Amit Kahana

Reported Organic Chemistry on Enceladus Supports Origin of Life in a Lipid-World Scenario

1
00:00:00,240 --> 00:00:10,839
[Music]

2
00:00:15,560 --> 00:00:14,060
my name is Amit a master student at the

3
00:00:19,030 --> 00:00:15,570
Weizmann Institute of Science in Israel

4
00:00:21,260 --> 00:00:19,040
I work with Professor Doron landset and

5
00:00:22,940 --> 00:00:21,270
my talk will be about instead of this

6
00:00:25,340 --> 00:00:22,950
and how it fits in the conversation

7
00:00:27,890 --> 00:00:25,350
about the origin of life this talk is

8
00:00:30,170 --> 00:00:27,900
based upon on a paper that was published

9
00:00:35,810 --> 00:00:30,180
yesterday so if you're interested check

10
00:00:38,180 --> 00:00:35,820
it out ok so we have a few theories

11
00:00:40,610 --> 00:00:38,190
about the origin of life they mainly

12
00:00:43,009 --> 00:00:40,620
group into two schools of thought there

13
00:00:45,290 --> 00:00:43,019

is the information first that mostly

14
00:00:47,029 --> 00:00:45,300
known for the RNA world which describes

15
00:00:49,669 --> 00:00:47,039
the first replicator as a self

16
00:00:52,399 --> 00:00:49,679
propagating RNA by a polymer that's

17
00:00:54,079 --> 00:00:52,409
capable of some catalytic reactions and

18
00:00:56,809 --> 00:00:54,089
then there is the metabolism first which

19
00:01:00,290 --> 00:00:56,819
is more based on metabolic reactions and

20
00:01:02,360 --> 00:01:00,300
it specifically features our origin of

21
00:01:04,130 --> 00:01:02,370
my theories the liquid world theory that

22
00:01:06,160 --> 00:01:04,140
a lab has originated and developed in

23
00:01:08,240 --> 00:01:06,170
the past over the past 20 years and

24
00:01:09,620 --> 00:01:08,250
described the first replicator as

25
00:01:13,220 --> 00:01:09,630
catalytic micelles

26
00:01:15,620 --> 00:01:13,230
of different ante files that are capable

27
00:01:17,180 --> 00:01:15,630
of compositional reproduction and I will

28
00:01:19,430 --> 00:01:17,190
talk more about later I will just say

29
00:01:21,640 --> 00:01:19,440
for now that these two schools of

30
00:01:24,080 --> 00:01:21,650
thought both have an expensive

31
00:01:26,090 --> 00:01:24,090
experimental body of work supporting

32
00:01:28,400 --> 00:01:26,100
them but the question still remains that

33
00:01:29,780 --> 00:01:28,410
we can't really arbitrate between these

34
00:01:32,300 --> 00:01:29,790
two school of thought because we can't

35
00:01:34,550 --> 00:01:32,310
go to the environmental engineers and

36
00:01:36,590 --> 00:01:34,560
sample it and determine which theory for

37
00:01:40,250 --> 00:01:36,600
the origin of life is more than cheating

38
00:01:41,690 --> 00:01:40,260

or more truthful what we can do is look

39
00:01:43,940 --> 00:01:41,700
at other prebiotic environments

40
00:01:46,700 --> 00:01:43,950
elsewhere in the universe and determine

41
00:01:48,320 --> 00:01:46,710
from the chemistry which theory for the

42
00:01:50,000 --> 00:01:48,330
origin of life best describes how life

43
00:01:54,560 --> 00:01:50,010
could have emerged in such an

44
00:01:57,410 --> 00:01:54,570
environment so this is a subsection of

45
00:02:00,110 --> 00:01:57,420
Enceladus how we talked about it earlier

46
00:02:03,070 --> 00:02:00,120
it is a moon of Saturn it has a thick

