2017 Astrobiology Graduate Conference

CHARLOTTESVILLE, VA

1
00:00:00,790 --> 00:00:07,419
[Music]

2
00:00:12,530 --> 00:00:09,830
so hello everyone my name is Nicolas

3
00:00:14,209 --> 00:00:12,540
Kovich my advisor is dr. Lauren Williams

4
00:00:16,670 --> 00:00:14,219
and we are at the Georgia Tech at

5
00:00:18,500 --> 00:00:16,680
Georgia Tech in Atlanta Georgia on the

6
00:00:20,269 --> 00:00:18,510
bioinformatics PhD candidate the school

7
00:00:22,640 --> 00:00:20,279
of chemistry and biochemistry and my

8
00:00:25,130 --> 00:00:22,650
talk today is titled frozen in time the

9
00:00:26,900 --> 00:00:25,140
history of proteins so I'll be talking

10
00:00:29,599 --> 00:00:26,910
about a really large molecular structure

11
00:00:32,150 --> 00:00:29,609
but I swear it pertains to the origin of

12
00:00:35,569 --> 00:00:32,160
life so just bear with the introduction

13
00:00:37,520 --> 00:00:35,579

I'll get to it eventually um so just a

14
00:00:40,430 --> 00:00:37,530
brief introduction about the central

15
00:00:41,780 --> 00:00:40,440
dogma of molecular biology I'm sure all

16
00:00:43,610 --> 00:00:41,790
of you guys are familiar with this but

17
00:00:50,360 --> 00:00:43,620
just to touch base with it for some of

18
00:00:53,090 --> 00:00:50,370
those geologists or some other people so

19
00:00:55,549 --> 00:00:53,100
here on the Left we have DNA and it's a

20
00:00:58,430 --> 00:00:55,559
nucleic acid polymer and on it

21
00:01:00,410 --> 00:00:58,440
we have encoded genes amongst other

22
00:01:02,510 --> 00:01:00,420
things but genes where we can talk about

23
00:01:05,630 --> 00:01:02,520
and over here in the blue we have an

24
00:01:08,060 --> 00:01:05,640
enzyme RNA polymerase which reads the

25
00:01:09,980 --> 00:01:08,070
DNA and looks at just the genes and

26
00:01:14,000 --> 00:01:09,990
copies those into RNA

27
00:01:16,249 --> 00:01:14,010
another nucleic acid polymer and so it's

28
00:01:19,130 --> 00:01:16,259
RNA then just has just the one gene on

29
00:01:22,070 --> 00:01:19,140
it and this gene on the mRNA goes to the

30
00:01:25,940 --> 00:01:22,080
ribosome and the ribosome then reads the

31
00:01:29,060 --> 00:01:25,950
mRNA it makes a protein and amino acid

32
00:01:31,910 --> 00:01:29,070
polymer and so I will be talking about

33
00:01:36,399 --> 00:01:31,920
the ribosome right here the key in it

34
00:01:39,170 --> 00:01:36,409
which reads RNA and makes protein so

35
00:01:41,210 --> 00:01:39,180
looking at the ribosome it has two

36
00:01:44,090 --> 00:01:41,220
subunits the small subunit and the large

37
00:01:45,620 --> 00:01:44,100
subunit the log the small subunit is all

38
00:01:49,280 --> 00:01:45,630

left and the large subunit is on the

39
00:01:52,130 --> 00:01:49,290
right RNA I have colored in pink and

40
00:01:54,560 --> 00:01:52,140
yellow and in blue are ribosomal

41
00:01:56,660 --> 00:01:54,570
proteins and then right there in the

42
00:01:59,480 --> 00:01:56,670
green at the very center of the large

43
00:02:02,030 --> 00:01:59,490
subunit is where peptide bond catalysis

44
00:02:04,399 --> 00:02:02,040
happens that is called the petiole

45
00:02:08,630 --> 00:02:04,409
transferase center and this particular

46
00:02:11,820 --> 00:02:08,640
transferase center is exclusively RNA so

47
00:02:15,520 --> 00:02:11,830
the ribosome is a ripe design

48
00:02:18,580 --> 00:02:15,530
okay so like I said the ribosome reads

49
00:02:20,650 --> 00:02:18,590
RNA it makes protein or it reads nucleic

50
00:02:22,990 --> 00:02:20,660
acid polymers and it makes an amino acid

51
00:02:25,360 --> 00:02:23,000
polymer or another way of saying that is

52
00:02:28,960 --> 00:02:25,370
its input as information and its output

53
00:02:30,610 --> 00:02:28,970
is a function so in 2009 the Nobel Prize

54
00:02:32,830 --> 00:02:30,620
in Chemistry was awarded to thanking

55
00:02:34,720 --> 00:02:32,840
ramakrishnan commerce sites in a tea

56
00:02:37,240 --> 00:02:34,730
oneth for the studies of the structure

57
00:02:39,520 --> 00:02:37,250
and function of the ribosome and they

58
00:02:41,590 --> 00:02:39,530
made this really cool animation and it's

59
00:02:42,910 --> 00:02:41,600
very complex but is this is the

60
00:02:45,610 --> 00:02:42,920
introduction of the ribosome so I just

61
00:02:47,410 --> 00:02:45,620
want to show you that on the bottom here

62
00:02:50,440 --> 00:02:47,420
we have the small subunit that's in

