,400

working towards at LC one of the

82

00:03:49,569 --> 00:03:47,150

important top things that you should

83

00:03:52,569 --> 00:03:49,579

understand is there are many ways by

84

00:03:54,069 --> 00:03:52,579

which biomolecules could have formed and

85

00:03:55,599 --> 00:03:54,079

assembled on earth that we as we've seen

86

00:03:58,539 --> 00:03:55,609

with many of these talks they could have

87

00:04:00,610 --> 00:03:58,549

come from extraterrestrial sources could

88

00:04:03,909 --> 00:04:00,620

have been synthesized from spark

89

00:04:07,059 --> 00:04:03,919

discharge or through catalysis by

90

00:04:08,860 --> 00:04:07,069

mineral surfaces and so there's a many

91

00:04:10,930 --> 00:04:08,870

ways by which you know nucleotides or

92

00:04:12,509 --> 00:04:10,940

amino acids or lipids could have could

93

00:04:14,920 --> 00:04:12,519

have been formed on the early Earth and

94

00:04:17,740 --> 00:04:14,930

one of the things that's very important

95

00:04:19,779 --> 00:04:17,750

to understand is that when you're

96

00:04:21,430 --> 00:04:19,789

forming these biomolecules you're also

97

00:04:24,250 --> 00:04:21,440

at the same time forming many non

98

00:04:26,260 --> 00:04:24,260

biomolecules there's many bio mode many

99

00:04:28,629 --> 00:04:26,270

molecules forming at the same time

100

00:04:31,480 --> 00:04:28,639

as these relevant biomolecules through

101
00:04:34,499 --> 00:04:31,490
all of these processes and so what I

102
00:04:36,969 --> 00:04:34,509
wanted to know was can non biomolecules

103
00:04:40,210 --> 00:04:36,979
catalyze life's immigrants in some ways

104
00:04:42,279 --> 00:04:40,220
can we take all of these you know extra

105
00:04:44,890 --> 00:04:42,289
things that also existed on early Earth

106
00:04:46,870 --> 00:04:44,900
and can that assemble into something

107
00:04:51,249 --> 00:04:46,880
interesting and important for the

108
00:04:53,290 --> 00:04:51,259
emergence of initial life I think Amy in

109
00:04:55,800 --> 00:04:53,300
her talk talked spoke briefly about

110
00:04:58,029 --> 00:04:55,810
alpha hydroxy acids basically

111
00:05:01,629 --> 00:04:58,039
structurally they're very similar to

112
00:05:04,719 --> 00:05:01,639
amino acids their differences one

113
00:05:07,629 --> 00:05:04,729

functional group and what's interesting

114

00:05:10,960 --> 00:05:07,639

about hydroxy acids is even though they

115

00:05:12,939 --> 00:05:10,970

don't participate in if you understand

116

00:05:14,589 --> 00:05:12,949

modern biology to be DNA are native

117

00:05:17,200 --> 00:05:14,599

proteins they don't participate in that

118

00:05:20,589 --> 00:05:17,210

type of process that which is so called

119

00:05:23,800 --> 00:05:20,599

central dogma but they are very

120

00:05:26,860 --> 00:05:23,810

pre-medical abundant and they also are

121

00:05:30,070 --> 00:05:26,870

compatible with modern biology so you

122

00:05:32,230 --> 00:05:30,080

can actually replace amino acids in the

123

00:05:34,810 --> 00:05:32,240

translation system that forms proteins

124

00:05:37,209 --> 00:05:34,820

and you can replace them with alpha

125

00:05:39,670 --> 00:05:37,219

hydroxy acids and what you get is in the

126

00:05:42,850 --> 00:05:39,680

end polymers of alpha hydroxy acids

127

00:05:44,860 --> 00:05:42,860

called polyesters so we know that these

128

00:05:49,260 --> 00:05:44,870

alpha hydroxy acids these monomers are

129

00:05:52,629 --> 00:05:49,270

very common prebiotic aliy and they're

130

00:05:55,719 --> 00:05:52,639

compatible with modern life and so what

131

00:05:58,330 --> 00:05:55,729

we wanted to do was we wanted to take

132

00:06:01,240 --> 00:05:58,340