47
00:02:06,230 --> 00:02:03,080
icy crust and a global subsurface ocean

48
00:02:07,610 --> 00:02:06,240
underneath it it is an active water body

49
00:02:08,660 --> 00:02:07,620
so there's terminal gradients that

50
00:02:10,910 --> 00:02:08,670
create

51
00:02:13,760 --> 00:02:10,920
these plumes that emanate from the ocean

52
00:02:16,100 --> 00:02:13,770
and through the ice holes in the eye

53
00:02:17,870 --> 00:02:16,110
it's an alien space where some of them

54
00:02:21,430 --> 00:02:17,880
have washed over Cassini that was sent

55
00:02:24,170 --> 00:02:21,440
to research the Saturnian system and

56
00:02:27,280 --> 00:02:24,180
Cassini has a mass spectrometer

57
00:02:29,530 --> 00:02:27,290
instrument on it and has analyzed the

58
00:02:33,620 --> 00:02:29,540
constituents of the plumes over its many

59
00:02:37,490 --> 00:02:33,630
flybys and last year the most detailed

60
00:02:39,229 --> 00:02:37,500
analysis of these constitute of these

61
00:02:43,370 --> 00:02:39,239
compounds that were found in the plumes

62
00:02:45,740 --> 00:02:43,380
was published and they have reported a

63
00:02:48,050 --> 00:02:45,750

rich organic chemistry in that ocean

64
00:02:50,720 --> 00:02:48,060
which makes it our first observation it

65
00:02:52,070 --> 00:02:50,730
detected prebiotic soup it's an active

66
00:02:54,699 --> 00:02:52,080
water body filled with organics so

67
00:02:58,610 --> 00:02:54,709
that's really exciting

68
00:03:01,759 --> 00:02:58,620
this is the data they have published so

69
00:03:05,030 --> 00:03:01,769
you can see it has two halves one is the

70
00:03:06,949 --> 00:03:05,040
high resolution low masses half and the

71
00:03:09,740 --> 00:03:06,959
other one is the low resolution higher

72
00:03:13,069 --> 00:03:09,750
masses have and if you look at the

73
00:03:14,120 --> 00:03:13,079
ninety to two-hundred you range you see

74
00:03:18,860 --> 00:03:14,130
they represent

75
00:03:23,750 --> 00:03:18,870
monomeric compounds of carbons of 7015

76
00:03:26,000 --> 00:03:23,760
carbons and in the higher masses range

77
00:03:28,190 --> 00:03:26,010
you have these big Peaks that are highly

78
00:03:30,759 --> 00:03:28,200
indicative of polymeric macromolecules

79
00:03:34,490 --> 00:03:30,769
there's big chunks of insoluble organics

80
00:03:37,190 --> 00:03:34,500
now the data couldn't offer us the exact

81
00:03:39,199 --> 00:03:37,200
empirical formula of these compounds but

82
00:03:42,620 --> 00:03:39,209
the authors did infer some of their

83
00:03:47,650 --> 00:03:42,630
chemical property and they say that it

84
00:03:50,960 --> 00:03:47,660
is the highly complex mostly unsaturated

85
00:03:53,090 --> 00:03:50,970
with high ratio of carbon to other

86
00:03:55,190 --> 00:03:53,100
hetero atoms like oxygen nitrogen and

87
00:03:59,470 --> 00:03:55,200
sulfur which means it's highly carbon

88
00:04:02,500 --> 00:03:59,480

dominated and it is mostly consisting of

89
00:04:05,630 --> 00:04:02,510
aromatic rings that are connected with

90
00:04:09,020 --> 00:04:05,640
aromatic and aliphatic hydrocarbons the

91
00:04:11,330 --> 00:04:09,030
office also indicated that it is highly

92
00:04:13,940 --> 00:04:11,340
similar to what we found in carbonaceous

93
00:04:16,099 --> 00:04:13,950
chondrite meteorites that have a higher

