Of Psychrophiles and Thermophiles

Cold/Freezing temperatures will:
- Freeze or gel cell membranes, decreas
- Ice crystals from freezing also disrupt

Hot/Boiling Temperatures will:
-Melt membranes, decrease enzyme ac
- Microbial Life needs some form of liq

1
00:00:09,460 --> 00:00:08,260
this was really a fun presentation for

2
00:00:12,220 --> 00:00:09,470
me to make cuz i get to tell you about

3
00:00:13,840 --> 00:00:12,230
all the cool stuff with bacteria and

4
00:00:15,640 --> 00:00:13,850
archaea and not just the cool stuff that

5
00:00:18,190 --> 00:00:15,650
i found so thank you for that

6
00:00:20,380 --> 00:00:18,200
opportunity and my goal for this

7
00:00:22,120 --> 00:00:20,390
presentation is to not you know tell you

8
00:00:23,830 --> 00:00:22,130
everything cool that i know about

9
00:00:25,900 --> 00:00:23,840
bacteria it's to kind of get you to

10
00:00:28,599 --> 00:00:25,910
think like a biologist for the day so

11
00:00:34,120 --> 00:00:28,609
you're following along think how would a

12
00:00:35,770 --> 00:00:34,130
biologist think and so the two types of

13
00:00:38,440 --> 00:00:35,780

organisms that kind of exist on earth

14
00:00:40,630 --> 00:00:38,450
are the prokaryotes and eukaryotes and

15
00:00:42,340 --> 00:00:40,640
most of the time I think all of the time

16
00:00:44,470 --> 00:00:42,350
this afternoon we'll be talking about

17
00:00:46,840 --> 00:00:44,480
the prokaryotes the bacteria and the

18
00:00:48,640 --> 00:00:46,850
archaea and the main differences between

19
00:00:50,110 --> 00:00:48,650
these two organisms and you can see

20
00:00:52,450 --> 00:00:50,120
there's actually a lot of similarity

21
00:00:53,710 --> 00:00:52,460
everything has a plasma membrane to keep

22
00:00:55,300 --> 00:00:53,720
it all together and keep all the

23
00:00:57,820 --> 00:00:55,310
interesting stuff together and doing

24
00:01:00,700 --> 00:00:57,830
interesting things it has a cytoplasm

25
00:01:02,370 --> 00:01:00,710
which you know allows is the lubricant

26
00:01:05,079 --> 00:01:02,380
that allows everything to work together

27
00:01:06,760 --> 00:01:05,089
everything has DNA but the main

28
00:01:09,700 --> 00:01:06,770
difference between the prokaryotes and

29
00:01:11,350 --> 00:01:09,710
eukaryotes is that the DNA and the

30
00:01:13,180 --> 00:01:11,360
prokaryotes just kind of bundles

31
00:01:15,730 --> 00:01:13,190
together in the middle in the nucleoid

32
00:01:17,770 --> 00:01:15,740
region whereas in the eukaryotes like us

33
00:01:19,270 --> 00:01:17,780
you actually have a nucleus and this has

34
00:01:22,960 --> 00:01:19,280
a lot of implications for further

35
00:01:24,610 --> 00:01:22,970
processing and for how RNA works but

36
00:01:28,690 --> 00:01:24,620
again the end of the day it's very

37
00:01:33,510 --> 00:01:28,700
similar and it has the ribosomes both

38
00:01:36,100 --> 00:01:33,520

everything we know of has ribosomes so

39
00:01:39,490 --> 00:01:36,110
secondary of life for the day we have

40
00:01:40,960 --> 00:01:39,500
the you care eukaryotes up here and the

41
00:01:43,630 --> 00:01:40,970
bacteria archaea which are your

42
00:01:45,399 --> 00:01:43,640
prokaryotes now within the bacteria you

43
00:01:47,260 --> 00:01:45,409
kind of have the siano bacteria and

44
00:01:49,180 --> 00:01:47,270
those are your photo synthesizers and

45
00:01:51,580 --> 00:01:49,190
you have the heterotrophic bacteria and

46
00:01:53,110 --> 00:01:51,590
those are the things that eat sugars

47
00:01:55,960 --> 00:01:53,120
that are already kicking around and I'm

48
00:01:57,910 --> 00:01:55,970
going to talk quite a bit about this so

49
00:01:59,890 --> 00:01:57,920
just a kind of introduction like what

50
00:02:01,960 --> 00:01:59,900
are bacteria doing you have grand

51
00:02:03,340 --> 00:02:01,970
positive and gram negative and this all

52
00:02:05,560 --> 00:02:03,350
has to do with the structure of their

53
00:02:07,450 --> 00:02:05,570
cell wall and the reaction to a Gram

54
00:02:09,490 --> 00:02:07,460
stain which is a technique that almost

55
00:02:11,979 --> 00:02:09,500
every microbiologist is used at some

56
00:02:13,449 --> 00:02:11,989
point and if you're a bacteriologist you

57
00:02:15,250 --> 00:02:13,459
have a favorite grand positive

58
00:02:18,789 --> 00:02:15,260
gram-negative and i'm a grand positive

59
00:02:19,809 --> 00:02:18,799
person some are extremely files so they

60
00:02:22,630 --> 00:02:19,819
like the really extra

61
00:02:24,789 --> 00:02:22,640
conditions that's probably what we're

62
00:02:27,789 --> 00:02:24,799
mainly talking about today again

63
00:02:30,250 --> 00:02:27,799

cyanobacteria photosynthesize and some

64
