Irena Mamajanov

From messy chemistry to biofunctional systems

1
00:00:00,160 --> 00:00:13,299
[Music]

2
00:00:19,700 --> 00:00:17,300
so incidentally I'm not only closing the

3
00:00:21,710 --> 00:00:19,710
symposium I'm closing a session that

4
00:00:24,620 --> 00:00:21,720
features two of former George Cody

5
00:00:28,519 --> 00:00:24,630
postdocs George Cody is a Carnegie

6
00:00:30,529 --> 00:00:28,529
Institute of in Washington oh actually

7
00:00:35,450 --> 00:00:30,539
and there is another one of his postdoc

8
00:00:39,530 --> 00:00:35,460
hi Jim so I arrived at LC exactly a year

9
00:00:42,160 --> 00:00:39,540
ago I I arrived just before the previous

10
00:00:45,110 --> 00:00:42,170
symposium last year's symposium and

11
00:00:47,029 --> 00:00:45,120
around that time we started to get our

12
00:00:47,840 --> 00:00:47,039
band together Mesa chemistry been

13
00:00:50,119 --> 00:00:47,850

together

14
00:00:53,330 --> 00:00:50,129
NARAS iscandar if you're here thank you

15
00:00:56,600 --> 00:00:53,340
for that image so today I'm gonna be

16
00:00:59,479 --> 00:00:56,610
presenting the work that is done by all

17
00:01:01,580 --> 00:00:59,489
these wonderful members of the band and

18
00:01:04,789 --> 00:01:01,590
this is not complete band this is just

19
00:01:06,380 --> 00:01:04,799
the work I'm going to talk about so what

20
00:01:08,480 --> 00:01:06,390
do we mean when we talk about messy

21
00:01:11,240 --> 00:01:08,490
chemistry first of all I am a chemist

22
00:01:14,450 --> 00:01:11,250
myself so the way I was taught to

23
00:01:17,300 --> 00:01:14,460
approach chemistry is to take reagent

24
00:01:19,130 --> 00:01:17,310
grade material ideally the ones that

25
00:01:20,840 --> 00:01:19,140
just arrived from sigma-aldrich and

26
00:01:24,440 --> 00:01:20,850
hasn't been sitting on the shelf for a

27
00:01:26,899 --> 00:01:24,450
long long time mix them in the specific

28
00:01:30,550 --> 00:01:26,909
way and just try to maximize your

29
00:01:34,550 --> 00:01:30,560
transform in in a very particular way to

30
00:01:39,260 --> 00:01:34,560
another set of compounds when we're

31
00:01:41,690 --> 00:01:39,270
talking about origin of life though we

32
00:01:45,319 --> 00:01:41,700
usually think not about single reaction

33
00:01:51,109 --> 00:01:45,329
but things like HCN polymers which are

34
00:01:53,300 --> 00:01:51,119
completely Messick complex systems

35
00:01:55,910 --> 00:01:53,310
polymeric systems we're of course

36
00:01:58,850 --> 00:01:55,920
thinking about Miller Urey experiment so

37
00:02:01,999 --> 00:01:58,860
in addition to a few amino acids it's a

38
00:02:05,209 --> 00:02:02,009

very very complex mixture of monomeric

39
00:02:08,270 --> 00:02:05,219
and polymeric materials we might be

40
00:02:11,740 --> 00:02:08,280
thinking about stalin's of Titan so some

41
00:02:13,570 --> 00:02:11,750
believe that this brownish color of the

42
00:02:18,280 --> 00:02:13,580
picture that was taken by Cassini

43
00:02:20,650 --> 00:02:18,290
Huygens Lander is due to complex

44
00:02:23,200 --> 00:02:20,660
polymeric matter or alternatively you

45
00:02:27,340 --> 00:02:23,210
can be thinking about insoluble organic

46
00:02:32,020 --> 00:02:27,350
matter that just yoga told us about when

47
00:02:34,900 --> 00:02:32,030
we think about our life we think about

48
00:02:37,480 --> 00:02:34,910
all of those metabolic pathways and when

49
00:02:39,910 --> 00:02:37,490
we talk about life like processes we're

50
00:02:43,990 --> 00:02:39,920
probably talking not about a single

51
00:02:46,300 --> 00:02:44,000
reaction but some subset of this network

52
00:02:48,940 --> 00:02:46,310
so this system of course very different

53
00:02:52,920 --> 00:02:48,950
from those this is a system is under

54
00:02:54,850 --> 00:02:52,930
very tight control performed by enzymes

55
00:02:57,699 --> 00:02:54,860
so what is messy

56
00:03:01,020 --> 00:02:57,709
well this is a famous quote from Steve

57
00:03:02,199 --> 00:03:01,030
Benner he it's one of his origin of life

58
00:03:06,460 --> 00:03:02,209
paradoxes

59
00:03:08,530 --> 00:03:06,470
he seems to think when molecules given

60
00:03:11,740 --> 00:03:08,540
energy and left to their own devices

61
00:03:14,740 --> 00:03:11,750
they devolve into something that is

62
00:03:17,020 --> 00:03:14,750
better suited to pave roads but not to

63
00:03:19,030 --> 00:03:17,030

start the origin of life with all due

64
00:03:22,720 --> 00:03:19,040
respect to Steve venner and I truly

65
00:03:25,570 --> 00:03:22,730
honestly mean it we disagree here so

66
00:03:27,820 --> 00:03:25,580
what is messy we're of course taking

67
00:03:29,320 --> 00:03:27,830
cues from systems chemistry and there

68
00:03:31,920 --> 00:03:29,330
are a couple of wonderful talk on the

69
00:03:36,490 --> 00:03:31,930
subject giving earlier in the symposium

70
00:03:40,150 --> 00:03:36,500
but systems chemistry per se can often

71
00:03:41,979 --> 00:03:40,160
mean very defined very small network so

72
00:03:44,080 --> 00:03:41,989
what we're doing here we're taking this

73
00:03:48,009 --> 00:03:44,090
system's chemistry to the next level

74
00:03:51,460 --> 00:03:48,019
we're talking about chemistry of complex

75
00:03:53,710 --> 00:03:51,470
interacting components which are under

76
00:03:56,470 --> 00:03:53,720
very limited control the system are not

77
00:03:59,140 --> 00:03:56,480
necessarily unstructured it just the

78
00:04:02,020 --> 00:03:59,150
structure of them is not apparent and in

79
00:04:04,810 --> 00:04:02,030
our mind from the origin of life is the

80
00:04:08,140 --> 00:04:04,820
transition from these messy chemistry's

81
00:04:11,110 --> 00:04:08,150
to well orchestrated biological system

82
00:04:14,819 --> 00:04:11,120
so what we do at LC we treat the messy

83
00:04:18,940 --> 00:04:14,829
chemistry network as a single entity and

84
00:04:22,600 --> 00:04:18,950
using computer and experimental modeling

85
00:04:25,390 --> 00:04:22,610
we try to decipher the structure of this

86
00:04:29,260 --> 00:04:25,400
entity and we also poke at it to

87
00:04:33,189 --> 00:04:29,270
figure out if there are any emergent

88
00:04:36,040 --> 00:04:33,199

phenomena to be found so first I want to

89
00:04:38,080 --> 00:04:36,050
talk about tangible messy chemistry

90
00:04:41,230 --> 00:04:38,090
something like HCN polymers are

91
00:04:44,469 --> 00:04:41,240
notoriously difficult to analyze and as

92
00:04:49,659 --> 00:04:44,479
Martha Grover eloquently explained

93
00:04:51,580 --> 00:04:49,669
already esterification reaction is is a