63
00:02:52,480 --> 00:02:50,450

transparent pink on the top we have and

64
00:02:55,270 --> 00:02:52,490
this transparent yellow that would be

65
00:02:56,950 --> 00:02:55,280
the large subunit the mRNA is in blue

66
00:02:59,950 --> 00:02:56,960
and it's being read by the small subunit

67
00:03:01,750 --> 00:02:59,960
and these structures going in and out of

68
00:03:04,900 --> 00:03:01,760
here are T RNAs and they're bringing

69
00:03:06,400 --> 00:03:04,910
amino acids and these amino acids are

70
00:03:08,020 --> 00:03:06,410
brought to the peptidyl transferase

71
00:03:10,510 --> 00:03:08,030
center right in the middle of the large

72
00:03:12,700 --> 00:03:10,520
subunit and they get strung together to

73
00:03:19,570 --> 00:03:12,710
make a peptide that then emerges out the

74
00:03:23,080 --> 00:03:19,580
back of the ribosome so now to look at

75
00:03:24,030 --> 00:03:23,090
the sequence of the ribosome so I'm sure

76
00:03:26,530 --> 00:03:24,040
many of you are familiar with

77
00:03:28,240 --> 00:03:26,540
phylogenetic trees of life where we have

78
00:03:31,150 --> 00:03:28,250
the three domains of life bacteria

79
00:03:32,800 --> 00:03:31,160
archaea and Eukarya over here we have

80
00:03:35,680 --> 00:03:32,810
animals and their distant relates a

81
00:03:37,600 --> 00:03:35,690
fungi and plants then we have our cans

82
00:03:39,760 --> 00:03:37,610
which are then you can barley distantly

83
00:03:40,960 --> 00:03:39,770
related to eukaryotes and then bacteria

84
00:03:44,260 --> 00:03:40,970
are all over here

85
00:03:47,170 --> 00:03:44,270
and so these phylogenetic trees are made

86
00:03:50,560 --> 00:03:47,180
by looking at the sequence of ribosomal

87
00:03:52,900 --> 00:03:50,570
genes so the ribosomal RNA and ribosomal

88
00:03:57,690 --> 00:03:52,910

proteins are encoded on the genome of

89
00:04:01,570 --> 00:03:57,700
all of every organism and so just the

90
00:04:04,320 --> 00:04:01,580
ribosomal RNA genes are just not made

91
00:04:06,370 --> 00:04:04,330
into protein they just stay as RNA but

92
00:04:07,840 --> 00:04:06,380
we can just be looking at the sequence

93
00:04:12,330 --> 00:04:07,850
and that's how we construct these

94
00:04:14,710 --> 00:04:12,340
phylogenetic trees so the ribosome has

95
00:04:18,340 --> 00:04:14,720
within it like the interrelatedness of

96
00:04:20,560 --> 00:04:18,350
all of life so looking at the ribosome

97
00:04:22,650 --> 00:04:20,570
from across the Tree of Life we can see

98
00:04:24,560 --> 00:04:22,660
that bacteria the large subunit has two

99
00:04:26,720 --> 00:04:24,570
ribosomal RNAs and

100
00:04:29,540 --> 00:04:26,730
33 ribosomal proteins where it's a small

101
00:04:32,330 --> 00:04:29,550
subunit has one ribosomal RNA and 22

102
00:04:34,520 --> 00:04:32,340
ribosomal proteins are kaons then have a

103
00:04:37,130 --> 00:04:34,530
few more ribosomal proteins and both

104
00:04:40,760 --> 00:04:37,140
both its large subunit and small subunit

105
00:04:42,530 --> 00:04:40,770
and then eukaryotes have one more one or

106
00:04:44,510 --> 00:04:42,540
two more ribosomal RNAs in its large

107
00:04:47,510 --> 00:04:44,520
subunit and a few more ribosomal

108
00:04:49,310 --> 00:04:47,520
proteins in both its l-s-u large living

109
00:04:53,060 --> 00:04:49,320
it and SS you small so you

110
00:04:55,070 --> 00:04:53,070
and so bacterias ribosomes are pretty

111
00:04:57,350 --> 00:04:55,080
small whereas our cans are a little bit

112
00:05:01,370 --> 00:04:57,360
bigger and eukaryotes have very large

113
00:05:03,380 --> 00:05:01,380

ribosomes so to conclude this

114
00:05:05,750 --> 00:05:03,390
introduction on the ribosome its

115
00:05:07,850 --> 00:05:05,760
sequence and structure ribosomes are

116
00:05:09,980 --> 00:05:07,860
made of both RNA and protein ribosomal

117
00:05:12,470 --> 00:05:09,990
RNA and protein sequences describe the

118
00:05:14,480 --> 00:05:12,480
interrelatedness of life and ribosomes

119
00:05:15,320 --> 00:05:14,490
size is highly correlated with species

120
00:05:18,350 --> 00:05:15,330
complexity

121
00:05:20,660 --> 00:05:18,360
here's another phylogenetic tree so on

122
00:05:23,780 --> 00:05:20,670
the top we have homo sapiens and below

123
00:05:26,260 --> 00:05:23,790
that shrimps so those are mammals and

124
00:05:27,850 --> 00:05:26,270
then farther down we have chicken and

125
00:05:31,790 --> 00:05:27,860
[Music]

