

## Genomic plasticity

| Organism                                | Osmoregulatory genes: choline/betaine uptake and synthesis |       |       |       |       |        |        |        |        |        |
|---|--|-------|-------|-------|-------|--------|--------|--------|--------|--------|
|   | Pro P  | Pro V | Pro W | Pro X | Opu D | OpuA A | OpuA B | OpuA C | BetB * | Glyc * |
| <i>Planococcus</i> sp. Or1              |  | X(2)  | X     | X(2)  | X(4)  | X(3)   | X(2)   | X(2)   | ?      | X      |
| <i>Psychrobacter cryohalobius</i> K3    |  | X     | X     |       | X     |        |        |        |        | X      |
| <i>Psychrobacter arcticus</i> 273-4     | X  |       |       |       |       |        |        |        |        | X      |
| <i>Psychromonas ingrahamii</i>          |  | X(3)  | X(3)  |       |       |        |        |        |        | X X    |
| <i>Colwellia psychrotolerans</i> 34H    |  | X     | X     | X     |       |        |        |        |        | X(3)   |
| <i>Desulfotalea psychrophila</i>        |  | X     | X     |       |       |        |        |        |        |        |
| <i>Erwinobacterium sibiricum</i> 255-15 | X  | X     |       | X     | X     |        | X      | X      |        | X      |

X, presence of gene; (#), number of copies in genome

(Mykytczuk et al. 2013)