94
00:04:57,249 --> 00:04:51,590
reaction between carboxylic acid and

95
00:04:59,650 --> 00:04:57,259
alcohol this this bond is somewhat

96
00:05:04,689 --> 00:04:59,660
reminiscent of a peptide bond but it's

97
00:05:08,110 --> 00:05:04,699
easier to form or gal in 2003 somewhat

98
00:05:13,930 --> 00:05:08,120
reluctantly proposed that peptides can

99
00:05:15,909 --> 00:05:13,940
be potential ancestors so a polyesters

100
00:05:20,020 --> 00:05:15,919
can be potential ancestors to peptide

101
00:05:23,129 --> 00:05:20,030
and alpha hydroxy acid that is alcohol

102
00:05:27,400 --> 00:05:23,139
analogs of amino acid are shown to be

103
00:05:29,800 --> 00:05:27,410
polymerized by ribosome and there is of

104
00:05:32,710 --> 00:05:29,810
course renewed interest in the context

105
00:05:35,350 --> 00:05:32,720
of origin of life with some beautiful

106
00:05:37,659 --> 00:05:35,360
work well if I say so myself coming out

107
00:05:43,060 --> 00:05:37,669
of Center of chemical evolution in

108
00:05:46,750 --> 00:05:43,070
Georgia Tech so what we did here we

109
00:05:50,710 --> 00:05:46,760
messed up the beautiful clean system

110
00:05:54,159 --> 00:05:50,720
that Marta showed us earlier so and this

111
00:05:57,969 --> 00:05:54,169
work was led by Jim Cleves and COO Hahn

112
00:06:01,240 --> 00:05:57,979
Chandru so what they did they took five

113
00:06:04,029 --> 00:06:01,250

different alpha hydroxy acids they

114
00:06:07,480 --> 00:06:04,039
subjected them to wet/dry cycles and

115
00:06:09,610 --> 00:06:07,490
they got a whole bunch of products and

116
00:06:13,870 --> 00:06:09,620
in you're thinking about it if you take

117
00:06:17,260 --> 00:06:13,880
this mixture of five and you assume they

118
00:06:20,350 --> 00:06:17,270
only gonna make twenty mer even in that

119
00:06:24,129 --> 00:06:20,360
case you end up to the five to the 20s

120
00:06:26,879 --> 00:06:24,139
unique sequences and the idea here was

121
00:06:29,589 --> 00:06:26,889
here we are going to have a diversity

122
00:06:31,779 --> 00:06:29,599
generating synthesis that will create

123
00:06:36,640 --> 00:06:31,789
functional polymer that we can draw from

124
00:06:37,940 --> 00:06:36,650
upon need so so far it's been tough to

125
00:06:41,680 --> 00:06:37,950
analyze this

126
00:06:45,410 --> 00:06:41,690
and what hunga son and nick did they

127
00:06:48,740 --> 00:06:45,420
were able to decipher something

128
00:06:53,150 --> 00:06:48,750
something like 43,000 unique sequences

129
00:06:56,450 --> 00:06:53,160
in my spectral so the next question is

130
00:06:59,750 --> 00:06:56,460
can Massey polymers be functional and

131
00:07:02,810 --> 00:06:59,760
the answer is yes in principle and here

132
00:07:05,660 --> 00:07:02,820
is one old example coming from Sydney

133
00:07:07,880 --> 00:07:05,670
Fox so what he did back in the sixties

134
00:07:11,060 --> 00:07:07,890
he took a mixtures of amino acid he

135
00:07:12,950 --> 00:07:11,070
treated them and he ended up with like

136
00:07:14,960 --> 00:07:12,960
those interesting looking structures

137
00:07:20,660 --> 00:07:14,970
that he looked that he called

138
00:07:23,600 --> 00:07:20,670

microspheres so there are very well

139
00:07:25,430 --> 00:07:23,610
mixed feeling about this work so the

140
00:07:27,860 --> 00:07:25,440
good about this work he actually in a

141
00:07:29,780 --> 00:07:27,870
few different cases have been able to

142
00:07:33,140 --> 00:07:29,790
show that these microspheres are

143
00:07:36,350 --> 00:07:33,150
catalytic the bad about this work is

144
00:07:38,720 --> 00:07:36,360
that catalytic activity is usually small

145
00:07:41,750 --> 00:07:38,730
especially when compared to grandiose

146
00:07:44,720 --> 00:07:41,760
claims he made and he never even tried

147
00:07:48,880 --> 00:07:44,730
to provide any mechanistic explanation

148
00:07:52,370 --> 00:07:48,890
to why these microspheres could be

149
00:07:55,010 --> 00:07:52,380
catalytic and so the ugly about his work

150
00:07:57,790 --> 00:07:55,020
is he had some very unsubstantiated

151
00:08:01,250 --> 00:07:57,800
claim for example of non-random

152
00:08:03,440 --> 00:08:01,260
incorporation of amino acid did nothing

153
00:08:08,150 --> 00:08:03,450
to that effect he claimed that he was

154
00:08:11,120 --> 00:08:08,160
making linear peptides and it's actually

155
00:08:13,490 --> 00:08:11,130
probably not true because this

156
00:08:17,030 --> 00:08:13,500
polymerization and microsphere formation

157
00:08:20,240 --> 00:08:17,040
only seems to be working when a glutamic

158
00:08:22,730 --> 00:08:20,250
acid was added in excess so what

159
00:08:25,970 --> 00:08:22,740
glutamic acid has two acid group that

160
00:08:29,150 --> 00:08:25,980
both can participate in peptide bond and

161
00:08:32,870 --> 00:08:29,160
provide branching points and most

162
00:08:36,020 --> 00:08:32,880
outrageously toward the end of Fox's

163
00:08:40,010 --> 00:08:36,030

Korea he claimed that his microspheres

164
00:08:42,500 --> 00:08:40,020
are lifelike and even conscious well and

165
00:08:45,710 --> 00:08:42,510
then throughout this symposium everybody

166
00:08:48,050 --> 00:08:45,720
found paper tube ash and unfortunately

167
00:08:49,940 --> 00:08:48,060
I'm bashing here somebody who's been

168
00:08:51,170 --> 00:08:49,950
dead for 20 years I don't feel

169
00:08:57,950 --> 00:08:51,180
particularly great

170
00:09:00,079 --> 00:08:57,960
about what a fox did in his time so he

171
00:09:02,990 --> 00:09:00,089
organized a number of conferences and

172
00:09:06,769 --> 00:09:03,000
origins of life and this is I'm talking

173
00:09:10,730 --> 00:09:06,779
about one in 1965 and at that conference

174
00:09:13,850 --> 00:09:10,740
it had a talk by a biophysicist from

175
00:09:17,650 --> 00:09:13,860
Stanford martsin blue ah and he gave a

176
00:09:22,310 --> 00:09:17,660
very interesting talk talking about

177
00:09:24,670 --> 00:09:22,320
thermal or prebiotic melanin so what he

178
00:09:27,860 --> 00:09:24,680
did he took histidine he treated it got

179
00:09:31,460 --> 00:09:27,870
black tarry polymer if you would expect

180
00:09:33,530 --> 00:09:31,470
he realized that his polymer is not like

181
00:09:36,650 --> 00:09:33,540
biological melanin which is more

182
00:09:39,079 --> 00:09:36,660
structured but quite messy but he saw it

183
00:09:41,030 --> 00:09:39,089
as the opportunity he said well maybe

184
00:09:44,360 --> 00:09:41,040
it's a good thing maybe we can have a

185
00:09:46,220 --> 00:09:44,370
lot of different catalytic sites that