126
00:05:35,840 --> 00:05:31,800
let's see mosquito right there so those

127
00:05:37,790 --> 00:05:35,850
are animals and then further down here

128
00:05:43,610 --> 00:05:37,800
we have single-celled eukaryotes like

129
00:05:44,060 --> 00:05:43,620
ester Vissi a fungus and what else we

130
00:05:46,550 --> 00:05:44,070
have here

131
00:05:49,490 --> 00:05:46,560
I think Plasmodium falciparum which is

132
00:05:51,020 --> 00:05:49,500
the parasite that causes malaria and

133
00:05:52,640 --> 00:05:51,030
then down here I just have archaea and

134
00:05:55,700 --> 00:05:52,650
bacteria because what I'm trying to show

135
00:05:58,190 --> 00:05:55,710
in this phylogenetic tree is the size of

136
00:06:00,560 --> 00:05:58,200
the ribosome so bacteria the ribosome is

137
00:06:02,750 --> 00:06:00,570
all about the same size but the sequence

138
00:06:04,190 --> 00:06:02,760

is very different and the same with our

139
00:06:06,140 --> 00:06:04,200
kaons their ribosomes a little bit

140
00:06:08,360 --> 00:06:06,150
larger than bacteria but their sequence

141
00:06:10,670 --> 00:06:08,370
is very different within the whole

142
00:06:12,530 --> 00:06:10,680
entire domain whereas eukaryotes there's

143
00:06:15,050 --> 00:06:12,540
like a really big difference in their

144
00:06:17,450 --> 00:06:15,060
size of the ribosomes and so that's what

145
00:06:20,060 --> 00:06:17,460
I have over here and these circles so

146
00:06:22,640 --> 00:06:20,070
bacteria the ribosome is small and

147
00:06:24,890 --> 00:06:22,650
Arcadians is also fairly small then the

148
00:06:26,990 --> 00:06:24,900
single cellular eukaryotes have you know

149
00:06:28,460 --> 00:06:27,000
medium sized ribosomes these animals

150
00:06:30,650 --> 00:06:28,470
have even larger ribosomes

151
00:06:32,870 --> 00:06:30,660
then mammals have the largest ribosomes

152
00:06:34,880 --> 00:06:32,880
that we see this so this is very highly

153
00:06:37,640 --> 00:06:34,890
correlated to how complex a species

154
00:06:38,430 --> 00:06:37,650
species is people used to think oh well

155
00:06:41,610 --> 00:06:38,440
maybe like the length

156
00:06:43,140 --> 00:06:41,620
you know the DNA of an organ organism

157
00:06:44,640 --> 00:06:43,150
would tell you how complex that species

158
00:06:46,290 --> 00:06:44,650
is but there is some really big

159
00:06:49,170 --> 00:06:46,300
anomalies that really just throw it off

160
00:06:52,320 --> 00:06:49,180
for instance the marble bunk fish has

161
00:06:52,620 --> 00:06:52,330
its genome was 120 billion nucleotides

162
00:06:56,250 --> 00:06:52,630
long

163
00:06:57,510 --> 00:06:56,260

whereas humans it's 6 billion so really

164
00:07:01,710 --> 00:06:57,520
that's not like a really good indication

165
00:07:03,960 --> 00:07:01,720
of how complex this species is okay so

166
00:07:05,130 --> 00:07:03,970
what am i doing in my project so I'm

167
00:07:08,190 --> 00:07:05,140
looking at the ribosome and I'm

168
00:07:09,990 --> 00:07:08,200
constructing a data set of its structure

169
00:07:12,060 --> 00:07:10,000
and the reason I'm doing that is because

170
00:07:14,190 --> 00:07:12,070
the ribosome is the origin of life it

171
00:07:17,220 --> 00:07:14,200
contains within its structuring sequence

172
00:07:19,350 --> 00:07:17,230
the history of protein folding and I

173
00:07:21,150 --> 00:07:19,360
believe that by mining the structure of

174
00:07:25,320 --> 00:07:21,160
it and the sequence set I can unravel

175
00:07:27,210 --> 00:07:25,330
how life has evolved so like I said I'm

176
00:07:30,180 --> 00:07:27,220
looking at structures of ribosomes and

177
00:07:32,070 --> 00:07:30,190
in 2009 the Nobel Prize was awarded for

178
00:07:34,050 --> 00:07:32,080
the structure for crystallize in

179
00:07:37,680 --> 00:07:34,060
ribosome and since then we have quite a

180
00:07:40,110 --> 00:07:37,690
few structures so we have bacteria E

181
00:07:42,390 --> 00:07:40,120
coli and thermus thermophilus on the

182
00:07:44,610 --> 00:07:42,400
Left we have the large subunit and on

183
00:07:46,050 --> 00:07:44,620
the right we have the small subunit we

184
00:07:48,390 --> 00:07:46,060
have the Arcadians halo rocky lamar

185
00:07:50,850 --> 00:07:48,400
smart i and pirate caucus furiosa s'