\* betaine or glycine

glycine or betaine

1  
00:00:11,340 --> 00:00:09,520  
yes so today I'd like to talk to you

2  
00:00:15,070 --> 00:00:11,350  
guys about some of the molecular

3  
00:00:16,750 --> 00:00:15,080  
adaptations to life in very cool

4  
00:00:18,580 --> 00:00:16,760  
environments and I'm going to

5  
00:00:21,370 --> 00:00:18,590  
specifically talk about a bacteria that

6  
00:00:25,420 --> 00:00:21,380  
we've isolated recently in my laboratory

7  
00:00:27,159 --> 00:00:25,430  
called panic caucus hello craft 'less so

8  
00:00:29,530 --> 00:00:27,169  
just to give a little bit of background

9  
00:00:32,650 --> 00:00:29,540  
most of the work in my laboratory is

10  
00:00:34,510 --> 00:00:32,660  
done in the Arctic or with microbial

11  
00:00:36,819 --> 00:00:34,520  
habitats and or microbes that live in

12  
00:00:39,250 --> 00:00:36,829  
the Arctic so there are a number of

13  
00:00:43,750 --> 00:00:39,260

unique microbial habitats that we find

14

00:00:47,110 --> 00:00:43,760

there they include hyper saline Springs

15

00:00:49,150 --> 00:00:47,120

permafrost and crypto endelis which you

16

00:00:50,650 --> 00:00:49,160

maybe can tell jackie was having a hard

17

00:00:52,900 --> 00:00:50,660

time earlier but you can see maybe the

18

00:00:56,610 --> 00:00:52,910

green layer there which is basically

19

00:00:59,500 --> 00:00:56,620

made up of microb microbes so these

20

00:01:01,239 --> 00:00:59,510

habitats are also pretty good

21

00:01:03,639 --> 00:01:01,249

terrestrial analogs for certain places

22

00:01:08,740 --> 00:01:03,649

in our solar system that's our kind of

23

00:01:10,060 --> 00:01:08,750

cold frozen or salty but they're also

24

00:01:11,980 --> 00:01:10,070

really good places for the study of

25

00:01:15,880 --> 00:01:11,990

profiles or extremophiles that like

26

00:01:18,550 --> 00:01:15,890

really really cold environments so just

27

00:01:20,830 --> 00:01:18,560

to situate you a little bit this is us

28

00:01:23,139 --> 00:01:20,840

somewhere right around here and if you

29

00:01:24,999 --> 00:01:23,149

enlarge this area up here this is

30

00:01:26,410 --> 00:01:25,009

ellesmere island and axel Heiberg island

31

00:01:28,929 --> 00:01:26,420

and a lot of the research the design in

32

00:01:30,130 --> 00:01:28,939

my lab is done here and plan a caucus

33

00:01:32,160 --> 00:01:30,140

the bacteria that I'm going to talk

34

00:01:37,870 --> 00:01:32,170

about was actually isolated from this

35

00:01:40,810 --> 00:01:37,880

region here Eureka none of it so plan a

36

00:01:42,160 --> 00:01:40,820

caucus hell Acropolis is really cool

37

00:01:43,660 --> 00:01:42,170

really interesting because it actually

38

00:01:45,550 --> 00:01:43,670

grows at the lowest temperature that

39

00:01:48,789 --> 00:01:45,560

we've ever recorded to date which is

40

00:01:50,800 --> 00:01:48,799

minus 15 degrees Celsius and it also

41

00:01:53,859 --> 00:01:50,810

tolerates up to nineteen percent salt

42

00:01:56,020 --> 00:01:53,869

which is very high this is a scanning

43

00:01:58,209 --> 00:01:56,030

electron micrograph of planet caucus so

44

00:01:59,770 --> 00:01:58,219

it's a typical guy I meaning that's

45

00:02:02,529 --> 00:01:59,780

round and diplo meaning that it usually

46

00:02:08,169 --> 00:02:02,539

lives with another another one of itself

47

00:02:09,490 --> 00:02:08,179

joined together so most of the work then

48

00:02:10,840 --> 00:02:09,500

I'm pretty much all the work that I'm

49

00:02:14,470 --> 00:02:10,850

going to present today is actually from

50

00:02:17,650 --> 00:02:14,480

an ex post doc in my laboratory her name

51  
00:02:18,660 --> 00:02:17,660  
is Nadia Nick mikha Chuck and so she

52  
00:02:20,370 --> 00:02:18,670  
isolated

53  
00:02:23,760 --> 00:02:20,380  
bacteria and then did a bunch of work

54  
00:02:25,589 --> 00:02:23,770  
looking at the molecular the molecular

55  
00:02:27,809 --> 00:02:25,599  
adaptations of this organism so she

56  
00:02:29,790 --> 00:02:27,819  
looked at genomic trade she basically

57  
00:02:31,290 --> 00:02:29,800  
sequenced the whole genome she looked at

58  
00:02:33,300 --> 00:02:31,300  
the trends she did transcriptomic

59  
00:02:35,940 --> 00:02:33,310  
analysis which is basically looking at

60  
00:02:38,460 --> 00:02:35,950  
are comparing which genes are active in

61  
00:02:40,170 --> 00:02:38,470  
certain conditions compared to four

62  
00:02:42,090 --> 00:02:40,180  
extra which teams are actually for

63  
00:02:43,830 --> 00:02:42,100

example at room temperature compared to

64

00:02:46,680 --> 00:02:43,840

Regine's are active at minus 15 degrees

65

00:02:48,780 --> 00:02:46,690

Celsius but one of the first things that

66

00:02:50,699 --> 00:02:48,790

she did is she looked to the bacteria

67

00:02:52,710 --> 00:02:50,709

under the microscope so these are

68

00:02:54,449 --> 00:02:52,720

scanning electron micrographs and she

69

00:02:57,270 --> 00:02:54,459

compared what they look like at

70

00:02:59,190 --> 00:02:57,280

different temperatures so this up here

71

00:03:01,920 --> 00:02:59,200

is 25 degrees Celsius and this is what

72

00:03:03,090 --> 00:03:01,930

Victoria usually look like this is what

73

00:03:05,309 --> 00:03:03,100

we see in this is what planet caucus

74

00:03:07,710 --> 00:03:05,319

usually looks like 25 when you look at

75

00:03:09,660 --> 00:03:07,720

it at minus-5 you can see that it starts

76  