00:02:32,979 --> 00:02:30,260
can be aerobic and some can be anaerobic

65
00:02:35,800 --> 00:02:32,989
which has gotten lost in translation on

66
00:02:37,449 --> 00:02:35,810
here but the archaea are neither

67
00:02:39,099 --> 00:02:37,459
grandpa's it over gram-negative they

68
00:02:41,259 --> 00:02:39,109
have a kind of a different structures to

69
00:02:43,539 --> 00:02:41,269
their cell walls and dope tend to react

70
00:02:45,909 --> 00:02:43,549
the same way to gram stains a lot of

71
00:02:48,369 --> 00:02:45,919
them are extreme of files and there's a

72
00:02:51,879 --> 00:02:48,379
super huge variety of metabolic

73
00:02:54,819 --> 00:02:51,889
activities for the archaea so the

74
00:02:57,699 --> 00:02:54,829
prokaryotic life cycle unlike our own is

75
00:02:59,470 --> 00:02:57,709
very rarely sexual sometimes you can get

76
00:03:01,839 --> 00:02:59,480
conjugation and transferring things

77
00:03:04,599 --> 00:03:01,849
around but most of the time you just get

78
00:03:07,270 --> 00:03:04,609
this binary fusion so basically that

79
00:03:08,860 --> 00:03:07,280
starts with you have your DNA you might

80
00:03:10,959 --> 00:03:08,870
have a plasmid or two or three or four

81
00:03:12,520 --> 00:03:10,969
kicking around in there you have a lot

82
00:03:14,949 --> 00:03:12,530
of ribosomes which you're doing their

83
00:03:16,990 --> 00:03:14,959
thing carrying out translation making

84
00:03:19,420 --> 00:03:17,000
proteins and then eventually when the

85
00:03:22,030 --> 00:03:19,430
cell is ready to divide you get DNA

86
00:03:24,490 --> 00:03:22,040
making more DNA copies itself the cells

87
00:03:27,939 --> 00:03:24,500
start to pull apart and a little more

88
00:03:29,890 --> 00:03:27,949

and eventually you get this total fusion

89
00:03:33,009 --> 00:03:29,900
of two different cellular membranes and

90
00:03:35,619 --> 00:03:33,019
then your peptidoglycan cleaves apart

91
00:03:37,749 --> 00:03:35,629
you have two cells and this looks really

92
00:03:39,699 --> 00:03:37,759
simple but this in itself is a process I

93
00:03:42,729 --> 00:03:39,709
don't think we have a full understanding

94
00:03:44,589 --> 00:03:42,739
of yet so kind of just gives you a key

95
00:03:49,330 --> 00:03:44,599
into how complex this actually is is

96
00:03:50,589 --> 00:03:49,340
that we still don't understand this so

97
00:03:51,939 --> 00:03:50,599
I'm going to talk a bit about the

98
00:03:53,349 --> 00:03:51,949
central dogma too and we've already

99
00:03:55,629 --> 00:03:53,359
heard about that but I'm going to talk

100
00:03:57,640 --> 00:03:55,639
about it in the context of what can we

101
00:04:00,369 --> 00:03:57,650
use each of these molecules for to tell

102
00:04:03,189 --> 00:04:00,379
us more about biology so you have DNA

103
00:04:05,770 --> 00:04:03,199
DNA replication and just having DNA

104
00:04:07,599 --> 00:04:05,780
kicking around you can do almost an

105
00:04:09,459 --> 00:04:07,609
infinite amount of experiments and learn

106
00:04:11,259 --> 00:04:09,469
almost an infinite amount of things from

107
00:04:12,809 --> 00:04:11,269
DNA but some of the things that we're

108
00:04:15,899 --> 00:04:12,819
going to hear about this afternoon is

109
00:04:18,819 --> 00:04:15,909
16s sequencing so we can take the DNA

110
00:04:20,680 --> 00:04:18,829
sequence the 16s gene which everything

111
00:04:22,510 --> 00:04:20,690
has everything has a ribosome I

112
00:04:24,040 --> 00:04:22,520
shouldn't say that that the 16s gene is

113
00:04:27,820 --> 00:04:24,050

actually coding for part of the ribosome

114
00:04:29,890 --> 00:04:27,830
and if you sequence this as a population

115
00:04:31,870 --> 00:04:29,900
you can get a really good sense of all

116
00:04:33,710 --> 00:04:31,880
the bacteria that are in that area and

117
00:04:35,750 --> 00:04:33,720
this is an incredibly

118
00:04:38,090 --> 00:04:35,760
important thing to know because we can

119
00:04:39,650 --> 00:04:38,100
kind of learn about that environment

120
00:04:42,320 --> 00:04:39,660
what kind of life that environment

121
00:04:45,170 --> 00:04:42,330
supports and since we can't culture all

122
00:04:48,410 --> 00:04:45,180
bacteria we can culture about 1% give or

123
00:04:50,690 --> 00:04:48,420
take this is sequencing is very

124
00:04:53,030 --> 00:04:50,700
important we can also sequence

125
00:04:54,980 --> 00:04:53,040
everything so not just the ribosome we

126
00:04:56,930 --> 00:04:54,990
can sequence all of the genes in an area

127
00:04:58,940 --> 00:04:56,940
and this gives us a really good idea of

128
00:05:01,030 --> 00:04:58,950
not what's going on but what could

129
00:05:03,520 --> 00:05:01,040
potentially go on so what that