186
00:09:49,900 --> 00:09:46,230
are stereospecific that can bide

187
00:09:53,600 --> 00:09:49,910
substrate substract substrates and

188
00:09:56,720 --> 00:09:53,610

catalyze reactions specifically so bla

189
00:09:59,510 --> 00:09:56,730
never I continued his research so he

190
00:10:02,660 --> 00:09:59,520
made a career in melanoma research and

191
00:10:07,070 --> 00:10:02,670
bioinformatics so that's the only place

192
00:10:11,230 --> 00:10:07,080
where his opinions appear so can we

193
00:10:14,000 --> 00:10:11,240
actually be big build proto enzymes and

194
00:10:16,579 --> 00:10:14,010
we probably can but we need to approach

195
00:10:20,750 --> 00:10:16,589
this more systematically so what is an

196
00:10:22,340 --> 00:10:20,760
enzyme enzyme is a molecule that has a

197
00:10:24,470 --> 00:10:22,350
catalytic site that actually

198
00:10:29,960 --> 00:10:24,480
participates in catalysis and it's

199
00:10:32,690 --> 00:10:29,970
usually scaffolded by RNA or peptide

200
00:10:36,850 --> 00:10:32,700
scaffold and the function of the

201
00:10:40,430 --> 00:10:36,860
scaffold is to specifically bind

202
00:10:43,490 --> 00:10:40,440
orientate substrates and not only that

203
00:10:46,280 --> 00:10:43,500
but provide environments that are

204
00:10:49,040 --> 00:10:46,290
different from surrounding water that

205
00:10:51,860 --> 00:10:49,050
might promote the reaction so in

206
00:10:54,670 --> 00:10:51,870
synthetic chemistry world this function

207
00:10:58,280 --> 00:10:54,680
of enzyme was quite successfully

208
00:11:00,910 --> 00:10:58,290
approximated by so-called and resins so

209
00:11:03,980 --> 00:11:00,920
dentro science-based are based on

210
00:11:05,030 --> 00:11:03,990
dendrimers dendrimers are that this

211
00:11:07,040 --> 00:11:05,040
fractal moly

212
00:11:08,600 --> 00:11:07,050
kills regular ones of the way you

213
00:11:12,110 --> 00:11:08,610

synthesize them is you have your

214
00:11:15,050 --> 00:11:12,120
catalytic site in the middle and you add

215
00:11:17,540 --> 00:11:15,060
upon it generations of branch polymers

216
00:11:21,050 --> 00:11:17,550
and of course this molecule is very

217
00:11:23,809 --> 00:11:21,060
engineered so you can change the

218
00:11:27,819 --> 00:11:23,819
chemistry of which layer of each

219
00:11:30,319 --> 00:11:27,829
generation here to get very specific

220
00:11:32,870 --> 00:11:30,329
reactivity that's not something we're

221
00:11:36,110 --> 00:11:32,880
looking for when we I'm talking about

222
00:11:39,139 --> 00:11:36,120
prebiotic chemistry however cousins of

223
00:11:42,910 --> 00:11:39,149
those genders dendrimers called hyper

224
00:11:45,620 --> 00:11:42,920
branch polymers retain a lot of their

225
00:11:49,370 --> 00:11:45,630
properties of course in less control way

226
00:11:52,720 --> 00:11:49,380
and often they can be synthesized in one

227
00:11:57,740 --> 00:11:52,730
pot synthesis and maybe some prebiotic

228
00:12:00,819 --> 00:11:57,750
conditions so what I try to do here is

229
00:12:04,160 --> 00:12:00,829
actually have an efficient essay of

230
00:12:07,189 --> 00:12:04,170
catalytic enzyme like activity of hyper

231
00:12:10,189 --> 00:12:07,199
branch polyesters polymers in this case

232
00:12:12,980 --> 00:12:10,199
so I chose reaction and it's camp

233
00:12:16,309 --> 00:12:12,990
elimination and I hope you don't run

234
00:12:20,030 --> 00:12:16,319
away when I say this is a reaction based

235
00:12:22,519 --> 00:12:20,040
catalyzed oxidative ring opening of

236
00:12:25,670 --> 00:12:22,529
Benzi Aqsa so this reaction of no

237
00:12:28,189 --> 00:12:25,680
particular interest to pre biotic

238
00:12:32,120 --> 00:12:28,199

chemistry what it is is a reaction very

239
00:12:35,090 --> 00:12:32,130
sensitive to medium environment so it

240
00:12:38,889 --> 00:12:35,100
precedes quite sluggishly in water but

241
00:12:43,250 --> 00:12:38,899
it's proceeded quite fast in less polar

242
00:12:48,559 --> 00:12:43,260
solvents so my thinking was here if we

243
00:12:50,600 --> 00:12:48,569
build catalysts that can provide micro

244
00:12:53,059 --> 00:12:50,610
environment that are more hydrophobic

245
00:12:57,319 --> 00:12:53,069
let's say water and I wanted to run this

246
00:13:01,160 --> 00:12:57,329
reaction in water can I actually make

247
00:13:05,150 --> 00:13:01,170
this reaction go faster so I started

248
00:13:07,819 --> 00:13:05,160
building a proto enzyme so i synthesized

249
00:13:11,230 --> 00:13:07,829
hyper branch polyesters here so I use

250
00:13:15,930 --> 00:13:11,240
citric acid which is multifunctional

251
00:13:18,750 --> 00:13:15,940
carboxylic acid glycerol

252
00:13:20,940 --> 00:13:18,760
pardon I threw in triathlon all I mean

253
00:13:24,120 --> 00:13:20,950
it's a base catalyzed reaction for the

254
00:13:27,810 --> 00:13:24,130
active site I was able to prepare this

255
00:13:32,640 --> 00:13:27,820
polymer quite easily so citric acid is

256
00:13:34,830 --> 00:13:32,650
quite polar so I also had system made

257
00:13:38,250 --> 00:13:34,840
with adipic acid and methyl succeeding

258
00:13:40,550 --> 00:13:38,260
and this have hydrophobic moieties for

259
00:13:44,250 --> 00:13:40,560
compared so and this is one example of

260
00:13:47,030 --> 00:13:44,260
adipic acid so this is my spectrum and

261
00:13:50,220 --> 00:13:47,040
as you can see here it is quite messy

262
00:13:53,940 --> 00:13:50,230
there's a lot of different compounds in

263
00:13:56,430 --> 00:13:53,950

that mixture of polymers but what I can

264
00:13:59,910 --> 00:13:56,440
tell you they're all quite short so

265
00:14:06,120 --> 00:13:59,920
we're talking at maximum 7 MERS and 8

266
00:14:10,920 --> 00:14:06,130
MERS and here are some results so when

267
00:14:13,080 --> 00:14:10,930
you use monomeric Triathlon limine well

268
00:14:16,680 --> 00:14:13,090
this is the rate of the reaction in red

269
00:14:19,710 --> 00:14:16,690
when you use citric acid polymer the

270
00:14:24,270 --> 00:14:19,720
reaction proceeded somewhat more fast

271
00:14:28,880 --> 00:14:24,280
and actually there is like factor of 3

272
00:14:33,150 --> 00:14:28,890
increase when you switch to metal 6 Inuk

273
00:14:36,120 --> 00:14:33,160
acid polymer so what can we learn from

274
00:14:38,190 --> 00:14:36,130
here short branched oligomers can be

275
00:14:40,590 --> 00:14:38,200
efficient catalyst and of course

276
00:14:43,560 --> 00:14:40,600
efficient here I want to take with the

277
00:14:46,140 --> 00:14:43,570
grain of salt because factor of 3 is

278