many different types of alpha hydroxy

133

00:06:04,719 --> 00:06:01,250

acids I don't worry about the detail so

134

00:06:07,029 --> 00:06:04,729

much but understand that we took many

135

00:06:09,339 --> 00:06:07,039

different chemical functionalities and

136

00:06:10,719 --> 00:06:09,349

we took many different alpha hydroxy

137

00:06:14,050 --> 00:06:10,729

acids with different chemical

138

00:06:17,020 --> 00:06:14,060

functionalities and in a complex mixture

139

00:06:20,529 --> 00:06:17,030

we wanted to utilize wet drying cycles

140

00:06:23,040 --> 00:06:20,539

to form polymers so monomers are one

141

00:06:25,480 --> 00:06:23,050

circle polymers are many circles kind of

142

00:06:29,020 --> 00:06:25,490

shove together and we wanted to form

143

00:06:31,089 --> 00:06:29,030

polymers and see if these polymers could

144

00:06:34,750 --> 00:06:31,099

have assembled into something useful for

145

00:06:36,820 --> 00:06:34,760

life's emergence so these are the five

146

00:06:38,559 --> 00:06:36,830

that we tested and we first took

147

00:06:40,209 --> 00:06:38,569

mixtures some

148

00:06:42,879 --> 00:06:40,219

missions of each of these they're

149

00:06:43,809 --> 00:06:42,889

concentrated solutions and water and we

150

00:06:46,570 --> 00:06:43,819

dried them down

151
00:06:48,100 --> 00:06:46,580
drying is reasonable primitive process

152
00:06:51,579 --> 00:06:48,110
we dried them down and we wanted to

153
00:06:53,529 --> 00:06:51,589
analyze the product so we did that by

154
00:06:56,980 --> 00:06:53,539
taking the products and subjecting that

155
00:06:59,469 --> 00:06:56,990
to something called MALDI ms so matrix

156
00:07:01,899 --> 00:06:59,479
assisted laser desorption ionic mass

157
00:07:05,010 --> 00:07:01,909
spectrometry basically we took a solid

158
00:07:07,659 --> 00:07:05,020
and we analyzed the components of that

159
00:07:10,179 --> 00:07:07,669
chemically through measuring the masses

160
00:07:12,639 --> 00:07:10,189
of whatever was in there and you read

161
00:07:15,459 --> 00:07:12,649
this by the x-axis is the mass of a

162
00:07:17,889 --> 00:07:15,469
given molecule and the y-axis is the

163
00:07:21,670 --> 00:07:17,899

abundance and what you end up seeing is

164

00:07:24,129 --> 00:07:21,680

that for example here this peak

165

00:07:27,369 --> 00:07:24,139

represents one molecule which is mass

166

00:07:30,730 --> 00:07:27,379

you know like 560 this peak represents a

167

00:07:33,129 --> 00:07:30,740

molecule of mass 600 something and what

168

00:07:35,379 --> 00:07:33,139

we saw was that after this

169

00:07:37,749 --> 00:07:35,389

polymerization process we didn't just

170

00:07:40,449 --> 00:07:37,759

make one product we made a variety of

171

00:07:46,509 --> 00:07:40,459

products as polydisperse products they

172

00:07:47,049 --> 00:07:46,519

ranged in size from you know a few units

173

00:07:51,369 --> 00:07:47,059

long

174

00:07:53,469 --> 00:07:51,379

up to the 40's and each peak was the

175

00:07:57,159 --> 00:07:53,479

difference between each people was the

176

00:07:58,600 --> 00:07:57,169

correct mass for each monomer unit and

177

00:08:02,559 --> 00:07:58,610

so that's how we knew that each one

178

00:08:04,569 --> 00:08:02,569

corresponding to a specific polymer

179

00:08:06,909 --> 00:08:04,579

links so yeah we were able to create up

180

00:08:12,909 --> 00:08:06,919

to you know in this case for lactic acid

181

00:08:14,409 --> 00:08:12,919

up to 44 units long polyesters and we

182

00:08:17,139 --> 00:08:14,419

did this for all five of these

183

00:08:19,839 --> 00:08:17,149

combinations and in each case you do you

184