130
00:05:08,660 --> 00:05:03,530
environment has the potential for doing

131
00:05:10,760 --> 00:05:08,670
metabolically or evolutionarily so DNA

132
00:05:13,970 --> 00:05:10,770
which we've already heard can be

133
00:05:16,130 --> 00:05:13,980
transcribed into RNA and if you want to

134
00:05:18,080 --> 00:05:16,140
look at the RNA of a population you can

135
00:05:19,910 --> 00:05:18,090
learn slightly different things so you

136
00:05:22,100 --> 00:05:19,920
can look at all of the RNA in an area

137
00:05:24,410 --> 00:05:22,110
and something called transcriptomics and

138
00:05:26,540 --> 00:05:24,420

that tells us about what the bugs in

139
00:05:29,390 --> 00:05:26,550
that area are actually doing so what

140
00:05:32,300 --> 00:05:29,400
part of the genome is active in a

141
00:05:35,420 --> 00:05:32,310
certain area you can also do something

142
00:05:38,840 --> 00:05:35,430
called 16s rrna so instead of sequencing

143
00:05:40,760 --> 00:05:38,850
the RNA from the DNA you're going to

144
00:05:44,000 --> 00:05:40,770
take the RNA directly and sequence that

145
00:05:46,490 --> 00:05:44,010
so DNA is fairly stable you can abuse it

146
00:05:49,159 --> 00:05:46,500
and use it and get a lot of information

147
00:05:50,600 --> 00:05:49,169
out of it RNA is not you look it up the

148
00:05:54,080 --> 00:05:50,610
wrong way in the lab and it just goes

149
00:05:56,330 --> 00:05:54,090
away on you so it might be the same

150
00:05:59,000 --> 00:05:56,340
thing in the environment so this might

151
00:06:01,640 --> 00:05:59,010
tell us what portion of a population is

152
00:06:02,960 --> 00:06:01,650
alive as opposed to what's there or what

153
00:06:06,680 --> 00:06:02,970
has ever been there because DNA is

154
00:06:08,659 --> 00:06:06,690
stable and then you can also once you've

155
00:06:10,520 --> 00:06:08,669
got into translation and you have some

156
00:06:12,350 --> 00:06:10,530
protein kicking around you can also do

157
00:06:14,270 --> 00:06:12,360
proteomics and you can do that in the

158
00:06:15,409 --> 00:06:14,280
environment and see what proteins are

159
00:06:17,510 --> 00:06:15,419
happening and what's happening

160
00:06:19,700 --> 00:06:17,520
metabolically in an area but you can

161
00:06:21,620 --> 00:06:19,710
also do that in the lab and look at what

162
00:06:22,880 --> 00:06:21,630
different bacteria are doing

163
00:06:24,980 --> 00:06:22,890

metabolically under different conditions

164
00:06:27,020 --> 00:06:24,990
that you can grow them in provide it you

165
00:06:28,310 --> 00:06:27,030
can grow those bacteria so we'll

166
00:06:34,500 --> 00:06:28,320
probably hear about all these things

167
00:06:41,520 --> 00:06:37,170
okay so what do bacteria need and

168
00:06:44,790 --> 00:06:41,530
bacteria need a lot this is dumb down to

169
00:06:46,920 --> 00:06:44,800
a very simple idea but they need

170
00:06:48,960 --> 00:06:46,930
essential elements so they need carbon

171
00:06:51,390 --> 00:06:48,970
they need iron I don't think we found

172
00:06:53,910 --> 00:06:51,400
anything yet that doesn't need iron they

173
00:06:55,650 --> 00:06:53,920
need nitrogen things like that most

174
00:06:58,320 --> 00:06:55,660
things need water I think everything we

175
00:07:00,660 --> 00:06:58,330
know of needs water right now energy of

176
00:07:02,370 --> 00:07:00,670
course they have to get stuff done and a

177
00:07:04,110 --> 00:07:02,380
lot of them have special adaptations to

178
00:07:06,980 --> 00:07:04,120
survive so I'm going to talk about that

179
00:07:09,180 --> 00:07:06,990
a little bit so growth in respiration

180
00:07:11,160 --> 00:07:09,190
basically just like us you need

181
00:07:14,340 --> 00:07:11,170
something to eat and you need something

182
00:07:17,220 --> 00:07:14,350
to breathe and I would say that there's

183
00:07:18,690 --> 00:07:17,230
unlimited ways of doing this you can

184
00:07:20,070 --> 00:07:18,700
count up all the ways we know about what

185
00:07:23,400 --> 00:07:20,080
we probably haven't scratched the

186
00:07:25,770 --> 00:07:23,410
surface so if you need organic carbon to

187
00:07:28,260 --> 00:07:25,780
eat like we do you're heterotroph or

188
00:07:31,860 --> 00:07:28,270

some things can make their own organic

189
00:07:34,470 --> 00:07:31,870
carbon and that's an autotroph and if

190
00:07:36,690 --> 00:07:34,480
you use oxygen if you breathe oxygen

191
00:07:39,510 --> 00:07:36,700
you're in anaerobe and if you breathe

192
00:07:41,820 --> 00:07:39,520
something other than oxygen sorry if you

193
00:07:43,410 --> 00:07:41,830
breathe oxygen you're an arrow if you've

194
00:07:45,390 --> 00:07:43,420
read something other than oxygen you're