94
00:04:19,009 --> 00:04:16,109
percentage of carbon in them and also

95
00:04:20,400 --> 00:04:19,019
seem a quite similar to carriage and the

96
00:04:23,490 --> 00:04:20,410
chain remains of

97
00:04:25,320 --> 00:04:23,500
biological matter here on earth and what

98
00:04:27,000 --> 00:04:25,330
we are interested in is the monomers

99
00:04:29,610 --> 00:04:27,010
that exist in a soup because that's how

100
00:04:33,390 --> 00:04:29,620
life can began not from this hydro from

101
00:04:36,000 --> 00:04:33,400
this macro molecular polymers and so we

102
00:04:37,860 --> 00:04:36,010
propose that by analyzing what monomers

103
00:04:41,040 --> 00:04:37,870
could escape or be extracted from these

104
00:04:43,830 --> 00:04:41,050
large macromolecular structures we can

105
00:04:48,180 --> 00:04:43,840
then infer about the nature of chemistry

106
00:04:49,800 --> 00:04:48,190
on Enceladus so this is the first

107
00:04:52,320 --> 00:04:49,810
example this is medicine

108
00:04:54,210 --> 00:04:52,330
it felt astray about 40 years ago and

109
00:04:57,810 --> 00:04:54,220
our colleague professor Schmidt Kaplan

110
00:04:59,820 --> 00:04:57,820
has produced an analysis no targeted

111
00:05:01,530 --> 00:04:59,830
high resolution analysis of solve

112
00:05:03,540 --> 00:05:01,540
products that were extracted from

113
00:05:07,020 --> 00:05:03,550

Murchison through applying different

114
00:05:08,970 --> 00:05:07,030
solvents and he has produced more than

115
00:05:10,730 --> 00:05:08,980
30,000 empirical formulae of these

116
00:05:13,620 --> 00:05:10,740
products which is an immense diversity

117
00:05:17,220 --> 00:05:13,630
and a lot of them were amphiphilic they

118
00:05:19,680 --> 00:05:17,230
have hydrophilic heads and hydrophobic

119
00:05:21,270 --> 00:05:19,690
tails and they tend to aggregate in for

120
00:05:23,460 --> 00:05:21,280
my sins and vesicles you can see in an

121
00:05:24,840 --> 00:05:23,470
earlier analysis how these vesicles just

122
00:05:27,420 --> 00:05:24,850
spontaneously formed from these

123
00:05:29,600 --> 00:05:27,430
extractions and in the schmidt Koplin

124
00:05:32,250 --> 00:05:29,610
analysis you can see that the major

125
00:05:34,290 --> 00:05:32,260
sample of of compounds that were

126
00:05:36,960 --> 00:05:34,300
extracted one that only have carbon

127
00:05:39,030 --> 00:05:36,970
hydrogen and oxygen atoms you can see

128
00:05:41,310 --> 00:05:39,040
that they tend to aggregated around two

129
00:05:43,860 --> 00:05:41,320
oxygen two oxygen atoms and twelve to

130
00:05:45,870 --> 00:05:43,870
thirty carbon atoms which are just

131
00:05:48,870 --> 00:05:45,880
structurally in the grave of MV felicity

132
00:05:53,010 --> 00:05:48,880
and reminiscent of what the structure of

133
00:05:55,940 --> 00:05:53,020
simple fatty acids looks like we see the

134
00:05:59,100 --> 00:05:55,950
same trends in courage interpretation so

135
00:06:00,840 --> 00:05:59,110
labs that have degraded keratin in

136
00:06:06,060 --> 00:06:00,850
hydras pearl his experiments which is

137
00:06:07,890 --> 00:06:06,070
just putting them in hot water okay they

138
00:06:10,230 --> 00:06:07,900

have produced an immense diversity of

139
00:06:14,120 --> 00:06:10,240
compounds and a lot of them are

140