00:08:21,759 --> 00:08:19,849

produce not just one compound you

185

00:08:24,999 --> 00:08:21,769

produce a poly dispersed mixture of

186

00:08:27,850 --> 00:08:25,009

compounds and the maximum length of each

187

00:08:30,369 --> 00:08:27,860

were differed between 15 and 40

188

00:08:33,730 --> 00:08:30,379

depending on each of the monomers that

189

00:08:35,559 --> 00:08:33,740

you used what we did see actually was

190

00:08:38,199 --> 00:08:35,569

after drying this is about after a week

191

00:08:43,389 --> 00:08:38,209

we saw we found this you know gel-like

192

00:08:45,699 --> 00:08:43,399

substance and we saw this for almost all

193

00:08:48,189 --> 00:08:45,709

of these samples we tested so for four

194

00:08:50,170 --> 00:08:48,199

out of the five homo polymer samples

195

00:08:52,810 --> 00:08:50,180

that is the samples with one

196

00:08:56,350 --> 00:08:52,820

of alpha-hydroxy acid in the starting

197

00:08:58,480 --> 00:08:56,360

mixture these all formed the gel-like

198

00:09:00,730 --> 00:08:58,490

substance and also when we mixed all

199

00:09:03,190 --> 00:09:00,740

five of them together and subjected it

200

00:09:05,800 --> 00:09:03,200

to the drying process they also form the

201
00:09:08,920 --> 00:09:05,810
gel like structure in one case poly

202
00:09:11,430 --> 00:09:08,930
glycolic so Polly glycolic acid did not

203
00:09:14,949 --> 00:09:11,440
form this gel like structure there's a

204
00:09:19,870 --> 00:09:14,959
mechanistic study that I won't get into

205
00:09:24,610 --> 00:09:19,880
right now so then if you formed this gel

206
00:09:26,170 --> 00:09:24,620
structure so on right so what the next

207
00:09:28,840 --> 00:09:26,180
thing we did was we actually highly

208
00:09:32,139 --> 00:09:28,850
hydrated these gel like structures it's

209
00:09:34,210 --> 00:09:32,149
been shown that with this alpha hydroxy

210
00:09:37,660 --> 00:09:34,220
acid polyester system you can do

211
00:09:40,000 --> 00:09:37,670
repeated rehydration and drying cycles

212
00:09:43,630 --> 00:09:40,010
and you actually get different sequences

213
00:09:45,430 --> 00:09:43,640

each time that assumes that the sample

214

00:09:47,440 --> 00:09:45,440

isn't dried to completion in this case

215

00:09:49,510 --> 00:09:47,450

it was actually dried to completion we

216

00:09:51,100 --> 00:09:49,520

believe which formed this Joe X

217

00:09:54,240 --> 00:09:51,110

structure and upon rehydration

218

00:09:58,030 --> 00:09:54,250

if assembled into these micro droplets

219

00:09:59,769 --> 00:09:58,040

each homo polyester formed micro

220

00:10:02,410 --> 00:09:59,779

droplets except the one that didn't form

221

00:10:05,460 --> 00:10:02,420

of the gel and the mixture also formed

222

00:10:09,970 --> 00:10:05,470

the micro droplets interestingly all

223

00:10:13,800 --> 00:10:09,980

mixtures of 2 3 4 or 5 all combinations

224

00:10:18,430 --> 00:10:13,810

of those all formed micro droplets and

225

00:10:20,079 --> 00:10:18,440

we believe that you can probably add in

226

00:10:22,720 --> 00:10:20,089

some other chemical functionalities and

227

00:10:23,980 --> 00:10:22,730

still form similar types of droplets and

228

00:10:26,350 --> 00:10:23,990

so what you what you should get from

229

00:10:29,199 --> 00:10:26,360

this is just that we can form polyester

230

00:10:31,570 --> 00:10:29,209

gels from drying of alpha hydroxy acids

231

00:10:35,199 --> 00:10:31,580

and they can assemble into micro

232

00:10:37,060 --> 00:10:35,209

droplets in aqueous media we're also

233

00:10:38,470 --> 00:10:37,070

interested to see some of the dynamics

234

00:10:41,860 --> 00:10:38,480

of these droplets so one of the