195
00:07:48,030 --> 00:07:45,400
in anaerobe so you're going to hear a

196
00:07:49,620 --> 00:07:48,040
lot of terms probably this is just an

197
00:07:51,120 --> 00:07:49,630
example and these can get long and

198
00:07:52,620 --> 00:07:51,130
confusing but just kind of break it down

199
00:07:55,710 --> 00:07:52,630
to their terms think about it that way

200
00:07:58,680 --> 00:07:55,720
so a chemo autotroph is something that

201
00:08:03,360 --> 00:07:58,690
can fix its own carbon so it's not

202
00:08:07,500 --> 00:08:03,370
eating things and it's chemo so it's

203
00:08:13,740 --> 00:08:07,510
breathing chemicals oh I've lost all my

204
00:08:15,060 --> 00:08:13,750
pictures that's not good anyways so

205
00:08:20,060 --> 00:08:15,070
there was a picture of a kid here eating

206
00:08:22,890 --> 00:08:20,070
cereal and he is a heterotrophic Arab

207
00:08:24,930 --> 00:08:22,900
because he eats a sugar you know the

208
00:08:27,870 --> 00:08:24,940
nice sugary cereal and he breathes

209
00:08:30,390 --> 00:08:27,880
oxygen and a lot of bacteria do this too

210
00:08:33,210 --> 00:08:30,400
and after he's done eating a cereal and

211
00:08:36,870 --> 00:08:33,220
breathing here aspires co2 and the sugar

212
00:08:40,380 --> 00:08:36,880
well you know what happens with that now

213
00:08:43,350 --> 00:08:40,390

I had some pictures back so another way

214
00:08:46,410 --> 00:08:43,360
of stead of just the basic heterotrophic

215
00:08:49,560 --> 00:08:46,420
in a row and a robe

216
00:08:51,870 --> 00:08:49,570
would be an aerobic so this guy's not

217
00:08:53,970 --> 00:08:51,880
using oxygen and he's making methane and

218
00:08:57,230 --> 00:08:53,980
there are just tons and tons of ways you

219
00:09:00,600 --> 00:08:57,240
can do this and one way is to use

220
00:09:04,800 --> 00:09:00,610
hydrogen and co2 and out of that get

221
00:09:07,139 --> 00:09:04,810
methane and h2o so very interesting the

222
00:09:09,930 --> 00:09:07,149
top metabolism but other ways of making

223
00:09:12,329 --> 00:09:09,940
methane you can make it out of acetate

224
00:09:14,400 --> 00:09:12,339
and if you're eating acetate your osito

225
00:09:19,439 --> 00:09:14,410
trophic or you can make it out of

226
00:09:23,340 --> 00:09:19,449
methane file and you could be methane at

227
00:09:25,920 --> 00:09:23,350
the Thyle trophic and just an

228
00:09:28,470 --> 00:09:25,930
interesting bit of trivia there when you

229
00:09:33,720 --> 00:09:28,480
eat asparagus that's why it stinks when

230
00:09:36,360 --> 00:09:33,730
you pee so you have all these bugs

231
00:09:37,829 --> 00:09:36,370
sitting there making methane when you're

232
00:09:40,470 --> 00:09:37,839
thinking as a biologist you're thinking

233
00:09:41,730 --> 00:09:40,480
what could use that f methane and one of

234
00:09:43,980 --> 00:09:41,740
the things that could use the methane

235
00:09:46,110 --> 00:09:43,990
are the bugs that eat it so those are

236
00:09:48,509 --> 00:09:46,120
the methanol tropes so some guys are

237
00:09:51,360 --> 00:09:48,519
making it some guys are eating it and a

238
00:09:54,360 --> 00:09:51,370

really nice example of this is actually

239
00:09:56,220 --> 00:09:54,370
in the permafrost so down deep where you

240
00:09:58,370 --> 00:09:56,230
have anaerobic conditions you have a

241
00:10:00,810 --> 00:09:58,380
nice little community of methanogens

242
00:10:02,880 --> 00:10:00,820
pumping out the methane but if you go

243
00:10:05,069 --> 00:10:02,890
higher up in the soil level where you

244
00:10:06,660 --> 00:10:05,079
get some oxygen mixed in you can have a

245
00:10:09,210 --> 00:10:06,670
nice little population of nathanael

246
00:10:11,730 --> 00:10:09,220
troves eating what the banana jeans made

247
00:10:13,530 --> 00:10:11,740
another way of thinking like a biologist

248
00:10:17,009 --> 00:10:13,540
what makes it and what can eat it and

249
00:10:20,329 --> 00:10:17,019
you might find them living together so

250
00:10:22,829 --> 00:10:20,339
another way of eating and breathing are

251
00:10:24,509 --> 00:10:22,839
photosynthetic autotrophs so these guys

252
00:10:26,579 --> 00:10:24,519
are using the Sun to make their own

253
00:10:28,860 --> 00:10:26,589
sugars so they're fixing carbon so you

254
00:10:34,519 --> 00:10:28,870
see the carving coming in oxygen coming

255
00:10:37,230 --> 00:10:34,529
out sugar is coming out my slides aren't

256
00:10:39,329 --> 00:10:37,240
translating that great but so extrema

257
00:10:40,590 --> 00:10:39,339
files are basically what we're talking

258
00:10:43,110 --> 00:10:40,600
about this afternoon and there any

259
00:10:45,180 --> 00:10:43,120