186
00:07:52,409 --> 00:07:50,860
halo arkla we only have a large subunit

187
00:07:55,260 --> 00:07:52,419
not the small subunit we can get

188
00:07:57,780 --> 00:07:55,270

crystallized we also have the protozoan

189
00:08:01,260 --> 00:07:57,790
a single cellular eukaryote again we

190
00:08:03,450 --> 00:08:01,270
only have the large subunit we have the

191
00:08:06,690 --> 00:08:03,460
single cellular fungi Saccharomyces

192
00:08:09,150 --> 00:08:06,700
cerevisiae the animals Drosophila like

193
00:08:11,400 --> 00:08:09,160
gaster and Homo sapiens fruit fly in

194
00:08:13,650 --> 00:08:11,410
humans and we also have the human

195
00:08:17,730 --> 00:08:13,660
protozoan parasites that cause malaria

196
00:08:20,370 --> 00:08:17,740
and African sleeping sickness and so

197
00:08:23,840 --> 00:08:20,380
what happens when we align all these on

198
00:08:26,030 --> 00:08:23,850
to each other well as you can see

199
00:08:27,960 --> 00:08:26,040
bacteria and archaea have pretty small

200
00:08:29,730 --> 00:08:27,970
ribosomes but then when you start

201
00:08:34,110 --> 00:08:29,740
putting on eukaryotes it gets a little

202
00:08:35,880 --> 00:08:34,120
bigger and larger and larger and then I

203
00:08:40,649 --> 00:08:35,890
have these human protozoan parasites

204
00:08:42,690 --> 00:08:40,659
over here for a discussion later on that

205
00:08:44,400 --> 00:08:42,700
maybe you have but for the focus of this

206
00:08:47,130 --> 00:08:44,410
talk I'm not going to talk too much

207
00:08:48,840 --> 00:08:47,140
about them but as you can see these

208
00:08:52,110 --> 00:08:48,850
structures are quite a bit larger than

209
00:08:54,629 --> 00:08:52,120
the E coli and other bacterial species

210
00:08:56,819 --> 00:08:54,639
and when we get is we get this big glob

211
00:08:59,009 --> 00:08:56,829
of like hundreds of millions of atoms

212
00:09:00,900 --> 00:08:59,019
and we really can't make sense of it

213
00:09:02,489 --> 00:09:00,910

when you look at that but when you look

214
00:09:05,730 --> 00:09:02,499
deep within its structure you can see

215
00:09:07,379 --> 00:09:05,740
that the structures of the RNA and the

216
00:09:11,400 --> 00:09:07,389
protein that make up the ribosome and

217
00:09:13,739 --> 00:09:11,410
the center of it are miraculously just

218
00:09:16,259 --> 00:09:13,749
similar their sequence is different but

219
00:09:18,989 --> 00:09:16,269
their structure is just crazy the same

220
00:09:20,879 --> 00:09:18,999
going from the center all the way out to

221
00:09:23,009 --> 00:09:20,889
near the surface of it it's only the

222
00:09:26,429 --> 00:09:23,019
surface of the ribosomal ribosomal

223
00:09:28,860 --> 00:09:26,439
structures that we see any variation so

224
00:09:30,929 --> 00:09:28,870
the center of it is just a common core

225
00:09:33,540 --> 00:09:30,939
of structure that just doesn't divulge

226
00:09:35,819 --> 00:09:33,550
from any species that we know of and

227
00:09:42,739 --> 00:09:35,829
it's when we look at the surface then

228
00:09:48,629 --> 00:09:46,499
so looking at that one helix from the

229
00:09:50,160 --> 00:09:48,639
last slide this is helix 25 and I'll

230
00:09:51,299 --> 00:09:50,170
just use this as an example to show you

231
00:09:55,319 --> 00:09:51,309
how ripe Izumo

232
00:09:58,410 --> 00:09:55,329
RNA has evolved so this helix 25 of

233
00:10:00,869 --> 00:09:58,420
bacteria we have our k ends protozoans

234
00:10:03,449 --> 00:10:00,879
fungi animals and our parasitic

235
00:10:06,210 --> 00:10:03,459
protozoan x' and then when we align

236
00:10:08,249 --> 00:10:06,220
these onto each other and this is

237
00:10:09,840 --> 00:10:08,259