00:14:50,940 --> 00:14:46,150
nothing compared to what enzymes can do

279
00:14:55,110 --> 00:14:50,950
but a few things to remember enzymes are

280
00:14:58,950 --> 00:14:55,120
hundreds of amino acids long this guys

281
00:15:03,510 --> 00:14:58,960
here are only seven and eight nurse I

282
00:15:05,220 --> 00:15:03,520
know for a fact I have polymers in the

283
00:15:08,010 --> 00:15:05,230
mixture there they don't have active

284
00:15:10,380 --> 00:15:08,020
side at all and some of the active sites

285
00:15:13,140 --> 00:15:10,390
might be decorating the periphery of the

286
00:15:17,550 --> 00:15:13,150
molecules and not the inside where you

287
00:15:19,260 --> 00:15:17,560
want them so a lot of biochemists are

288
00:15:23,160 --> 00:15:19,270

more comfortable when we're talking

289
00:15:26,190 --> 00:15:23,170
about peptide based catalyst so we

290
00:15:27,920 --> 00:15:26,200
probably can do that too and we can do

291
00:15:30,890 --> 00:15:27,930
it

292
00:15:33,560 --> 00:15:30,900
through Depp see peptides something that

293
00:15:37,730 --> 00:15:33,570
Martha described earlier this in the

294
00:15:40,210 --> 00:15:37,740
symposium we can try some sort of the

295
00:15:42,650 --> 00:15:40,220
direct synthesis of branched peptides

296
00:15:45,800 --> 00:15:42,660
let's say we take lysine and

297
00:15:48,320 --> 00:15:45,810
incidentally branched license are quite

298
00:15:53,150 --> 00:15:48,330
well documented in different context in

299
00:15:57,290 --> 00:15:53,160
the literature so in this next work

300
00:16:01,250 --> 00:15:57,300
direct synthesis of peptides was done by

301
00:16:03,850 --> 00:16:01,260
Musashi here reaching and kahan so what

302
00:16:07,010 --> 00:16:03,860
they did they did took a variant of

303
00:16:10,670 --> 00:16:07,020
Fox's synthesis so they went and

304
00:16:13,310 --> 00:16:10,680
scorched a solution of glycine for very

305
00:16:16,480 --> 00:16:13,320
short periods of time so you see you can

306
00:16:19,490 --> 00:16:16,490
see the formation of dark tarry material

307
00:16:22,130 --> 00:16:19,500
so then what they did is actually

308
00:16:25,579 --> 00:16:22,140
analyzed yields and length of those

309
00:16:29,269 --> 00:16:25,589
peptides so what they're finding that

310
00:16:31,040 --> 00:16:29,279
you can make some short peptides when

311
00:16:34,040 --> 00:16:31,050
you're doing it that way that that would

312
00:16:37,579 --> 00:16:34,050
form in like first twenty seconds and

313
00:16:40,640 --> 00:16:37,589

then they tend to degrade into this dark

314
00:16:44,990 --> 00:16:40,650
polymer so is there a way to somewhat

315
00:16:48,740 --> 00:16:45,000
bias this reaction so we can only get

316
00:16:52,340 --> 00:16:48,750
peptides and they decided it is

317
00:16:54,800 --> 00:16:52,350
conceivable that this can be done well

318
00:16:57,199 --> 00:16:54,810
with periodic heating and cooling of

319
00:17:00,110 --> 00:16:57,209
this solution and this is incidentally a

320
00:17:03,429 --> 00:17:00,120
regime that is known in natural hot

321
00:17:06,710 --> 00:17:03,439
springs geysers with intermittent boils

322
00:17:09,980 --> 00:17:06,720
so they built these beautiful apparatus

323
00:17:13,640 --> 00:17:09,990
so this apparatus can deliver flashes of

324
00:17:19,490 --> 00:17:13,650
heat and it can be immersed in ice water

325
00:17:32,890 --> 00:17:19,500
for quick cooling and here is another

326
00:17:39,500 --> 00:17:35,000
well sorry about that but you could

327
00:17:41,270 --> 00:17:39,510
enjoy those intermittent boils here well

328
00:17:45,770 --> 00:17:41,280
and that just took actually a lot of

329
00:17:48,890 --> 00:17:45,780
work the guys tinkered a lot with the

330
00:17:51,590 --> 00:17:48,900
type of heating block with the

331
00:17:55,490 --> 00:17:51,600
concentration of glycine in this case

332
00:17:58,760 --> 00:17:55,500
with the pH and like heating and cooling

333
00:18:00,919 --> 00:17:58,770
durations and actually after a while

334
00:18:02,930 --> 00:18:00,929
well they came up with optimal regimes

335
00:18:05,539 --> 00:18:02,940
they seems to be forming at least

336
00:18:08,120 --> 00:18:05,549
something and when they analyzed they

337
00:18:10,190 --> 00:18:08,130
got a non-negligible concentration of

338
00:18:14,510 --> 00:18:10,200

shorter peptides of course but that

339
00:18:17,419 --> 00:18:14,520
might be okay for our purposes so they

340
00:18:20,090 --> 00:18:17,429
went further and scorched low tech at

341
00:18:23,539 --> 00:18:20,100
this point a few different amino acid

342
00:18:25,310 --> 00:18:23,549
and what seems to be happening those

343
00:18:28,280 --> 00:18:25,320
different amino acids seems to be

344
00:18:29,060 --> 00:18:28,290
responding differently to heat and what

345
00:18:31,850 --> 00:18:29,070
I mean by it

346
00:18:33,890 --> 00:18:31,860
they there seems to be different profile

347
00:18:38,390 --> 00:18:33,900
of formation and degradation as a

348
00:18:42,370 --> 00:18:38,400
function of time and temperature and

349
00:18:49,669 --> 00:18:42,380
this result at this moment are simulated

350
00:18:53,600 --> 00:18:49,679
but what Gohan reaching and Musashi

351
00:18:57,830 --> 00:18:53,610
trying to to do is to find out whether

352
00:19:00,140 --> 00:18:57,840
if we had some more creative heating

353
00:19:03,020 --> 00:19:00,150
schedules and we applied them to

354
00:19:06,049 --> 00:19:03,030
mixtures of amino acid can we actually

355
00:19:10,070 --> 00:19:06,059
control or somewhat control the sequence

356
00:19:13,610 --> 00:19:10,080
of peptide formation so incidentally

357
00:19:20,120 --> 00:19:13,620
we're working on understanding better

358
00:19:22,880 --> 00:19:20,130
Fox's work and so right now I would like

359
00:19:26,480 --> 00:19:22,890
to switch gears a little bit and talk

360
00:19:28,850 --> 00:19:26,490
about projects in artificial chemistry

361
00:19:32,960 --> 00:19:28,860
is that part of the messy chemistry a

362
00:19:36,799 --> 00:19:32,970
group have been working with and so this

363
00:19:41,060 --> 00:19:36,809

is a very simple system so what you have

364
00:19:43,460 --> 00:19:41,070
here is the solution with large number

365
00:19:47,169 --> 00:19:43,470
of different

366
00:19:49,880 --> 00:19:47,179
and so this solution undergoes

367
00:19:54,919 --> 00:19:49,890
evaporative cycles but not to a complete

368
00:19:58,610 --> 00:19:54,929
dryness and the precipitation of part of

369
00:20:01,909 --> 00:19:58,620
the components of this mixture are

370
00:20:05,230 --> 00:20:01,919