235

00:10:43,449 --> 00:10:41,870

important things that were in we think

236

00:10:46,269 --> 00:10:43,459

is important for early life is the

237

00:10:49,780 --> 00:10:46,279

preservation of individuality how long

238

00:10:52,630 --> 00:10:49,790

that can separate droplets stay before

239

00:10:56,290 --> 00:10:52,640

they merge together and so this is just

240

00:10:57,880 --> 00:10:56,300

a video at their ambient conditions and

241

00:11:00,760 --> 00:10:57,890

you can see that maybe it's a bit grainy

242

00:11:02,759 --> 00:11:00,770

but the droplets don't easily don't

243

00:11:04,710 --> 00:11:02,769

quickly call us

244

00:11:06,210 --> 00:11:04,720

on the order of minutes hours it takes

245

00:11:08,579 --> 00:11:06,220

about a day or so for them to call us

246

00:11:12,150 --> 00:11:08,589

and to kind of a large microscopic

247

00:11:13,829 --> 00:11:12,160

droplet but when we added salt we

248

00:11:15,569 --> 00:11:13,839

actually saw that the droplet started to

249

00:11:17,670 --> 00:11:15,579

coalesce much more quickly and they

250

00:11:20,340 --> 00:11:17,680

actually stuck to the glass surface in

251
00:11:22,559 --> 00:11:20,350
the microscope we believe that this is

252
00:11:25,050 --> 00:11:22,569
because the salt and some researchers

253
00:11:27,540 --> 00:11:25,060
have done simulations on this that we

254
00:11:29,280 --> 00:11:27,550
believe that the salt is locating to the

255
00:11:31,319 --> 00:11:29,290
outside of the droplets it's lowering

256
00:11:33,780 --> 00:11:31,329
the surface tension of the droplets and

257
00:11:37,559 --> 00:11:33,790
that's causing them to kind of merge

258
00:11:40,110 --> 00:11:37,569
together a bit more and stick to the

259
00:11:42,660 --> 00:11:40,120
glass surface quickly and further

260
00:11:44,340 --> 00:11:42,670
studies are ongoing into determining

261
00:11:46,620 --> 00:11:44,350
exactly this mechanism including

262
00:11:51,090 --> 00:11:46,630
measuring directly where these salts

263
00:11:53,400 --> 00:11:51,100

ended up and then there are some also

264

00:11:56,430 --> 00:11:53,410

implications of these droplets as

265

00:11:58,889 --> 00:11:56,440

compartments as you know cells contain

266

00:12:02,129 --> 00:11:58,899

many things in the modern cells genetic

267

00:12:04,710 --> 00:12:02,139

material enzymes nutrients primitive

268

00:12:08,420 --> 00:12:04,720

cells protocells also necessarily had to

269

00:12:11,850 --> 00:12:08,430

contain some type of catalytic or

270

00:12:14,370 --> 00:12:11,860

informational polymer in them and so

271

00:12:15,870 --> 00:12:14,380

these droplets we first we want to test

272

00:12:18,030 --> 00:12:15,880

whether they could encapsulate things

273

00:12:20,819 --> 00:12:18,040

and we the easy thing to do was we found

274

00:12:23,210 --> 00:12:20,829

some fluorescent dyes and we saw that

275

00:12:26,610 --> 00:12:23,220

these fluorescent dyes were able to

276

00:12:28,710 --> 00:12:26,620

segregate into the droplets the dyes are

277

00:12:31,170 --> 00:12:28,720

fairly hydrophobic and we believe that

278

00:12:33,500 --> 00:12:31,180

the interior of the droplets is also

279

00:12:36,960 --> 00:12:33,510

very hydrophobic owing to the very long

280

00:12:38,910 --> 00:12:36,970

polyesters that produce them but also

281

00:12:41,550 --> 00:12:38,920

we're able to see that fluorescently

282

00:12:43,470 --> 00:12:41,560

labeled RNA is able to go into one of

283

00:12:47,189 --> 00:12:43,480

the droplet types which suggest that

284

00:12:49,500 --> 00:12:47,199

perhaps one of these droplets or some

285

00:12:52,879 --> 00:12:49,510

droplet type that we haven't probed in