aligning the ribosomes I'm just I'm just

238
00:10:11,460 --> 00:10:09,850

cutting away the rest of the ribosome

239
00:10:13,799 --> 00:10:11,470
and only looking at this helix that's on

240
00:10:16,889 --> 00:10:13,809
the surface we can see that the

241
00:10:18,720 --> 00:10:16,899
structure is also very conserved at that

242
00:10:22,049 --> 00:10:18,730
very first helix but there's HeLa C's

243
00:10:23,549 --> 00:10:22,059
budding off of that and as you can see

244
00:10:25,980 --> 00:10:23,559
going through more and more complex

245
00:10:28,319 --> 00:10:25,990
species you can see that this helix is

246
00:10:30,780 --> 00:10:28,329
just has more and more HeLa C's just

247
00:10:33,600 --> 00:10:30,790
budding off of it and so we believe that

248
00:10:35,429 --> 00:10:33,610
this is how the ribosome has a ribosome

249
00:10:38,100 --> 00:10:35,439
while RNA has evolved is that just HeLa

250
00:10:43,009 --> 00:10:38,110
sees just butted off from other HeLa C's

251
00:10:45,629 --> 00:10:43,019
and so this kind of so to wrap that up

252
00:10:49,470 --> 00:10:45,639
the ribosome has a common core and it's

253
00:10:51,119 --> 00:10:49,480
made of RNA and protein and the RNA is

254
00:10:53,610 --> 00:10:51,129
really conserved in structure but not

255
00:10:55,259 --> 00:10:53,620
sequence and these sites of ribosomal

256
00:10:57,329 --> 00:10:55,269
RNA evolution are referred to as

257
00:10:59,579 --> 00:10:57,339
expansion segments and they but offer

258
00:11:01,499 --> 00:10:59,589
the common core of the ribosome and they

259
00:11:05,879 --> 00:11:01,509
do not perturb the common core structure

260
00:11:07,559 --> 00:11:05,889
and the sounds to make an analogy

261
00:11:09,509 --> 00:11:07,569
it's kind of like a tree when you look

262
00:11:11,280 --> 00:11:09,519
at a tree you can tell the newest

263
00:11:14,009 --> 00:11:11,290

sections of it are the leaves whereas

264
00:11:15,629 --> 00:11:14,019
the oldest section is the trunk and so

265
00:11:18,419 --> 00:11:15,639
we're looking at these structures and

266
00:11:20,220 --> 00:11:18,429
we're seeing these eukaryotic expansion

267
00:11:22,559 --> 00:11:20,230
segments those are like the leaves and

268
00:11:24,329 --> 00:11:22,569
the outermost branches and when we take

269
00:11:26,639 --> 00:11:24,339
away these leaves and take away these

270
00:11:29,579 --> 00:11:26,649
branches we can just go deeper and

271
00:11:31,919 --> 00:11:29,589
deeper into the past the ribosome and we

272
00:11:34,650 --> 00:11:31,929
eventually get to just one helix and

273
00:11:37,139 --> 00:11:34,660
that would just be the trunk of the tree

274
00:11:40,829 --> 00:11:37,149
this one helix is the peptidyl

275
00:11:43,470 --> 00:11:40,839
transferase center so it's where peptide

276
00:11:48,389 --> 00:11:43,480
bonds are made and so we can look at how

277
00:11:50,609 --> 00:11:48,399
the ribosomal RNA has evolved okay so

278
00:11:52,559 --> 00:11:50,619
that's the RNA of the ribosome well what

279
00:11:55,199 --> 00:11:52,569
about the protein well the protein is

280
00:11:57,749 --> 00:11:55,209
also very similar in some regards so

281
00:12:01,859 --> 00:11:57,759
this is universal protein number four of

282
00:12:04,429 --> 00:12:01,869
the large subunit ul4 and so for those

283
00:12:07,229 --> 00:12:04,439
of you who are familiar with proteins or

284
00:12:09,150 --> 00:12:07,239
maybe not I guess up here we have a

285
00:12:11,069 --> 00:12:09,160
globular domain and that looks a lot

286
00:12:13,229 --> 00:12:11,079
like the proteins we see in all white

287
00:12:14,939 --> 00:12:13,239
today but these ribosomal proteins are