driven only by intermolecular

371
00:20:08,169 --> 00:20:05,240
interaction there just we only get Coco

372
00:20:11,210 --> 00:20:08,179
precipitation and at this point

373
00:20:13,940 --> 00:20:11,220
supernatant is containing something that

374
00:20:17,960 --> 00:20:13,950
hasn't been precipitated is discarded

375
00:20:20,149 --> 00:20:17,970
and fresh solution is added and so what

376
00:20:23,600 --> 00:20:20,159
you do you go leather rings repeat

377
00:20:27,980 --> 00:20:23,610
letterings repeat until you achieve

378
00:20:30,970 --> 00:20:27,990
steady-state so that is somewhat

379
00:20:34,130 --> 00:20:30,980
building built in into the model itself

380
00:20:38,149 --> 00:20:34,140
model is more specific at low

381
00:20:41,270 --> 00:20:38,159
temperature and less specific at high

382
00:20:44,270 --> 00:20:41,280
temperature so what's happening here and

383
00:20:48,620 --> 00:20:44,280
you at the state steady state and some

384
00:20:52,460 --> 00:20:48,630
given state in red is your system

385
00:20:55,760 --> 00:20:52,470
remains messy and if you go when you go

386
00:20:59,830 --> 00:20:55,770
further at low temperature system

387
00:21:03,590 --> 00:20:59,840
becomes sparse which is interesting and

388
00:21:06,289 --> 00:21:03,600

even more interesting here they decided

389
00:21:08,930 --> 00:21:06,299
to test whether this system responds to

390
00:21:13,430 --> 00:21:08,940
any sort of perturbation any sort of

391
00:21:17,210 --> 00:21:13,440
change in the environment so what they

392
00:21:22,690 --> 00:21:17,220
did here is to to arbitrary environment

393
00:21:27,680 --> 00:21:22,700
and in the few steps they linearly

394
00:21:29,960 --> 00:21:27,690
varied the parameter space of this of

395
00:21:32,720 --> 00:21:29,970
this state trying to blend one state

396
00:21:36,110 --> 00:21:32,730
into another and what they did here they

397
00:21:38,450 --> 00:21:36,120
try to follow concentration of certain

398
00:21:41,390 --> 00:21:38,460
components and what we're finding here

399
00:21:44,810 --> 00:21:41,400
that next it's some case in certain

400
00:21:47,180 --> 00:21:44,820
components dominate once or one

401
00:21:49,880 --> 00:21:47,190
condition and certain other dominate

402
00:21:53,090 --> 00:21:49,890
another so it are trying to say we can

403
00:21:56,370 --> 00:21:53,100
have this example of very idealized but

404
00:21:59,420 --> 00:21:56,380
nevertheless adaptable

405
00:22:08,210 --> 00:21:59,430
a system that can undergo rudimentary

406
00:22:10,860 --> 00:22:08,220
evolution so what I'm hoping this our

407
00:22:13,800 --> 00:22:10,870
complex system group will do soon is

408
00:22:16,440 --> 00:22:13,810
with few tweaks to that model will help

409
00:22:21,630 --> 00:22:16,450
me understand actually my own results

410
00:22:25,350 --> 00:22:21,640
this is my first experiment with hyper

411
00:22:27,960 --> 00:22:25,360
branch polyesters so what I did in in

412
00:22:30,360 --> 00:22:27,970
this experiment I synthesized citric

413
00:22:32,850 --> 00:22:30,370

acid and glycerol polymer and took me

414
00:22:36,120 --> 00:22:32,860
some trial and error to figure out that

415
00:22:38,250 --> 00:22:36,130
I want to do it with one part citric

416
00:22:41,010 --> 00:22:38,260
acid two part glycerol because when you

417
00:22:43,320 --> 00:22:41,020
do it one to one you get cross-linked

418
00:22:48,390 --> 00:22:43,330
polymer leather rather than hyper branch

419
00:22:51,870 --> 00:22:48,400
one and here I was and I also what I

420
00:22:55,500 --> 00:22:51,880
wanted to do is to see if the devil and

421
00:22:58,830 --> 00:22:55,510
carry-ons any salts have any influence

422
00:23:01,680 --> 00:22:58,840
on the polymers I'm getting so what's

423
00:23:05,640 --> 00:23:01,690
happened here i synthesized this polymer

424
00:23:07,500 --> 00:23:05,650
under drying in neat and when I analyzed

425
00:23:10,950 --> 00:23:07,510
it by my specs of what you would expect

426
00:23:15,030 --> 00:23:10,960
what would happen is you get a lot of

427
00:23:16,530 --> 00:23:15,040
glycerol rich species let's follow the

428
00:23:19,500 --> 00:23:16,540
stoichiometry of the starting material

429
00:23:23,730 --> 00:23:19,510
and interestingly enough when I added

430
00:23:28,320 --> 00:23:23,740
calcium chloride while the system became

431
00:23:32,510 --> 00:23:28,330
more spores and there some of the peaks

432
00:23:37,410 --> 00:23:32,520
are given rise to species that are the

433
00:23:39,450 --> 00:23:37,420
citric acid rich glycerol poor and what

434
00:23:41,520 --> 00:23:39,460
I tried to in trying to understand here

435
00:23:46,890 --> 00:23:41,530
so what I'm thinking happening here is

436
00:23:50,370 --> 00:23:46,900
that citric acid kill aids my calcium

437
00:23:54,330 --> 00:23:50,380
over here and in any given time some of

438
00:23:56,430 --> 00:23:54,340

the acid of the citric acid are blocked

439
00:23:58,920 --> 00:23:56,440
toward these certifications so

440
00:24:05,280 --> 00:23:58,930
ultimately you need more to include more

441
00:24:07,230 --> 00:24:05,290
of citric acid to get epona and actually

442
00:24:09,529 --> 00:24:07,240
I've been very good so I am just I'm not

443
00:24:12,619 --> 00:24:09,539
standing between

444
00:24:15,919 --> 00:24:12,629
you guys in your beer so I want to

445
00:24:17,810 --> 00:24:15,929
conclude so we just to remind you we're

446
00:24:20,529 --> 00:24:17,820
thinking origin of life is the

447
00:24:23,779 --> 00:24:20,539
transition between messy chemistry and

448
00:24:27,469 --> 00:24:23,789
or well-orchestrated biochemical

449
00:24:30,139 --> 00:24:27,479
networks so messy chemistry can give

450
00:24:32,570 --> 00:24:30,149
rise to a number of adaptable and

451
00:24:35,599 --> 00:24:32,580
possibly a vulnerable system accessible

452
00:24:37,940 --> 00:24:35,609
through experiment or computationally

453
00:24:41,239 --> 00:24:37,950
and one last thing

454
00:24:43,369 --> 00:24:41,249
Terry materials might be a nightmare for

455
00:24:45,889 --> 00:24:43,379
synthetic and analytical chemists but

456
00:24:48,379 --> 00:24:45,899
they actually might be very important in

457
00:24:50,330 --> 00:24:48,389
our search for origin of life and just

458
00:24:54,560 --> 00:24:50,340
what I want to mention this work has

459
00:24:56,719 --> 00:24:54,570
been funded by WPI by Yann biker Ken he

460
00:24:59,509 --> 00:24:56,729
and my work with George Cody has been

461
00:25:03,010 --> 00:24:59,519
funded by Salmons foundation thank you

462
00:25:20,570 --> 00:25:07,119
[Applause]