00:06:17,190 --> 00:06:14,130
antigenic like alcohols and ketones and

141
00:06:20,580 --> 00:06:17,200
similarly even when they sample the

142
00:06:23,280 --> 00:06:20,590
non-biological extraction products of

143
00:06:25,590 --> 00:06:23,290
degradation of Kuragin in actual

144
00:06:28,140 --> 00:06:25,600
hydrothermal vents they have produced a

145
00:06:31,920 --> 00:06:28,150
lot of these cations and this is an

146
00:06:32,650 --> 00:06:31,930
example of the reaction pathway that

147
00:06:36,550 --> 00:06:32,660
even the No

148
00:06:39,160 --> 00:06:36,560
dispersible molecules such as alkenes

149
00:06:42,010 --> 00:06:39,170
how would a modify them and making them

150
00:06:43,810 --> 00:06:42,020
more dispersible and a lot more and

151
00:06:46,180 --> 00:06:43,820
fulfilling because they tend to bond to

152
00:06:47,800 --> 00:06:46,190
a new channel carbon which they just

153
00:06:50,560 --> 00:06:47,810
tend to make them a lot more and he

154
00:06:53,290 --> 00:06:50,570
falls in the water and so after this

155
00:06:55,530 --> 00:06:53,300
very quick overview here's what we think

156
00:07:00,550 --> 00:06:55,540
the inside of prebiotic soup looks like

157
00:07:02,800 --> 00:07:00,560
it is a rich organic water body with all

158
00:07:05,260 --> 00:07:02,810
these different dispersible molecules

159
00:07:07,960 --> 00:07:05,270
fills with the amplifiers that aggregate

160
00:07:11,140 --> 00:07:07,970
to form micelles let's float in the

161
00:07:13,660 --> 00:07:11,150
ocean and it even has two more

162
00:07:15,340 --> 00:07:13,670
solidified layers of organics one of no

163
00:07:17,980 --> 00:07:15,350

massive organics that float on the water

164
00:07:20,590 --> 00:07:17,990
and underneath the ice and one that is

165
00:07:22,420 --> 00:07:20,600
more that is solidified under the core

166
00:07:24,340 --> 00:07:22,430
weird undergoes differentiation into the

167
00:07:27,190 --> 00:07:24,350
water assisted by the thermal gradients

168
00:07:29,400 --> 00:07:27,200
that the core image and all this is

169
00:07:33,100 --> 00:07:29,410
reflected in the plumes at escape

170
00:07:35,170 --> 00:07:33,110
outside of Enceladus and so now that we

171
00:07:36,610 --> 00:07:35,180
know a bit more about the nature of the

172
00:07:39,970 --> 00:07:36,620
chemistry of Enceladus we can go back to

173
00:07:43,080 --> 00:07:39,980
our original question and try to

174
00:07:45,400 --> 00:07:43,090
determine which origin of life theory

175
00:07:48,070 --> 00:07:45,410
best describes how life could emerge

176
00:07:51,270 --> 00:07:48,080
from this environment and I hope you can

177
00:07:54,070 --> 00:07:51,280
agree with me that the lipid world is

178
00:07:56,710 --> 00:07:54,080
more advantageous in that comparison

179
00:07:58,240 --> 00:07:56,720
because we potentially have the first

180
00:07:58,570 --> 00:07:58,250
group of a few files floating in the

181
00:08:01,690 --> 00:07:58,580
water

182
00:08:04,120 --> 00:08:01,700
whereas compounds that are relevant to

183
00:08:09,120 --> 00:08:04,130
the RNA like nuclear bases and sugars

184
00:08:13,360 --> 00:08:11,530
but it is only one point of comparison

185
00:08:15,810 --> 00:08:13,370
so the lipid world here has the

186
00:08:17,590 --> 00:08:15,820
advantage but we can also compare the