286

00:12:55,759 --> 00:12:52,889

this study could have been able to

287

00:13:01,019 --> 00:12:55,769

compartmentalize and segregate primitive

288

00:13:04,350 --> 00:13:01,029

genetic materials and so this also has

289

00:13:06,509 --> 00:13:04,360

implications that the initial chemical

290

00:13:09,509 --> 00:13:06,519

components of these alpha hydroxy acids

291

00:13:10,710 --> 00:13:09,519

that we use to make the droplets will

292

00:13:13,359 --> 00:13:10,720

determine their

293

00:13:16,479 --> 00:13:13,369

phenotypic function if you will because

294

00:13:19,269 --> 00:13:16,489

only one of them could segregate these

295

00:13:21,639 --> 00:13:19,279

fluorescent RNA and just a few more

296

00:13:26,039 --> 00:13:21,649

examples of the interaction between the

297

00:13:29,619 --> 00:13:26,049

droplets and biomolecules we took some

298

00:13:33,759 --> 00:13:29,629

super folded GFP that was expressed by a

299

00:13:35,619 --> 00:13:33,769

collaborator at LC he's in Sean McGinnes

300

00:13:38,799 --> 00:13:35,629

lab that name has been floating around a

301
00:13:41,109 --> 00:13:38,809
few times and he provided us some super

302
00:13:43,030 --> 00:13:41,119
folded GFP this actually function in the

303
00:13:47,229 --> 00:13:43,040
droplet suggesting that even within this

304
00:13:49,780 --> 00:13:47,239
confined space the function and the

305
00:13:52,989 --> 00:13:49,790
structure of these this protein could

306
00:13:55,989 --> 00:13:52,999
still be preserved and we were able to

307
00:13:58,960 --> 00:13:55,999
see that certain fluorescent lipid could

308
00:14:00,309 --> 00:13:58,970
assemble layer around one of the

309
00:14:03,129 --> 00:14:00,319
droplets we're not sure whether it's a

310
00:14:05,919 --> 00:14:03,139
single layer by layer multi layer maybe

311
00:14:08,650 --> 00:14:05,929
it's a multi layer but we can see that

312
00:14:10,150 --> 00:14:08,660
this fluorescent lipid does have some

313
00:14:12,309 --> 00:14:10,160

propensity to assemble around this

314

00:14:14,859 --> 00:14:12,319

droplet suggesting that maybe the

315

00:14:17,829 --> 00:14:14,869

droplets we whether or not they were

316

00:14:21,069 --> 00:14:17,839

direct precursors to modern cells or

317

00:14:23,049 --> 00:14:21,079

primitive cells or not and possibly they

318

00:14:25,509 --> 00:14:23,059

weren't they could have still catalyzed

319

00:14:28,239 --> 00:14:25,519

the assembly of some structures that

320

00:14:30,669 --> 00:14:28,249

could have been providing important for

321

00:14:34,419 --> 00:14:30,679

the initial emergence of life and so

322

00:14:36,699 --> 00:14:34,429

with that said I'd like to just go over

323

00:14:40,179 --> 00:14:36,709

this really quickly we started with a

324

00:14:43,659 --> 00:14:40,189

monomer solution we dried by heat to

325

00:14:45,639 --> 00:14:43,669

form polymers polyesters upon

326

00:14:48,489 --> 00:14:45,649

rehydration they form micro droplets and

327

00:14:50,799 --> 00:14:48,499

these micro droplets are able to

328

00:14:53,710 --> 00:14:50,809

compartmentalize certain dies and

329

00:14:57,280 --> 00:14:53,720

biomolecules and so what I hope that you

330

00:14:59,019 --> 00:14:57,290

got from this study is that non vesicle

331

00:15:02,460 --> 00:14:59,029

compartments are also important for

332

00:15:05,619 --> 00:15:02,470

origin of life studies and that even

333

00:15:09,039 --> 00:15:05,629

non-biological molecules could have had

334

00:15:13,600 --> 00:15:09,049

a hand in producing important biological

335

00:15:16,059 --> 00:15:13,610

structures or materials or molecules

336

00:15:17,590 --> 00:15:16,069