463
00:25:22,789 --> 00:25:20,580

all right do you have any questions sir

464
00:25:24,080 --> 00:25:22,799
so food photo in Ian evolution

465
00:25:25,700 --> 00:25:24,090
particular for the win and selection you

466
00:25:28,310 --> 00:25:25,710
need some sort of inherits in some way

467
00:25:30,139 --> 00:25:28,320
of getting a somewhat reliable

468
00:25:33,950 --> 00:25:30,149
inheritance have you had any thoughts

469
00:25:42,399 --> 00:25:33,960
about this well Nathaniel certainly did

470
00:25:44,779 --> 00:25:42,409
if he can get a microphone also yes so

471
00:25:46,389 --> 00:25:44,789
traditionally in evolutionary biology we

472
00:25:48,769 --> 00:25:46,399
think of evolution as requiring

473
00:25:52,159 --> 00:25:48,779
reproduction with her table variability

474
00:25:53,989 --> 00:25:52,169
and selection the point here is that the

475
00:25:55,339 --> 00:25:53,999
first to pretty seem to be pretty hard

476
00:25:57,440 --> 00:25:55,349
to achieve in chemistry but the third

477
00:26:02,659 --> 00:25:57,450
one is really easy right I mean if you

478
00:26:04,820 --> 00:26:02,669
just have so for example in that in that

479
00:26:07,159 --> 00:26:04,830
last model there is no there's no

480
00:26:08,960 --> 00:26:07,169
reproduction but what you're doing is

481
00:26:11,119 --> 00:26:08,970
you're starting with a bunch of a mess a

482
00:26:12,499 --> 00:26:11,129
bunch of random things and in the end

483
00:26:14,869 --> 00:26:12,509
you're selecting the ones that are able

484
00:26:16,580 --> 00:26:14,879
to interact with the interact with each

485
00:26:20,620 --> 00:26:16,590
other in the right way to to become

486
00:26:26,380 --> 00:26:24,820
so the the the so that's the kind of

487
00:26:29,380 --> 00:26:26,390
that's the key point there and then the

488
00:26:31,240 --> 00:26:29,390

and then the idea is that if selection

489
00:26:33,220 --> 00:26:31,250
can get you from a mess to a to a

490
00:26:34,960 --> 00:26:33,230
functional spar system that had

491
00:26:37,000 --> 00:26:34,970
selection itself can or it can be a help

492
00:26:38,200 --> 00:26:37,010
in getting you towards the types of

493
00:26:41,080 --> 00:26:38,210
systems where you're able to have

494
00:26:43,740 --> 00:26:41,090
replication and and heredity so we

495
00:26:45,970 --> 00:26:43,750
haven't done that yet but that's the

496
00:26:56,080 --> 00:26:45,980
that's the that's where we're going with

497
00:26:58,780 --> 00:26:56,090
it okay I have one you mention about

498
00:26:59,920 --> 00:26:58,790
Sydney Fox work which the bad you show

499
00:27:02,500 --> 00:26:59,930
that he didn't show any kind of

500
00:27:04,660 --> 00:27:02,510
mechanism how important is mechanism on

501
00:27:06,460 --> 00:27:04,670
a messy system because from my

502
00:27:08,020 --> 00:27:06,470
understanding a mechanism is when you do

503
00:27:09,940 --> 00:27:08,030
clean chemistry you can figure out the

504
00:27:13,480 --> 00:27:09,950
mechanism in various technique in a

505
00:27:15,790 --> 00:27:13,490
messy system how can one do it well and

506
00:27:18,220 --> 00:27:15,800
just if it's like mechanism like we're

507
00:27:20,560 --> 00:27:18,230
studying in organic chemistry books or

508
00:27:22,720 --> 00:27:20,570
it's not but you need there need to be a

509
00:27:25,000 --> 00:27:22,730
reason you need to show that this is not

510
00:27:28,450 --> 00:27:25,010
a fluke right there's need to be some

511
00:27:29,770 --> 00:27:28,460
chemical reasoning right synthetic Oh

512
00:27:31,660 --> 00:27:29,780
for your messy chemistry for messy

513
00:27:33,430 --> 00:27:31,670

chemistry right I mean as a chemist I

514
00:27:35,590 --> 00:27:33,440
want to see a reason I want to see that

515
00:27:37,300 --> 00:27:35,600
oh it's not random it's not just a fluke

516
00:27:38,980 --> 00:27:37,310
I want to understand what's happening

517
00:27:41,620 --> 00:27:38,990
there and I don't want like very

518
00:27:44,320 --> 00:27:41,630
specific mechanism or no shifting

519
00:27:47,260 --> 00:27:44,330
electrons here and there I just kind of

520
00:27:50,320 --> 00:27:47,270
a set of plausible steps that can lead

521
00:27:52,240 --> 00:27:50,330
you from A to B but again what you want

522
00:27:56,370 --> 00:27:52,250
and what you get is two different things

523
00:28:06,120 --> 00:27:56,380
right so no that's true that's true

524
00:28:13,930 --> 00:28:09,850
thanks for the first formal yokozuna

525
00:28:16,300 --> 00:28:13,940
sure and I was hoping you could talk a

526
00:28:18,780 --> 00:28:16,310
little bit more about the impact of the

527
00:28:21,250 --> 00:28:18,790
the calcium ions in your polymerization

528
00:28:25,660 --> 00:28:21,260
and more broadly I started to wonder

529
00:28:27,370 --> 00:28:25,670
about different cation sizes so for

530
00:28:29,830 --> 00:28:27,380
example if you had a transition metal in

531
00:28:31,310 --> 00:28:29,840
there or something with a different

532
00:28:33,320 --> 00:28:31,320
ionic radius with

533
00:28:36,200 --> 00:28:33,330
sort of effects my you start expecting

534
00:28:38,360 --> 00:28:36,210
to see so yeah this work published and

535
00:28:40,190 --> 00:28:38,370
actually in this worker had series of

536
00:28:43,040 --> 00:28:40,200
different divalent cations and

537
00:28:45,740 --> 00:28:43,050
transition there doesn't seem to be a

538
00:28:47,900 --> 00:28:45,750

difference this as a result in every

539
00:28:50,960 --> 00:28:47,910
case in this particular system are the

540
00:28:53,480 --> 00:28:50,970
same but you know this is the start this

541
00:29:04,790 --> 00:28:53,490
is somewhat messy and it just needs a

542
00:29:06,830 --> 00:29:04,800
closer to loop do you foresee structure

543
00:29:10,130 --> 00:29:06,840
coming out of this anything similar to

544
00:29:13,070 --> 00:29:10,140
peptides or is it all just pure chemical

545