187
00:08:19,330 --> 00:08:17,600
models based on their chemical

188
00:08:21,100 --> 00:08:19,340

properties and I want to present you

189
00:08:23,820 --> 00:08:21,110
with three more points of comparison

190
00:08:28,210 --> 00:08:23,830
that I hope will be persuasive

191
00:08:29,770 --> 00:08:28,220
so first the diversity in the

192
00:08:32,740 --> 00:08:29,780
environment so lipid in world is

193
00:08:34,150 --> 00:08:32,750
actually beneficial diversity of

194
00:08:36,490 --> 00:08:34,160
compounds because as long as their

195
00:08:38,830 --> 00:08:36,500
amphiphilic they can form or join

196
00:08:42,400 --> 00:08:38,840
micelles and take part in the dynamics

197
00:08:45,080 --> 00:08:42,410
that underlie lipid world model whereas

198
00:08:47,450 --> 00:08:45,090
in the RNA world this messy cam

199
00:08:50,800 --> 00:08:47,460
she is highly impedin for the formation

200
00:08:56,750 --> 00:08:50,810
of nucleotides where which is a very

201
00:08:58,519 --> 00:08:56,760
complex reaction pathway micelles can

202
00:09:00,050 --> 00:08:58,529
also form in very dilute concentrations

203
00:09:02,090 --> 00:09:00,060
especially mixed mices of different

204
00:09:04,700 --> 00:09:02,100
alpha file types where the

205
00:09:07,490 --> 00:09:04,710
polymerization of RNA it's equivalent of

206
00:09:09,410 --> 00:09:07,500
an assembly is a very complex and

207
00:09:11,990 --> 00:09:09,420
challenging pathway especially when

208
00:09:12,440 --> 00:09:12,000
considering the diversity that I've just

209
00:09:14,180 --> 00:09:12,450
talked about

210
00:09:16,250 --> 00:09:14,190
and lastly their environmental

211
00:09:18,950 --> 00:09:16,260
resilience so my cells are highly

212
00:09:23,329 --> 00:09:18,960
tolerant to extreme temperatures and bra

213
00:09:27,530 --> 00:09:23,339

and pH gradient where an RNA is

214
00:09:31,220 --> 00:09:27,540
inherently unstable and delicate so I

215
00:09:33,590 --> 00:09:31,230
support the liquid world and I will just

216
00:09:35,690 --> 00:09:33,600
in the time I have remaining I would

217
00:09:37,420 --> 00:09:35,700
like to go over just the basic concept

218
00:09:42,769 --> 00:09:37,430
concept of lipid world which is

219
00:09:44,480 --> 00:09:42,779
reputable ism micelles has information

220
00:09:46,880 --> 00:09:44,490
it's called a compositional information

221
00:09:48,200 --> 00:09:46,890
it is the relative concentrations of the

222
00:09:50,720 --> 00:09:48,210
different molecular types within an

223
00:09:53,720 --> 00:09:50,730
assembly and myosins gonna create more

224
00:09:55,880 --> 00:09:53,730
monomers to join it and by that changing

225
00:09:57,680 --> 00:09:55,890
the composition information but in some

226
00:10:01,579 --> 00:09:57,690
special cases this composition

227
00:10:03,110 --> 00:10:01,589
information can remain if the relative

228
00:10:04,610 --> 00:10:03,120
concentrations of the different

229
00:10:07,220 --> 00:10:04,620
molecular types has been preserved over

230
00:10:08,690 --> 00:10:07,230
growth periods the mices stays in a

231
00:10:10,910 --> 00:10:08,700
steady state of what we call homeostatic

232
00:10:13,220 --> 00:10:10,920
growth and if this remains over this

233
00:10:15,410 --> 00:10:13,230
fission of splits events this is the

234