288
00:12:17,129 --> 00:12:14,949

very weird looking they have these

289
00:12:18,989 --> 00:12:17,139
really strange like tails that just go

290
00:12:20,489 --> 00:12:18,999
into the ribosome and they don't really

291
00:12:23,309 --> 00:12:20,499
look like other proteins that we know

292
00:12:24,509 --> 00:12:23,319
and so a lot of people just don't really

293
00:12:26,159 --> 00:12:24,519
look at them and they throw them out of

294
00:12:27,329 --> 00:12:26,169
their analysis and stuff like that but

295
00:12:30,689 --> 00:12:27,339
I'm looking at them because I think

296
00:12:33,329 --> 00:12:30,699
they're interesting and so this is ul4

297
00:12:35,039 --> 00:12:33,339
from a bacterial species and that's uo4

298
00:12:38,189 --> 00:12:35,049
from an our canyon and that's you all

299
00:12:40,079 --> 00:12:38,199
for from eukaryote and then when we look

300
00:12:42,840 --> 00:12:40,089
at them within these aligned crystal

301
00:12:47,129 --> 00:12:42,850
structures we see that they line right

302
00:12:49,739 --> 00:12:47,139
on top of each other and they all have

303
00:12:51,569 --> 00:12:49,749
this tail that goes deep into the

304
00:12:53,789 --> 00:12:51,579
ribosome and they have this globular

305
00:12:56,309 --> 00:12:53,799
domain that hasn't really changed in

306
00:12:57,929 --> 00:12:56,319
structure either but then arcane's and

307
00:13:00,239 --> 00:12:57,939
eukaryotes have this little loop here

308
00:13:01,919 --> 00:13:00,249
and then eukaryotes have a little bit

309
00:13:04,559 --> 00:13:01,929
more over here and there's large alpha

310
00:13:07,049 --> 00:13:04,569
helix that buds off there and this goes

311
00:13:09,539 --> 00:13:07,059
on to the surface of the ribosome where

312
00:13:12,269 --> 00:13:09,549
the ribosome has been evolving but all

313
00:13:14,879 --> 00:13:12,279

has this common core right here and this

314
00:13:17,340 --> 00:13:14,889
common core goes deep into the ribosome

315
00:13:18,790 --> 00:13:17,350
and it goes right next to the peptidyl

316
00:13:22,569 --> 00:13:18,800
transferase center

317
00:13:24,369 --> 00:13:22,579
right here and so it's almost like if

318
00:13:27,609 --> 00:13:24,379
you are looking make a reaction

319
00:13:29,829 --> 00:13:27,619
coordinate of this that you know here

320
00:13:32,019 --> 00:13:29,839
would be like the oldest peptides and

321
00:13:34,960 --> 00:13:32,029
here would be the newer ones like I

322
00:13:37,210 --> 00:13:34,970
showed in that last figure the very

323
00:13:39,970 --> 00:13:37,220
center of the ribosome is the oldest

324
00:13:41,859 --> 00:13:39,980
part it's the oldest ribosomal RNA

325
00:13:44,470 --> 00:13:41,869
whereas the outside is the newest and

326
00:13:48,069 --> 00:13:44,480
when you look at these proteins it's the

327
00:13:50,109 --> 00:13:48,079
same the proteins that protein the amino

328
00:13:52,269 --> 00:13:50,119
acids and peptides are closest to the

329
00:13:54,489 --> 00:13:52,279
petiole transfer a center or the oldest

330
00:13:57,309 --> 00:13:54,499
ones where the ones on the exterior of

331
00:13:59,859 --> 00:13:57,319
the ribosome are the newest ones and so

332
00:14:04,600 --> 00:13:59,869
looking at this we can see how proteins

333
00:14:06,910 --> 00:14:04,610
have evolved since the origin of life so

334
00:14:10,119 --> 00:14:06,920
I made this like protein folding peak

335
00:14:14,530 --> 00:14:10,129
and so basically what it was showing is

336
00:14:15,939 --> 00:14:14,540
that close to the center of the peptidyl

337
00:14:18,609 --> 00:14:15,949
transferase center we get these

338
00:14:20,319 --> 00:14:18,619

unstructured peptides but then as you