organism that's able to you know live

260
00:10:48,360 --> 00:10:45,190
maybe not thrive but survive in

261
00:10:53,490 --> 00:10:48,370
conditions that are normally fatal to

262
00:10:55,050 --> 00:10:53,500
anything that's not an extremal file so

263
00:10:56,730 --> 00:10:55,060

you're going to hear all kind of terms

264
00:10:58,590 --> 00:10:56,740
about what kind of extrema file these

265
00:10:59,970 --> 00:10:58,600
guys actually are so you can have

266
00:11:01,740 --> 00:10:59,980
thermophiles

267
00:11:05,610 --> 00:11:01,750
these guys live at high temperatures and

268
00:11:08,490 --> 00:11:05,620
it says 45 and it says 122 over here so

269
00:11:11,520 --> 00:11:08,500
high temperature guys crile files are

270
00:11:14,220 --> 00:11:11,530
anything that can survive at minus 15

271
00:11:16,530 --> 00:11:14,230
for a given length of time hypo lists

272
00:11:19,080 --> 00:11:16,540
are anything that can live it in rocks

273
00:11:20,760 --> 00:11:19,090
and cold deserts so very extreme

274
00:11:23,250 --> 00:11:20,770
condition there and then you can also

275
00:11:27,630 --> 00:11:23,260
you know combined any of these things to

276
00:11:29,370 --> 00:11:27,640
make other Oh files so a thermo acidify

277
00:11:31,200 --> 00:11:29,380
ille as an example of when we combine

278
00:11:36,420 --> 00:11:31,210
things and these guys can survive

279
00:11:37,890 --> 00:11:36,430
thermophilic and high acid conditions so

280
00:11:39,540 --> 00:11:37,900
another way of instead of you know

281
00:11:41,730 --> 00:11:39,550
having adaptations which I'm going to

282
00:11:43,800 --> 00:11:41,740
talk about in a minute is just go on

283
00:11:46,530 --> 00:11:43,810
strike you know I'm not working anymore

284
00:11:48,330 --> 00:11:46,540
until conditions improve and bacteria do

285
00:11:50,310 --> 00:11:48,340
this and it's called sporulation so they

286
00:11:52,440 --> 00:11:50,320
pack up some of their genetic material

287
00:11:54,900 --> 00:11:52,450
and they quit working until they get

288
00:11:58,260 --> 00:11:54,910

better conditions and this is a nice

289
00:11:59,670 --> 00:11:58,270
little process and it's a great way

290
00:12:02,820 --> 00:11:59,680
spores can survive almost anything

291
00:12:07,710 --> 00:12:02,830
spores can survive on Mars good way of

292
00:12:11,010 --> 00:12:07,720
surviving so adaptations are a huge

293
00:12:14,360 --> 00:12:11,020
field in extremo file biology what kind

294
00:12:16,530 --> 00:12:14,370
of traits allow you to survive and

295
00:12:17,910 --> 00:12:16,540
identifying these figuring out how they

296
00:12:20,370 --> 00:12:17,920
work and figuring out what all they can

297
00:12:21,990 --> 00:12:20,380
do is a huge part of this field so I'm

298
00:12:24,420 --> 00:12:22,000
just going to talk about this for a

299
00:12:26,660 --> 00:12:24,430
little bit so temperature extremes I

300
00:12:29,220 --> 00:12:26,670
can't obviously go through all of the

301
00:12:30,780 --> 00:12:29,230
adaptations to extreme environments so

302
00:12:32,220 --> 00:12:30,790
I'm going to hit on thermo files and

303
00:12:36,180 --> 00:12:32,230
psycho files and we can kind of compare

304
00:12:38,190 --> 00:12:36,190
and contrast these two so thermophiles

305
00:12:40,380 --> 00:12:38,200
are things that are surviving up here

306
00:12:42,800 --> 00:12:40,390
and you can see if everything grew and

307
00:12:44,640 --> 00:12:42,810
divided at the same rate you know

308
00:12:47,100 --> 00:12:44,650
extrapolate it from the Arrhenius plot

309
00:12:48,690 --> 00:12:47,110
that you'd expect based on the things

310
00:12:50,520 --> 00:12:48,700
that are kind of in the middle you can

311
00:12:52,920 --> 00:12:50,530
see they be growing a lot faster up here

312
00:12:54,810 --> 00:12:52,930
at high temperatures and a lot faster at

313
00:12:56,610 --> 00:12:54,820

low temperatures but there's this place

314
00:12:58,620 --> 00:12:56,620
here where things kind of drop off at

315
00:13:00,510 --> 00:12:58,630
high temperatures and drop off here at

316
00:13:02,280 --> 00:13:00,520
low temperatures and basically what's

317
00:13:03,960 --> 00:13:02,290
happening there is your enzymes just

318
00:13:05,430 --> 00:13:03,970
aren't working as they should there be

319
00:13:11,740 --> 00:13:05,440
coming to nature they can't find their

320
00:13:14,660 --> 00:13:11,750
substrate so things drop off

321
00:13:16,190 --> 00:13:14,670
so cold air freezing temperatures will

322
00:13:18,620 --> 00:13:16,200
do a ton of things that aren't so good

323
00:13:20,990 --> 00:13:18,630
for the cells they'll freeze your cell

324
00:13:26,660 --> 00:13:21,000
membranes they'll cause gelling they can

325