00:29:14,570 --> 00:29:13,080
systems that you're creating here from

546
00:29:16,490 --> 00:29:14,580
the messy chemist from the Mesa

547
00:29:20,720 --> 00:29:16,500
chemistry let's say structure when I

548
00:29:23,210 --> 00:29:20,730
talked about hyper branch polymers right

549
00:29:26,500 --> 00:29:23,220
and so here I'm talking about yeah well

550
00:29:30,050 --> 00:29:26,510
we know that most enzymes are globular

551
00:29:32,240 --> 00:29:30,060
this system are also globular so I mean

552
00:29:35,300 --> 00:29:32,250
there should be some generality to

553
00:29:39,170 --> 00:29:35,310
structure in that sense sense right not

554
00:29:41,360 --> 00:29:39,180
necessarily in Mexican Singh and folding

555
00:29:45,620 --> 00:29:41,370
but it's just kind of this general shape

556
00:29:47,630 --> 00:29:45,630
can be similar in that sense I think but

557
00:29:49,880 --> 00:29:47,640
you know that's just some steps how you

558
00:29:52,160 --> 00:29:49,890
get from like this general shapes

559
00:29:54,200 --> 00:29:52,170
there's a you know shapes as they're

560
00:29:55,820 --> 00:29:54,210
expressed in current biology that's a

561
00:30:00,130 --> 00:29:55,830
different question I don't have an

562
00:30:03,170 --> 00:30:00,140
answer yet okay would you expect like a

563
00:30:05,240 --> 00:30:03,180

consistent morphology to come out of it

564
00:30:07,490 --> 00:30:05,250
consistent shapes like beta sheets or

565
00:30:16,670 --> 00:30:07,500
HeLa C's or something that could be

566
00:30:20,000 --> 00:30:16,680
universal between your messy system just

567
00:30:21,980 --> 00:30:20,010
that's a very good question no I don't

568
00:30:23,510 --> 00:30:21,990
see it don't predict those that just

569
00:30:26,510 --> 00:30:23,520
says that there's I'm gonna be some

570
00:30:28,190 --> 00:30:26,520
general similarity maybe within those

571
00:30:30,020 --> 00:30:28,200
structure that they would learn to

572
00:30:32,480 --> 00:30:30,030
support something like beta sheet and

573
00:30:37,850 --> 00:30:32,490
alpha helixes maybe through Dipsy

574
00:30:39,550 --> 00:30:37,860
peptide backbones but you know it's how

575
00:30:42,560 --> 00:30:39,560
should I put it

576
00:30:44,600 --> 00:30:42,570
alpha heel is a beta sheets are so

577
00:30:48,230 --> 00:30:44,610
unique seem to be so unique

578
00:30:50,480 --> 00:30:48,240
two linear peptides it's gonna be in a

579
00:31:03,740 --> 00:30:50,490
in a large sense it's going to be hard

580
00:31:06,169 --> 00:31:03,750
to replicate thank you thank you this is

581
00:31:09,380 --> 00:31:06,179
more of a comment as I thought that was

582
00:31:11,330 --> 00:31:09,390
fantastic and what I'm wondering is

583
00:31:13,220 --> 00:31:11,340
whether you're really with the origin of

584
00:31:14,240 --> 00:31:13,230
life talking about not just messy

585
00:31:17,390 --> 00:31:14,250
chemistry but I've come to the

586
00:31:19,549 --> 00:31:17,400
conclusion it's a sloppy ecosystem and

587
00:31:21,560 --> 00:31:19,559
that any attempt to have an origin of

588
00:31:23,720 --> 00:31:21,570

life based on some neat little single

589
00:31:26,120 --> 00:31:23,730
molecule is going to fail that it was it

590
00:31:27,919 --> 00:31:26,130
was some kind of messy ecosystem and

591
00:31:30,460 --> 00:31:27,929
life has always been sloppy and always

592
00:31:33,710 --> 00:31:30,470
complex and that's the nature of life

593
00:31:36,760 --> 00:31:33,720
thank you it seems to be necessary surge

594
00:31:39,470 --> 00:31:36,770
by biology these days it's quite messy

595
00:31:43,990 --> 00:31:39,480
am i right Shawn and he's a resident

596
00:31:46,520 --> 00:31:44,000
biology just to follow up on that one

597
00:31:49,520 --> 00:31:46,530
how do you see the steps coming on so

598
00:31:52,850 --> 00:31:49,530
for example when does a membrane come up

599
00:31:54,620 --> 00:31:52,860
how when does Hera did you come so which

600
00:31:56,330 --> 00:31:54,630
other steps if you've had any thoughts

601
00:31:58,789 --> 00:31:56,340
about this I have any thoughts about

602
00:32:01,460 --> 00:31:58,799
that so actually this system so it's I

603
00:32:04,010 --> 00:32:01,470
don't have a scenario here so here

604
00:32:07,549 --> 00:32:04,020
thinking about for example proto enzymes

605
00:32:09,500 --> 00:32:07,559
only yeah it's hard I mean actually I

606
00:32:11,360 --> 00:32:09,510
have to think at some point I'll have to

607
00:32:14,510 --> 00:32:11,370
think at some point would come first at

608
00:32:15,980 --> 00:32:14,520
this point I don't know and then you

609
00:32:21,560 --> 00:32:15,990
have to get from the messy one to a

610
00:32:24,650 --> 00:32:21,570
cleaner one just you need some better

611
00:32:26,890 --> 00:32:24,660
control better catalysts better enzymes

612
00:32:28,520 --> 00:32:26,900
so when membrane comes in to

613
00:32:31,580 --> 00:32:28,530

compartmentalization and the whether

614
00:32:33,350 --> 00:32:31,590
it's important to clean up messy

615
00:32:35,780 --> 00:32:33,360
chemistry maybe it is because the key

616
00:32:38,630 --> 00:32:35,790
here you can have a diffusion through a

617
00:32:41,060 --> 00:32:38,640
membrane right yeah that it just that's

618
00:32:44,060 --> 00:32:41,070
not membrane is exactly one way to clean

619
00:32:46,039 --> 00:32:44,070
up the mess yeah so everywhere we don't

620
00:32:48,950 --> 00:32:46,049
have a particular scenario every in each

621
00:32:56,649 --> 00:32:48,960
case every and each selective pressure

622
00:33:02,419 --> 00:32:58,969
well thank you so much for the talk so

623
00:33:06,109 --> 00:33:02,429
um I'm kind of envisioning a transition

624
00:33:08,029 --> 00:33:06,119
from the messy chemistry to like a world

625
00:33:11,539 --> 00:33:08,039
where the translation system is started

626
00:33:13,909 --> 00:33:11,549
to like emerge so I think the talk by

627