339
00:14:22,030 --> 00:14:20,329
move farther and farther out from it you

340
00:14:24,699 --> 00:14:22,040
start saying okay well there's like some

341
00:14:27,160 --> 00:14:24,709
you know beta sheets or beta hairpins

342
00:14:29,230 --> 00:14:27,170
and then you move farther out then you

343
00:14:30,819 --> 00:14:29,240
start seeing like beta barrels and as

344
00:14:32,699 --> 00:14:30,829
you go into the surface of the ribosome

345
00:14:35,980 --> 00:14:32,709
then you see is really complex looking

346
00:14:39,549 --> 00:14:35,990
proteins that we see in all of cellular

347
00:14:41,379 --> 00:14:39,559
life and so it it's a reaction

348
00:14:43,929 --> 00:14:41,389
coordinate of how proteins have evolved

349
00:14:46,509 --> 00:14:43,939
since the origin of life and so that's

350
00:14:47,859 --> 00:14:46,519
what I have been looking at and so to

351
00:14:50,710 --> 00:14:47,869
conclude these ribosomal protein

352
00:14:53,289 --> 00:14:50,720
evolution you can see that ribosomal

353
00:14:54,910 --> 00:14:53,299
proteins have also have expansions and

354
00:14:57,519 --> 00:14:54,920
this is very similar to the ribosomal

355
00:14:59,109 --> 00:14:57,529
RNA however these ribosomal protein

356
00:15:00,970 --> 00:14:59,119
structural differences are much more

357
00:15:02,559 --> 00:15:00,980
pronounced we just know a lot more about

358
00:15:04,749 --> 00:15:02,569
proteins proteins have been struck

359
00:15:06,639 --> 00:15:04,759
studied for a while whereas RNA the

360
00:15:08,319 --> 00:15:06,649
structures and everything haven't been

361
00:15:11,199 --> 00:15:08,329
very interesting to a lot of people for

362
00:15:13,359 --> 00:15:11,209
much time and these that these ribosomal

363
00:15:16,269 --> 00:15:13,369

proteins there's a common core to it and

364
00:15:18,850 --> 00:15:16,279
the common core just like RNA no protein

365
00:15:20,530 --> 00:15:18,860
is all exactly the same the sequence

366
00:15:23,650 --> 00:15:20,540
might differ but the structure is the

367
00:15:25,569 --> 00:15:23,660
same and so we believe that ribosomal

368
00:15:28,030 --> 00:15:25,579
evolution happens in both RNA and

369
00:15:29,769 --> 00:15:28,040
protein and the RNA and protein have

370
00:15:30,810 --> 00:15:29,779
evolved together in a mutualistic

371
00:15:34,530 --> 00:15:30,820
fashion

372
00:15:36,390 --> 00:15:34,540
and then so to conclude I just like to

373
00:15:38,480 --> 00:15:36,400
do show this one slide from a project

374
00:15:41,160 --> 00:15:38,490
I'm working on because we're all

375
00:15:42,540 --> 00:15:41,170
astrobiologists here and it's a little

376
00:15:44,340 --> 00:15:42,550
bit talking about metals and I just

377
00:15:46,560 --> 00:15:44,350
maybe want to show some people so that

378
00:15:51,090 --> 00:15:46,570
maybe they can give me some input later

379
00:15:53,610 --> 00:15:51,100
on so a lot of these ribosomal proteins

380
00:15:55,560 --> 00:15:53,620
are binding zinc and zinc is very

381
00:15:57,660 --> 00:15:55,570
important for a lot of proteins in

382
00:16:00,570 --> 00:15:57,670
looking at any organism that we see

383
00:16:03,320 --> 00:16:00,580
around today you know four to 10% of

384
00:16:05,400 --> 00:16:03,330
their proteins need zinc to function and

385
00:16:07,650 --> 00:16:05,410
zinc is found in many of these ribosomal

386
00:16:09,420 --> 00:16:07,660
proteins and these proteins that it's in

387
00:16:12,150 --> 00:16:09,430
are usually very simple-looking

388
00:16:13,500 --> 00:16:12,160

so here's one of them and so there's the

389
00:16:16,250 --> 00:16:13,510
zinc that's coordinating with four

390
00:16:19,560 --> 00:16:16,260