00:13:29,180 --> 00:13:26,670
decrease your enzyme activity you'll see

326
00:13:32,360 --> 00:13:29,190
that a lot of the times your DNA needs

327
00:13:35,930 --> 00:13:32,370
to pull apart for DNA replication or RNA

328
00:13:37,370 --> 00:13:35,940
transcription and it won't do that just

329
00:13:40,310 --> 00:13:37,380
because the temperatures are too cold

330
00:13:41,900 --> 00:13:40,320
and you can also get ice crystals

331
00:13:43,639 --> 00:13:41,910
forming that disrupt your cellular

332
00:13:46,699 --> 00:13:43,649
membrane on these cold temperatures

333
00:13:48,170 --> 00:13:46,709
whereas it hot temperatures you have a

334
00:13:50,750 --> 00:13:48,180
cell membrane that will just break apart

335
00:13:53,600 --> 00:13:50,760
when the water starts to boil again your

336
00:13:56,480 --> 00:13:53,610
enzymes will decrease in their activity

337
00:13:58,069 --> 00:13:56,490
and your DNA will pull apart because the

338
00:14:00,050 --> 00:13:58,079

temperatures are just too cold for the

339
00:14:03,259 --> 00:14:00,060
bar to form for the bonds to hold it

340
00:14:04,880 --> 00:14:03,269
together and microbial life needs some

341
00:14:06,530 --> 00:14:04,890
form of liquid water so if you're living

342
00:14:09,139 --> 00:14:06,540
at minus 15 you have to have a way to

343
00:14:11,780 --> 00:14:09,149
keep the water liquid and if you're

344
00:14:13,910 --> 00:14:11,790
living it plus 120 you have to keep away

345
00:14:19,150 --> 00:14:13,920
you have to find a way for the water not

346
00:14:22,340 --> 00:14:19,160
to boil off so here you can see how many

347
00:14:24,980 --> 00:14:22,350
slides are really bad I don't know what

348
00:14:27,650 --> 00:14:24,990
happened there the psycho files and the

349
00:14:29,569 --> 00:14:27,660
thermo files so with the psycho files

350
00:14:31,939 --> 00:14:29,579
they have a lot of different ways to

351
00:14:33,380 --> 00:14:31,949
keep their membranes intact and one of

352
00:14:36,290 --> 00:14:33,390
the ways they can do this is increase

353
00:14:38,420 --> 00:14:36,300
the amount of unsaturated fatty acids

354
00:14:41,030 --> 00:14:38,430
and when saturate when acids are

355
00:14:43,340 --> 00:14:41,040
saturated fatty acids they basically are

356
00:14:45,980 --> 00:14:43,350
straight you know there's very strong

357
00:14:48,439 --> 00:14:45,990
order to them but when they're

358
00:14:50,389 --> 00:14:48,449
unsaturated they get these quaint pinks

359
00:14:52,519 --> 00:14:50,399
and twists and turns and bends and this

360
00:14:55,670 --> 00:14:52,529
helps maintain fluidity so you're not

361
00:14:58,250 --> 00:14:55,680
just freezing up and the same is true

362
00:15:00,530 --> 00:14:58,260
the double bonds it allows kinks and

363
00:15:02,269 --> 00:15:00,540

twists and bends whereas the thermo

364
00:15:04,040 --> 00:15:02,279
files have a different way of keeping

365
00:15:06,710 --> 00:15:04,050
their membrane intact at high

366
00:15:10,730 --> 00:15:06,720
temperatures and they have special waxy

367
00:15:12,230 --> 00:15:10,740
chemicals that aren't really the double

368
00:15:15,290 --> 00:15:12,240
layer bar on you'd expect to see and

369
00:15:16,910 --> 00:15:15,300
they actually have so that this is a

370
00:15:19,760 --> 00:15:16,920
normal membrane where you have your

371
00:15:22,370 --> 00:15:19,770
lipid bilayer but a lot of hypothermia

372
00:15:24,290 --> 00:15:22,380
files just kind of bind them together so

373
00:15:25,460 --> 00:15:24,300
there's these bonds that are not as

374
00:15:29,690 --> 00:15:25,470
easily broken

375
00:15:31,460 --> 00:15:29,700
as here and the membrane stays intact so

376
00:15:33,110 --> 00:15:31,470
you also have to maintain enzyme

377
00:15:35,210 --> 00:15:33,120
activity because that's huge right you

378
00:15:37,250 --> 00:15:35,220
gotta carry out your metabolism at these

379
00:15:39,350 --> 00:15:37,260
super high or super low temperatures and

380
00:15:41,930 --> 00:15:39,360
you can basically make your D your

381
00:15:44,600 --> 00:15:41,940
proteins do that in a number of ways so

382
00:15:46,370 --> 00:15:44,610
in cold temperatures everything's really

383
00:15:48,890 --> 00:15:46,380
fluid and it has high catalytic

384
00:15:50,270 --> 00:15:48,900
efficiency what I mean by that is it's

385
00:15:52,130 --> 00:15:50,280
not binding and grabbing and staying

386
00:15:53,600 --> 00:15:52,140
there it's binding and then it's letting

387
00:15:55,460 --> 00:15:53,610
go and then it's binding and then it's

388
00:15:59,330 --> 00:15:55,470

letting go so it can pump through a lot

389
00:16:02,030 --> 00:15:59,340
more substrate you can also have more

390