00:33:15,859 --> 00:33:13,919
Lauren Williams was like one of the

628
00:33:18,439 --> 00:33:15,869
functions of the ribosome is to actually

629
00:33:20,359 --> 00:33:18,449
make a linear polymer compared to the

630
00:33:22,639 --> 00:33:20,369
East Branch in Homer so if there's these

631
00:33:24,229 --> 00:33:22,649
like backup system running behind to

632
00:33:27,709 --> 00:33:24,239
actually do all the metabolic Network

633
00:33:31,639 --> 00:33:27,719
and you start to have these emerging

634
00:33:35,259 --> 00:33:31,649
ribosome will there be inhibit

635
00:33:38,629 --> 00:33:35,269
inhibitory effect from these messy

636
00:33:41,449 --> 00:33:38,639
branched polymers against those rising

637
00:33:43,249 --> 00:33:41,459
you know ribosome what it does it

638
00:33:46,399 --> 00:33:43,259

actually support or would it kind of

639
00:33:49,609 --> 00:33:46,409
block the interaction between the co

640
00:33:51,769 --> 00:33:49,619
symbiont of peptide and RNA sorry it

641
00:33:54,019 --> 00:33:51,779
might be a little no no just I don't

642
00:33:57,109 --> 00:33:54,029
know I don't have an answer it's hard to

643
00:33:59,089 --> 00:33:57,119
do it hard to envision oh the mechanism

644
00:34:01,249 --> 00:33:59,099
at this moment so what I'm understanding

645
00:34:04,639 --> 00:34:01,259
we had this conversation with Chris

646
00:34:08,240 --> 00:34:04,649
Adame once so the the reason that might

647
00:34:10,789 --> 00:34:08,250
be life chose linear polymers those are

648
00:34:13,749 --> 00:34:10,799
easier to encode for easier to replicate

649
00:34:17,419 --> 00:34:13,759
and now just we talked about branch

650
00:34:20,149 --> 00:34:17,429
polymers in that he didn't see any way

651
00:34:21,950 --> 00:34:20,159
of you know in that way it got to be

652
00:34:26,529 --> 00:34:21,960
some sort of photography how you would

653
00:34:28,999 --> 00:34:26,539
photograph a structure so in that sense

654
00:34:31,309 --> 00:34:29,009
these things actually might be

655
00:34:34,039 --> 00:34:31,319
inhibiting but you know what are the

656
00:34:36,649 --> 00:34:34,049
exact mechanisms or number of mechanisms

657
00:34:38,960 --> 00:34:36,659
I don't know yet I guess we can do some

658
00:34:41,809 --> 00:34:38,970
experiment for example mixing these the

659
00:34:43,460 --> 00:34:41,819
branch polymer would for example their

660
00:34:45,919 --> 00:34:43,470
RNA strands and peptides and like

661
00:34:47,809 --> 00:34:45,929
everything together and and and see

662
00:34:50,240 --> 00:34:47,819
actually you know how these interact you

663
00:34:57,560 --> 00:34:50,250

know these kind of selection we will

664
00:35:05,450 --> 00:35:02,780
I have a question again messy chemistry

665
00:35:09,440 --> 00:35:05,460
systems chemistry systems biology why

666
00:35:14,180 --> 00:35:09,450
the woods changing all the time oh yeah

667
00:35:17,060 --> 00:35:14,190
that's how sure I said so systems

668
00:35:19,160 --> 00:35:17,070
chemistry system biology means so many

669
00:35:23,690 --> 00:35:19,170
things to me so many different people

670
00:35:25,760 --> 00:35:23,700
and we wanted a different term and so

671
00:35:27,440 --> 00:35:25,770
some of you know as you talk to them

672
00:35:31,340 --> 00:35:27,450
that don't really like the word messy

673
00:35:35,180 --> 00:35:31,350
it's it's really not precise but any one

674
00:35:37,610 --> 00:35:35,190
of like prebiotic chemistry with Missy

675
00:35:39,080 --> 00:35:37,620
system with prebiotic chemistry you know

676
00:35:42,410 --> 00:35:39,090
they know they understand what

677
00:35:44,600 --> 00:35:42,420
qualitatively messy means right away

678
00:35:48,890 --> 00:35:44,610
so I think that was my thinking when we

679
00:35:50,930 --> 00:35:48,900
decided to call our chemistry messy do

680
00:35:53,900 --> 00:35:50,940
you have any last questions this is the

681
00:35:54,710 --> 00:35:53,910
last talk of the day and inviting

682
00:36:03,740 --> 00:35:54,720
questions

683
00:36:06,290 --> 00:36:03,750
jimp lives nice talk I wanted to ask

684
00:36:08,660 --> 00:36:06,300
your opinion so earlier in the week we

685
00:36:11,300 --> 00:36:08,670
heard this this kind of notion that life

686
00:36:13,130 --> 00:36:11,310
built itself up from simplicity into

687
00:36:16,400 --> 00:36:13,140
complexity and this seems like

688
00:36:23,020 --> 00:36:16,410

completely the opposite notion is there

689
00:36:31,940 --> 00:36:25,550
well it just all depends how I defined

690
00:36:34,160 --> 00:36:31,950
simplicity and no complexity I think so

691
00:36:35,660 --> 00:36:34,170
in what sense i I just you know if

692
00:36:37,370 --> 00:36:35,670
you're just talking about chemistry

693
00:36:40,100 --> 00:36:37,380
I can't envision like very clean

694
00:36:42,290 --> 00:36:40,110
chemistry happening without enzymes on

695
00:36:46,130 --> 00:36:42,300
the other hands you know what I only

696
00:36:47,810 --> 00:36:46,140
just like different how did different

697
00:36:49,790 --> 00:36:47,820
kind of processes different kind of

698
00:36:52,010 --> 00:36:49,800
chemistry happening here it's that's

699
00:36:54,920 --> 00:36:52,020
actually a limited amount chemistry is

700
00:36:57,710 --> 00:36:54,930
simple no structures are complex and

701
00:37:00,500 --> 00:36:57,720
when you transfer going to biology I

702
00:37:03,670 --> 00:37:00,510
think that you know the chemical space

703
00:37:07,490 --> 00:37:03,680
is vast but you don't structures are

704
00:37:10,550 --> 00:37:07,500
relatively not simple but similar

705
00:37:11,390 --> 00:37:10,560
repetitive does that answer your

706
00:37:12,799 --> 00:37:11,400
question

707
00:37:20,599 --> 00:37:12,809
well yeah there's a lot of ways to

708
00:37:22,770 --> 00:37:20,609
answer it yeah all right then thank you

709
00:37:24,820 --> 00:37:22,780
let's give a ham

710
00:37:36,940 --> 00:37:24,830
[Applause]