00:10:16,910 --> 00:10:15,420
primitive form of what replication and

235
00:10:19,510 --> 00:10:16,920
reproduction is and it smears what

236
00:10:23,270 --> 00:10:19,520
happens in our very own cells this is

237
00:10:25,520 --> 00:10:23,280
being possible by mutual catalytic

238
00:10:27,949 --> 00:10:25,530

network that exists inside these

239
00:10:30,230 --> 00:10:27,959
assemblies and in our monte carlo

240
00:10:31,699 --> 00:10:30,240
simulations we've proved these states

241
00:10:33,920 --> 00:10:31,709
exist and that they can undergo

242
00:10:36,140 --> 00:10:33,930
selection and evolution which I think

243
00:10:40,610 --> 00:10:36,150
it's pretty critical to every origin of

244
00:10:43,880 --> 00:10:40,620
life theory and lastly maximal catalysis

245
00:10:46,810 --> 00:10:43,890
so my system lipids are hot catalytic we

246
00:10:49,930 --> 00:10:46,820
usually think as biologists as on

247
00:10:52,699 --> 00:10:49,940
proteins and RNA as being big but also

248
00:10:56,390 --> 00:10:52,709
lipids and mices are very catalytic

249
00:10:58,000 --> 00:10:56,400
they have a wide array of reactions that

250
00:11:00,220 --> 00:10:58,010
they can catalyze and

251
00:11:01,840 --> 00:11:00,230
then from basically from two parameters

252
00:11:03,790 --> 00:11:01,850
that they have first is the structural

253
00:11:06,850 --> 00:11:03,800
chemical properties which we usually

254
00:11:08,260 --> 00:11:06,860
call as the soda phase model which is

255
00:11:10,450 --> 00:11:08,270
just interaction of the hydrophobic

256
00:11:13,330 --> 00:11:10,460
interior with the aqueous medium the

257
00:11:15,880 --> 00:11:13,340
hydrophilic exterior and some reactions

258
00:11:18,940 --> 00:11:15,890
can be catalyzed that way and also just

259
00:11:20,920 --> 00:11:18,950
the highly diverse healthy that lipids

260
00:11:24,480 --> 00:11:20,930
can have it can have simple catalytic a

261
00:11:28,810 --> 00:11:24,490
groups like carboxylic acids and also

262
00:11:31,030 --> 00:11:28,820
they can have more traditional head

263
00:11:33,760 --> 00:11:31,040

groups such as amino acids and

264
00:11:38,020 --> 00:11:33,770
nucleotides and also chelating metals

265
00:11:41,530 --> 00:11:38,030
and and minerals such as four states and

266
00:11:44,740 --> 00:11:41,540
like all catalytic so my solar catalyst

267
00:11:47,500 --> 00:11:44,750
is a very well known term and while

268
00:11:49,930 --> 00:11:47,510
combining all the different aspects the

269
00:11:51,730 --> 00:11:49,940
catalysis and the reproduction I think

270
00:11:53,950 --> 00:11:51,740
we can imagine how there's different

271
00:11:57,250 --> 00:11:53,960
catalytic my cells have complexified

272
00:11:59,260 --> 00:11:57,260
over time and rapid used and assisted

273
00:12:01,840 --> 00:11:59,270
the emergence of other poly biopolymers

274
00:12:04,600 --> 00:12:01,850
like RNA important proteins and from

275
00:12:06,790 --> 00:12:04,610
there have evolved to become a more

276
00:12:10,030 --> 00:12:06,800
mature prata cell on the onset to luca

277
00:12:12,010 --> 00:12:10,040
and further life so thanks for listening

278
00:12:13,830 --> 00:12:12,020
and if you have questions I'll be happy

279
00:12:17,900 --> 00:12:13,840
to answer them

280
00:12:20,670 --> 00:12:17,910
[Applause]