that could have helped in the initial

337

00:15:21,039 --> 00:15:17,600

emergence of life so I'd like to thank

338

00:15:22,440 --> 00:15:21,049

all my funding Oh my collaborator

339

00:15:25,730 --> 00:15:22,450

especially those in both

340

00:15:29,850 --> 00:15:25,740

who directly contributed to this study

341

00:15:31,710 --> 00:15:29,860

and I'm from Elsi were an

342

00:15:34,650 --> 00:15:31,720

interdisciplinary Institute in Tokyo

343

00:15:36,690 --> 00:15:34,660

that's interested in studying the origin

344

00:15:38,069 --> 00:15:36,700

and evolution of planets earth and life

345

00:15:40,920 --> 00:15:38,079

on earth and so if you have any

346

00:15:43,170 --> 00:15:40,930

opportunity please I hope you can visit

347

00:15:44,850 --> 00:15:43,180

we have an annual symposium every year

348

00:15:46,860 --> 00:15:44,860

next year's will be in February so I

349

00:15:48,900 --> 00:15:46,870

hope that you can if you're able to

350

00:15:50,340 --> 00:15:48,910

please join us so thank you very much

351

00:16:05,610 --> 00:15:50,350

for your time and attention and have you

352

00:16:07,400 --> 00:16:05,620

take any questions questions for Tony so

353

00:16:12,900 --> 00:16:07,410

what why do you think you've got that

354

00:16:21,329 --> 00:16:12,910

Gaussian distribution it was like Bill

355

00:16:26,400 --> 00:16:21,339

like okay so you're referring to then

356

00:16:30,960 --> 00:16:26,410

you got yeah okay this one yeah so if

357

00:16:35,210 --> 00:16:30,970

you assume that the condensation of an

358

00:16:38,639 --> 00:16:35,220

additional monomer piece is somewhat

359

00:16:41,400 --> 00:16:38,649

stochastic then perhaps you get some

360

00:16:45,900 --> 00:16:41,410

type of distribution where there is like

361

00:16:47,910 --> 00:16:45,910

a medium amine and there fewer molecules

362

00:16:50,430 --> 00:16:47,920

that are larger and fewer molecules that

363

00:16:53,939 --> 00:16:50,440

are smaller and this is also helped by

364

00:16:56,370 --> 00:16:53,949

the fact that this conjugation reaction

365

00:16:59,340 --> 00:16:56,380

is not one direction it's bi-directional

366

00:17:01,380 --> 00:16:59,350

and so you do get once you form the

367

00:17:05,240 --> 00:17:01,390

polyesters once form the polymers you do

368

00:17:09,030 --> 00:17:05,250

have some backwards reaction as well

369

00:17:14,039 --> 00:17:09,040

thank you Tony I had a couple questions

370

00:17:16,530 --> 00:17:14,049

um so this was just one drying it wasn't

371

00:17:17,939 --> 00:17:16,540

wet dry cycling is that correct yeah can

372

00:17:19,380 --> 00:17:17,949

you speak about what you think would

373

00:17:22,199 --> 00:17:19,390

happen if you were cycling a little bit

374

00:17:26,390 --> 00:17:22,209

yeah so I think the cycling question is

375

00:17:29,880 --> 00:17:26,400

heavily determined by whether the

376

00:17:32,490 --> 00:17:29,890

initial reactants have completely dried

377

00:17:35,420 --> 00:17:32,500

or not if you're still in a mostly

378

00:17:37,430 --> 00:17:35,430

liquid state then by rehydrating your

379

00:17:40,970 --> 00:17:37,440

shifting the equilibrium of the reaction

380

00:17:42,350 --> 00:17:40,980

from formation of polymers back into

381

00:17:44,240 --> 00:17:42,360

monomers and this is because the

382

00:17:48,620 --> 00:17:44,250

formation of the polymers requires loss

383

00:17:51,020 --> 00:17:48,630

of water but if you're in this gel soft

384

00:17:53,120 --> 00:17:51,030

state kind of not quite liquid not quite

385

00:17:56,320 --> 00:17:53,130

solid state maybe there is some

386

00:17:58,880 --> 00:17:56,330

hydrolysis and I think it depends on the