00:16:03,740 --> 00:16:02,040
polar less hydrophobic amino acids and

391
00:16:05,900 --> 00:16:03,750
this just helps again to keep things

392
00:16:07,460 --> 00:16:05,910
fluid whereas in thermo files you don't

393
00:16:09,290 --> 00:16:07,470
want to keep things fluid you want to

394
00:16:11,030 --> 00:16:09,300
keep things as structured as possible so

395
00:16:13,040 --> 00:16:11,040
it's not melting and pulling apart and

396
00:16:14,720 --> 00:16:13,050
to do this you can pack your proteins

397
00:16:16,790 --> 00:16:14,730
into a dense core and just not let water

398
00:16:20,090 --> 00:16:16,800
in and then they can't boil you apart

399
00:16:22,610 --> 00:16:20,100
you can add these disulfide bonds which

400
00:16:25,220 --> 00:16:22,620
are down here and again it's just

401
00:16:28,130 --> 00:16:25,230
another layer of structure and you can

402
00:16:31,790 --> 00:16:28,140
have charged residues like this that

403
00:16:34,970 --> 00:16:31,800
will form to hydro hydrogen bonds to

404
00:16:36,850 --> 00:16:34,980
keep things just more structured you

405
00:16:39,230 --> 00:16:36,860
also have to keep your DNA together and

406
00:16:42,470 --> 00:16:39,240
that's for hot and you have to let it

407
00:16:43,910 --> 00:16:42,480
pull apart for cold so psycho files

408
00:16:47,420 --> 00:16:43,920
where things don't want to pull apart

409
00:16:50,270 --> 00:16:47,430
you see a lot of 80 bonds and like we

410
00:16:52,760 --> 00:16:50,280
learned earlier 80 forms to hydrogen

411
00:16:56,060 --> 00:16:52,770
bonds where GC forms three so we're just

412
00:16:58,520 --> 00:16:56,070
using more of less hydrogen bond formers

413
00:17:01,100 --> 00:16:58,530

whereas in thermal files you kind of do

414
00:17:02,660 --> 00:17:01,110
the opposite and you can also have you

415
00:17:04,550 --> 00:17:02,670
can make a lot of this DNA guy raised

416
00:17:08,930 --> 00:17:04,560
that twists your DNA it turns it and

417
00:17:11,090 --> 00:17:08,940
keeps it together from pulling apart but

418
00:17:13,880 --> 00:17:11,100
there's still a lot we don't understand

419
00:17:15,740 --> 00:17:13,890
about psycho files thermophiles extreme

420
00:17:17,990 --> 00:17:15,750
files in general and this is a picture

421
00:17:20,870 --> 00:17:18,000
from our lab this is the bug that grows

422
00:17:22,760 --> 00:17:20,880
at minus 15 and you can see it doesn't

423
00:17:24,770 --> 00:17:22,770
look like a normal cell normal cells are

424
00:17:26,450 --> 00:17:24,780
nice and smooth on the outside this guy

425
00:17:29,030 --> 00:17:26,460
is lumpy it's got these weird things

426
00:17:31,040 --> 00:17:29,040
through here and is this some kind of

427
00:17:32,990 --> 00:17:31,050
adaptation that's allowing it to

428
00:17:35,330 --> 00:17:33,000
maintain liquid water possibly on the

429
00:17:36,920 --> 00:17:35,340
outside or is it some adaptation that's

430
00:17:39,320 --> 00:17:36,930
protecting it against something either

431
00:17:41,480 --> 00:17:39,330
salt or cold and answers we just don't

432
00:17:47,419 --> 00:17:41,490
so this could be a whole new adaptation

433
00:17:50,210 --> 00:17:47,429
to the cold I think these are three

434
00:17:52,820 --> 00:17:50,220
cells one two three and this is plano

435
00:17:54,940 --> 00:17:52,830
caucus hollow cryo Phyllis and you'll

436
00:17:57,799 --> 00:17:54,950
hear more about that this afternoon and

437
00:18:00,049 --> 00:17:57,809
I'm going to end with a quote that's not

438
00:18:01,820 --> 00:18:00,059

really fitting on the screen but this is

439
00:18:04,669 --> 00:18:01,830
former prof of mine it's a little crass

440
00:18:06,950 --> 00:18:04,679
so I'm not going to give it to a quoting

441
00:18:08,720 --> 00:18:06,960
a certain person but he said in any

442
00:18:10,970 --> 00:18:08,730
effed up environment on earth you'll

443
00:18:12,470 --> 00:18:10,980
find something living somewhere that's

444
00:18:16,820 --> 00:18:12,480
found something to eat and somehow

445
00:18:18,799 --> 00:18:16,830
survives and it is crass but it's a

446
00:18:20,299 --> 00:18:18,809
beautiful quote because it's true and I

447
00:18:21,529 --> 00:18:20,309
was saying last night that we could

448
00:18:23,389 --> 00:18:21,539
almost have a drinking game at this

449
00:18:25,070 --> 00:18:23,399
conference where every time someone says

450
00:18:27,830 --> 00:18:25,080
life will find a way we all take a shot

451
00:18:30,230 --> 00:18:27,840
and at the end of the conference it

452
00:18:34,700 --> 00:18:30,240
would just be the geologist standing I'm

453
00:18:37,310 --> 00:18:34,710
sure but at the same time it's a really

454
00:18:40,279 --> 00:18:37,320
good message so in a couple years maybe