281
00:12:23,540 --> 00:12:20,680
very nice talk and a question right up

282
00:12:28,470 --> 00:12:26,670
hi so it seems to me like the liquid

283
00:12:31,920 --> 00:12:28,480
world is really interesting in multiple

284
00:12:34,860 --> 00:12:31,930
ways one is as a potential form of

285
00:12:39,120 --> 00:12:34,870
living evolvable chemistry of some kind

286
00:12:40,620 --> 00:12:39,130
and the other as a stage in the origin

287
00:12:42,510 --> 00:12:40,630
and evolution of cellular life as we

288
00:12:44,220 --> 00:12:42,520

know it and it seems to me I've always

289
00:12:48,420 --> 00:12:44,230
had this question about the lipid world

290
00:12:50,460 --> 00:12:48,430
how do you get a hydrophilic interior do

291
00:12:52,410 --> 00:12:50,470
you mean how we make the jump from Isis

292
00:12:55,380 --> 00:12:52,420
to vesicles basically yes

293
00:12:57,330 --> 00:12:55,390
so vesicles form as you've seen it

294
00:13:00,510 --> 00:12:57,340
spontaneously also from the medicine

295
00:13:04,830 --> 00:13:00,520
extractions but they also are unstable

296
00:13:08,190 --> 00:13:04,840
except for specific lipids that can

297
00:13:11,670 --> 00:13:08,200
sustain it like in ourselves with the

298
00:13:13,260 --> 00:13:11,680
phosphate head roots basically so it's

299
00:13:15,710 --> 00:13:13,270
it's basically throughout the evolution

300
00:13:18,980 --> 00:13:15,720
of chemical evolution of micelles the

301
00:13:21,450 --> 00:13:18,990
link exchange they evolved to become to

302
00:13:24,510 --> 00:13:21,460
to have different metabolic reactions

303
00:13:26,310 --> 00:13:24,520
that they can sustain so over evolution

304
00:13:29,130 --> 00:13:26,320
periods that could have been a stage

305
00:13:30,360 --> 00:13:29,140
where we are creative or modified it's

306
00:13:31,200 --> 00:13:30,370
different different lipids that could

307
00:13:33,210 --> 00:13:31,210
make the jump

308
00:13:35,070 --> 00:13:33,220
there are many papers that show how you

309
00:13:37,350 --> 00:13:35,080
can jump from isel's to vesicles with

310
00:13:39,660 --> 00:13:37,360
specific reactions or the catalytic sets

311
00:13:41,760 --> 00:13:39,670
and the like I don't know if they are

312
00:13:44,220 --> 00:13:41,770
very convincing but it surely is a

313
00:13:47,130 --> 00:13:44,230

phenomenon that is real and is

314
00:13:51,180 --> 00:13:47,140
potentially has occurred so just to

315
00:13:53,250 --> 00:13:51,190
clarify yeah change the molecular

316
00:13:58,680 --> 00:13:53,260
structure of the lipids and you change

317
00:14:00,870 --> 00:13:58,690
the structure overall um thank you for

318
00:14:02,880 --> 00:14:00,880
your talk um I especially appreciate

319
00:14:05,340 --> 00:14:02,890
that the visual nature of it is great I

320
00:14:06,900 --> 00:14:05,350
had a question hopefully you can

321
00:14:08,760 --> 00:14:06,910
elaborate a little bit more on the doing

322
00:14:11,370 --> 00:14:08,770
solution problem

323
00:14:13,410 --> 00:14:11,380
I guess that ever-recurring common

324
00:14:15,660 --> 00:14:13,420
problems provide a chemistry is of

325
00:14:18,550 --> 00:14:15,670
course what to do in a dilute solution

326
00:14:20,680 --> 00:14:18,560
yeah especially one of my

327
00:14:22,920 --> 00:14:20,690
temperatures 50 that 100 degree

328
00:14:26,500 --> 00:14:22,930
centigrade as you guys were proposing

329
00:14:32,970 --> 00:14:26,510
how do you in the lipid world hypothesis

330
00:14:38,590 --> 00:14:36,160
so as I said lipids tend to aggregate

331
00:14:41,320 --> 00:14:38,600
just on their alpha felicity in nature

332
00:14:43,090 --> 00:14:41,330
it happens in very dilute concentrations

333
00:14:44,860 --> 00:14:43,100
I don't have the numbers with me here

334
00:14:48,579 --> 00:14:44,870
but you can find it in my in my Tarot