387

00:18:01,790 --> 00:17:58,890

chemistry that you've used specifically

388

00:18:04,760 --> 00:18:01,800

but also perhaps the fact that you're

389

00:18:07,700 --> 00:18:04,770

forming these kind of aggregated

390

00:18:11,270 --> 00:18:07,710

structures the surface area that water

391

00:18:13,430 --> 00:18:11,280

can attack if you will is may be limited

392

00:18:14,960 --> 00:18:13,440

by formation of these structures so we

393

00:18:16,420 --> 00:18:14,970

haven't done any of these studies yet

394

00:18:21,140 --> 00:18:16,430

but we're interested to study whether

395

00:18:23,690 --> 00:18:21,150

actually assembly can prevent their own

396

00:18:25,490 --> 00:18:23,700

degradation and also if they can prevent

397

00:18:27,490 --> 00:18:25,500

the degradation of things that have been

398

00:18:31,100 --> 00:18:27,500

compartmentalized within the droplets

399

00:18:33,320 --> 00:18:31,110

and then I also just wanted maybe I

400

00:18:34,640 --> 00:18:33,330

missed it but what was the scale bar for

401
00:18:37,610 --> 00:18:34,650
those images what are the sizes of all

402
00:18:40,940 --> 00:18:37,620
yeah good question sorry I actually

403
00:18:46,760 --> 00:18:40,950
completely skipped that so these images

404
00:18:48,920 --> 00:18:46,770
are all so the main image scale bars so

405
00:18:52,190 --> 00:18:48,930
those down here this is going to be a

406
00:18:54,260 --> 00:18:52,200
hundred microns and this is ten microns

407
00:18:56,960 --> 00:18:54,270
so they range in size from a few microns

408
00:19:00,050 --> 00:18:56,970
up to tens of microns you know 50 or 70

409
00:19:02,390 --> 00:19:00,060
and it does I think it depends on the

410
00:19:05,330 --> 00:19:02,400
chemistry involved but also you can make

411
00:19:25,520 --> 00:19:05,340
them smaller by sonication and vortexing

412
00:19:28,370 --> 00:19:25,530
and yeah so we were gonna be starting to

413
00:19:31,250 --> 00:19:28,380

do some of these this work actually so I

414

00:19:32,630 --> 00:19:31,260

mentioned that we could assemble a lipid

415

00:19:34,520 --> 00:19:32,640

layer that was a phospholipid layer

416

00:19:36,800 --> 00:19:34,530

around perhaps assembling this type of

417

00:19:38,690 --> 00:19:36,810

layer mono layer by layer multi layer we

418

00:19:40,280 --> 00:19:38,700

don't know but perhaps assembling this

419

00:19:44,300 --> 00:19:40,290

type of lipid layer around it could

420

00:19:45,270 --> 00:19:44,310

prevent a coalescence and also maybe

421

00:19:47,250 --> 00:19:45,280

prevent

422

00:19:50,130 --> 00:19:47,260

you know the exchange of things in and

423

00:19:52,049 --> 00:19:50,140

out of the droplets but also there are

424

00:19:54,840 --> 00:19:52,059

things called Pickering emulsions which

425

00:19:56,460 --> 00:19:54,850

are basically if you have some type of

426
00:19:57,960 --> 00:19:56,470
phase separated system there's these

427
00:19:59,490 --> 00:19:57,970
little particles that locate

428
00:20:02,100 --> 00:19:59,500
specifically to the outside of the

429
00:20:03,960 --> 00:20:02,110
droplets that prevent coalescence one of

430
00:20:05,669 --> 00:20:03,970
which is it's an interesting study by

431
00:20:08,549 --> 00:20:05,679
Christine Keating's group at Penn State

432
00:20:10,350 --> 00:20:08,559
where they use clay particles around a

433
00:20:12,120 --> 00:20:10,360
quiz two-phase system droplets to

434
00:20:14,310 --> 00:20:12,130
prevent their coalescence so there are

435
00:20:17,370 --> 00:20:14,320
some like chemical or physical ways

436
00:20:21,870 --> 00:20:17,380
perhaps that these could maintain their

437
00:20:25,289 --> 00:20:21,880
individuality any other questions for