cystines and it's just made of like to

391
00:16:23,160 --> 00:16:19,570
beta hairpins and so and I'm looking at

392
00:16:24,690 --> 00:16:23,170
this it's like it's pretty these

393
00:16:27,360 --> 00:16:24,700
proteins are usually found pretty deep

394
00:16:28,760 --> 00:16:27,370
within the ribosome and I believe that

395
00:16:33,180 --> 00:16:28,770
these could be some very ancient

396
00:16:35,160 --> 00:16:33,190
peptides or proteins and I'm looking at

397
00:16:37,350 --> 00:16:35,170
the literature and you know there's all

398
00:16:39,240 --> 00:16:37,360
sorts of you know hypothesis of how like

399
00:16:41,460 --> 00:16:39,250
the world came about and everything and

400
00:16:43,110 --> 00:16:41,470
what kind of concentrations models were

401
00:16:45,600 --> 00:16:43,120
at and everything and you know there's

402
00:16:48,290 --> 00:16:45,610
some debate about zinc and whatnot but

403
00:16:50,760 --> 00:16:48,300
our lab has also shown in the past that

404
00:16:53,010 --> 00:16:50,770
you know the ribosome needs magnesium

405
00:16:55,200 --> 00:16:53,020
cations to stabilize its tertiary

406
00:16:58,290 --> 00:16:55,210
interactions between the RNA HeLa C's

407
00:16:59,640 --> 00:16:58,300
because they're very negative and there

408
00:17:02,760 --> 00:16:59,650
have been studies in our lab and other

409
00:17:04,800 --> 00:17:02,770
labs that have shown that you know RNA

410
00:17:08,430 --> 00:17:04,810
doesn't necessarily need magnesium but

411
00:17:10,200 --> 00:17:08,440
it could be using reduced iron and I

412
00:17:13,410 --> 00:17:10,210
found some literature saying that these

413
00:17:15,570 --> 00:17:13,420

peptides these zinc ribbons that these

414
00:17:20,400 --> 00:17:15,580
original proteins have that they can

415
00:17:21,870 --> 00:17:20,410
also bind iron instead of zinc and so

416
00:17:24,300 --> 00:17:21,880
hopefully tomorrow I can like look at

417
00:17:26,070 --> 00:17:24,310
some posters and maybe some talks and

418
00:17:29,160 --> 00:17:26,080
hopefully some we talking about zinc or

419
00:17:30,630 --> 00:17:29,170
iron or something like that but so I

420
00:17:32,430 --> 00:17:30,640
guess that will be conclude it um

421
00:17:35,220 --> 00:17:32,440
there's really not much to put in this

422
00:17:43,230 --> 00:17:35,230
presentation summary but this is our lab

423
00:17:50,430 --> 00:17:45,700
all right we got time for one quick

424
00:17:57,970 --> 00:17:53,770
um yeah I'm so my question if you can go

425
00:18:02,890 --> 00:17:57,980
back to slides sorry uh what are the

426
00:18:05,020 --> 00:18:02,900
arrows on the protein fold okay so it's

427
00:18:09,100 --> 00:18:05,030
just showing like so I go the way you

428
00:18:11,140 --> 00:18:09,110
like depict the protein is these arrows

429
00:18:12,880 --> 00:18:11,150
are just beta sheets and so that's just

430
00:18:15,760 --> 00:18:12,890
how it's like structured and so right

431
00:18:18,340 --> 00:18:15,770
between that like this is a simplistic

432
00:18:20,320 --> 00:18:18,350
diagram you have your amino acids and

433
00:18:22,420 --> 00:18:20,330
they're aligning and hydrogen bonding to

434
00:18:24,720 --> 00:18:22,430
each other and then the arrow is just

435
00:18:26,620 --> 00:18:24,730
pointing to like okay so this is the

436
00:18:30,370 --> 00:18:26,630
n-terminal and then this is the

437
00:18:31,810 --> 00:18:30,380
c-terminus of the protein so it's just a

438
00:18:35,320 --> 00:18:31,820

simple way of drawing a protein

439
00:18:35,860 --> 00:18:35,330
structure mm-hmm alright thank you very

440
00:18:37,180 --> 00:18:35,870
much

441
00:18:38,900 --> 00:18:37,190
Thanks