335
00:14:49,660 --> 00:14:48,589
you know anywhere else specifically mix

336
00:14:52,030 --> 00:14:49,670
my cells so if you have different types

337
00:14:54,310 --> 00:14:52,040
of my alpha empty files

338
00:14:55,990 --> 00:14:54,320

laughs don't usually do that but it

339
00:14:58,450 --> 00:14:56,000
really reduces the same see the

340
00:15:00,310 --> 00:14:58,460
concentration that is necessary to form

341
00:15:02,769 --> 00:15:00,320
these different micelles and once you

342
00:15:05,170 --> 00:15:02,779
form these different muscles then it's a

343
00:15:06,490 --> 00:15:05,180
proximity factor so everything the head

344
00:15:07,960 --> 00:15:06,500
groups really touched together and

345
00:15:09,910 --> 00:15:07,970
interact with each other even in very

346
00:15:11,829 --> 00:15:09,920
dilute concentrations of the molecules

347
00:15:13,840 --> 00:15:11,839
overall for as long as they're part of

348
00:15:16,660 --> 00:15:13,850
the head drops of liquids on the my

349
00:15:18,910 --> 00:15:16,670
soles it really helps you to catalyze a

350
00:15:23,530 --> 00:15:18,920
lot of the reactions that doesn't really

351
00:15:25,620 --> 00:15:23,540
occur in a non micellar solution so I

352
00:15:30,550 --> 00:15:25,630
think that's one of the really cool

353
00:15:35,079 --> 00:15:30,560
property is about my so my hardest of a

354
00:15:37,090 --> 00:15:35,089
Sabah so I said that they are they can

355
00:15:39,940 --> 00:15:37,100
be preserved over extreme temperatures

356
00:15:42,820 --> 00:15:39,950
and pH gradients based mostly upon their

357
00:15:45,010 --> 00:15:42,830
hydrophobic core which holds everything

358
00:15:48,820 --> 00:15:45,020
together so they are the most stable for

359
00:15:52,930 --> 00:15:48,830
example the most trouble then vesicles

360
00:15:55,480 --> 00:15:52,940
that form probiotic Li and that is why I

361
00:15:58,180 --> 00:15:55,490
think you know and mostly over RNA and

362
00:16:01,240 --> 00:15:58,190
so I think it is a our best candidate

363
00:16:02,680 --> 00:16:01,250

for the original 5 in my opinion you

364
00:16:08,590 --> 00:16:02,690
know one last question is a great time

365
00:16:11,199 --> 00:16:08,600
for how diverse and how efficient are

366
00:16:13,650 --> 00:16:11,209
the reaction that can be catalyzed by

367
00:16:18,579 --> 00:16:13,660
micelles and how does that compare to

368
00:16:21,550 --> 00:16:18,589
reactions catalyzed by RNA okay so to

369
00:16:23,980 --> 00:16:21,560
the best of my knowledge we have found

370
00:16:28,980 --> 00:16:23,990
our innate are capable of catalytic

371
00:16:33,300 --> 00:16:31,890
catalytic capacity by itself so

372
00:16:34,860 --> 00:16:33,310
we find different types of our aníbal

373
00:16:37,050 --> 00:16:34,870
problem is that each one has its own

374
00:16:40,290 --> 00:16:37,060
like can only capacity origin of its own

375
00:16:42,180 --> 00:16:40,300
but one by poem it can cannot catalyze a

376
00:16:43,710 --> 00:16:42,190
lot of reactions where as my soul's

377
00:16:45,600 --> 00:16:43,720
because of the different head people

378
00:16:48,829 --> 00:16:45,610
they can have because of the structures

379
00:16:53,310 --> 00:16:48,839
even in a very diverse solution in a

380
00:16:55,890 --> 00:16:53,320
prebiotic clutter it can come as a wide

381
00:16:58,110 --> 00:16:55,900
array of different reactions and it's a

382
00:16:59,880 --> 00:16:58,120
really known well-known term micellar

383
00:17:03,079 --> 00:16:59,890
catalysis in organic chemistry can find

384
00:17:05,730 --> 00:17:03,089
a multitude of papers that use this

385
00:17:07,290 --> 00:17:05,740
method to catalyze all these different

386
00:17:12,090 --> 00:17:07,300
reactions so it's a highly diverse

387
00:17:14,309 --> 00:17:12,100
choleric templates yeah that's a even