455
00:18:42,169 --> 00:18:40,289
you know within my lifetime if we don't

456
00:18:44,210 --> 00:18:42,179
find life on another planet I think

457
00:18:46,610 --> 00:18:44,220
it'll mean more to me than if we do

458
00:18:47,899 --> 00:18:46,620
because I can't see how it wouldn't be

459
00:18:51,379 --> 00:18:47,909
on another planet somewhere out there

460
00:19:01,090 --> 00:18:51,389
and if we don't find it you know I might

461
00:19:01,100 --> 00:19:14,890
anybody have questions for Jen

462
00:19:22,070 --> 00:19:19,640
about those sense so what would a normal

463
00:19:23,630 --> 00:19:22,080

one look like normal cells are just

464
00:19:25,460 --> 00:19:23,640
smooth you don't see the bumpiness

465
00:19:27,529 --> 00:19:25,470
circles like lions that look like

466
00:19:35,140 --> 00:19:27,539
spaghetti on the cell surface membrane

467
00:19:38,960 --> 00:19:35,150
just smooth yeah yeah again can you just

468
00:19:40,850 --> 00:19:38,970
you used on several slides and when you

469
00:19:43,850 --> 00:19:40,860
talk you said survive and sometimes

470
00:19:47,299 --> 00:19:43,860
thrive is there a difference I mean for

471
00:19:50,600 --> 00:19:47,309
the sacrifice I mean do you have a

472
00:19:52,190 --> 00:19:50,610
definition for surviving um hard and

473
00:19:55,610 --> 00:19:52,200
fast definitions I think are a little

474
00:19:58,880 --> 00:19:55,620
hard but for example surviving and

475
00:20:01,669 --> 00:19:58,890
thriving the cells i showed you they i

476
00:20:03,409 --> 00:20:01,679
would say thrive where generation x or

477
00:20:05,210 --> 00:20:03,419
maybe a couple minutes to a couple hours

478
00:20:08,060 --> 00:20:05,220
at room temperature with not a lot of

479
00:20:11,060 --> 00:20:08,070
salt whereas you draw from 215 they

480
00:20:13,310 --> 00:20:11,070
survive they make more cells but it's a

481
00:20:16,520 --> 00:20:13,320
lot slower and the cells seem to be more

482
00:20:18,140 --> 00:20:16,530
fragile and I imagine that's kind of the

483
00:20:20,600 --> 00:20:18,150
way those cells would interact with

484
00:20:23,360 --> 00:20:20,610
nature it's things would go very slowly

485
00:20:25,279 --> 00:20:23,370
but they are alive as opposed to in the

486
00:20:26,960 --> 00:20:25,289
lab when we give them an all-you-can-eat

487
00:20:31,430 --> 00:20:26,970
buffet and warm them up they just go to

488
00:20:32,840 --> 00:20:31,440

town would be thriving so I actually

489
00:20:35,090 --> 00:20:32,850
have a question it kind of goes to both

490
00:20:37,580 --> 00:20:35,100
of you since you introduced metabolisms

491
00:20:40,250 --> 00:20:37,590
and you introduced Luca I'm kind of

492
00:20:42,950 --> 00:20:40,260
curious do we have any ideas about early

493
00:20:45,500 --> 00:20:42,960
ecospace as in are these things only

494
00:20:47,210 --> 00:20:45,510
doing one metal like operating on one

495
00:20:49,039 --> 00:20:47,220
metabolic pathway are they taking

496
00:20:51,380 --> 00:20:49,049
advantage of anything that's free have

497
00:20:58,870 --> 00:20:51,390
they differentiated yet into methanogens

498
00:21:04,629 --> 00:21:01,629
I've just noticed people to look into

499
00:21:06,519 --> 00:21:04,639
like that for sure I just don't so when

500
00:21:07,839 --> 00:21:06,529
we're thinking about Luca I mean are we

501
00:21:11,619 --> 00:21:07,849
only thinking about it being trapped to

502
00:21:18,759 --> 00:21:11,629
one locality or do we think it's theirs

503
00:21:19,959 --> 00:21:18,769
eco spaces everywhere I don't say that

504
00:21:23,259 --> 00:21:19,969
Luger you're probably going to be

505
00:21:25,599 --> 00:21:23,269
geographically pretty close because you

506
00:21:27,219 --> 00:21:25,609
know stuff like RNA isn't really stable

507
00:21:29,919 --> 00:21:27,229
so if it's going to be transferring back

508
00:21:31,569 --> 00:21:29,929
and forth it can't go very far so I'd

509
00:21:33,969 --> 00:21:31,579
say yeah I would say species

510
00:21:36,069 --> 00:21:33,979
differentiation at that point you've got

511
00:21:38,139 --> 00:21:36,079
you know Geographic barriers and then

512
00:21:39,639 --> 00:21:38,149
you know lots of different spaces and

513
00:21:41,829 --> 00:21:39,649

stuff like that but at least for

514
00:21:43,779 --> 00:21:41,839
everything up to Luca and Luca probably

515
00:21:47,739 --> 00:21:43,789
had to be pretty close to at least in my

516
00:21:49,269 --> 00:21:47,749
vision I'd agree with that you're

517
00:21:51,249 --> 00:21:49,279
talking about a lot different

518
00:21:55,930 --> 00:21:51,259
environment to a lot harsher than what

519
00:21:59,769 --> 00:21:55,940
we have now is probably any other