00:03:11,580 --> 00:03:09,670  
to change a little bit the surface looks

77  
00:03:13,740 --> 00:03:11,590  
a little bit more different not sure

78  
00:03:15,660 --> 00:03:13,750  
what's going on but it's you but it

79  
00:03:17,940 --> 00:03:15,670  
looks a little strange when you go to

80  
00:03:20,309 --> 00:03:17,950  
minus-15 it looks completely different

81  
00:03:22,800 --> 00:03:20,319  
so something is happening to the surface

82  
00:03:25,199 --> 00:03:22,810  
of the bacteria minus 15 degrees Celsius

83  
00:03:26,789 --> 00:03:25,209  
now i wish i could tell you like that we

84  
00:03:28,470 --> 00:03:26,799  
know exactly what's going on that we

85  
00:03:30,960 --> 00:03:28,480  
know exactly what this is and the reason

86  
00:03:32,729 --> 00:03:30,970  
why it's there but we don't we're

87  
00:03:34,860 --> 00:03:32,739  
looking into that right now jen is

88  
00:03:36,300 --> 00:03:34,870

actually looking into maybe what this is

89

00:03:39,270 --> 00:03:36,310

composed of and the reason why this

90

00:03:41,759 --> 00:03:39,280

envelope is there it's there's a few

91

00:03:43,020 --> 00:03:41,769

different possibilities it could be a

92

00:03:46,440 --> 00:03:43,030

mixture of different things it could be

93

00:03:49,380 --> 00:03:46,450

proteins lipids maybe biofilm of some

94

00:03:52,590 --> 00:03:49,390

sort it could be just residue from cell

95

00:03:55,020 --> 00:03:52,600

wall when the bacteria separates where

96

00:03:57,720 --> 00:03:55,030

where the actual separation when the

97

00:04:00,690 --> 00:03:57,730

vector replicates where that happens it

98

00:04:03,059 --> 00:04:00,700

could be just extra cell membrane that

99

00:04:05,690 --> 00:04:03,069

is just left there but we don't really

100

00:04:08,069 --> 00:04:05,700

know right now exactly what's going on

101  
00:04:11,250 --> 00:04:08,079  
so the next thing that not you did after

102  
00:04:13,080 --> 00:04:11,260  
she looked at at added under the

103  
00:04:14,940 --> 00:04:13,090  
microscope is she basically did she

104  
00:04:17,930 --> 00:04:14,950  
sequence the entire genome and then she

105  
00:04:21,000 --> 00:04:17,940  
analyzed the genome for essentially

106  
00:04:23,190 --> 00:04:21,010  
adaptations that she could find for life

107  
00:04:25,260 --> 00:04:23,200  
in cold environments and one of the

108  
00:04:27,180 --> 00:04:25,270  
things that she found is this is what we

109  
00:04:31,790 --> 00:04:27,190  
call genomic plasticity and so it's this

110  
00:04:33,830 --> 00:04:31,800  
idea that organisms like conical

111  
00:04:36,830 --> 00:04:33,840  
this organisms that that live in really

112  
00:04:38,510 --> 00:04:36,840  
cold or stressful environments have many

113  
00:04:39,980 --> 00:04:38,520

copies of the same genes so they

114

00:04:42,200 --> 00:04:39,990

basically have many versions of the same

115

00:04:44,839 --> 00:04:42,210

gene and the reason why they do this is

116

00:04:46,430 --> 00:04:44,849

this basically allows them to survive in

117

00:04:49,040 --> 00:04:46,440

these in these in many different

118

00:04:51,439 --> 00:04:49,050

stressful conditions so for example in a

119

00:04:53,659 --> 00:04:51,449

warmer or a salt condition you might use

120

00:04:55,309 --> 00:04:53,669

one version of a gene whereas in another

121

00:04:56,990 --> 00:04:55,319

condition like a colder condition you'll

122

00:04:58,219 --> 00:04:57,000

use another version of a gene so

123

00:05:00,320 --> 00:04:58,229

depending on which condition you're in

124

00:05:01,999 --> 00:05:00,330

which stress you have you're going to be

125

00:05:04,430 --> 00:05:02,009

using a different version of the same

126

00:05:06,680 --> 00:05:04,440

gene and each version is a little bit

127

00:05:08,779 --> 00:05:06,690

different and it allows you it allows

128

00:05:09,950 --> 00:05:08,789

the organism to use that same gene but

129

00:05:11,899 --> 00:05:09,960

in these different environmental

130

00:05:14,059 --> 00:05:11,909

stressors so you can see for plan or

131

00:05:16,369 --> 00:05:14,069

caucus for example this is looking at

132

00:05:18,110 --> 00:05:16,379

choline betaine uptake so this is

133

00:05:20,089 --> 00:05:18,120

looking at solute I've taken synthesis

134

00:05:22,159 --> 00:05:20,099

and solute is really important for the

135

00:05:24,350 --> 00:05:22,169

bacteria in order to allow it to survive

136

00:05:26,240 --> 00:05:24,360

in really high salt conditions so it

137

00:05:28,129 --> 00:05:26,250

accumulates these solutes these little

138

00:05:30,170 --> 00:05:28,139

organic molecules inside the cell and

139

00:05:32,300 --> 00:05:30,180

they actually allow it to survive

140

00:05:34,760 --> 00:05:32,310

eighteen nineteen percent salt and

141

00:05:36,200 --> 00:05:34,770

really high salt percentages and so if

142

00:05:38,390 --> 00:05:36,210

you look at just these genes that are

143

00:05:40,159 --> 00:05:38,400

involved in this process final caucus

144

00:05:42,499 --> 00:05:40,169

has a lot of them and has many copies of

145

00:05:43,820 --> 00:05:42,509

these genes so it's just idea then that

146

00:05:46,700 --> 00:05:43,830

depending on the environment will find

147

00:05:49,129 --> 00:05:46,710

itself in it can up-regulate one version

148

00:05:50,990 --> 00:05:49,139

of the same gene whichever one is

149

00:05:53,529 --> 00:05:51,000

necessary for the environment that it's

150

00:05:56,600 --> 00:05:53,539

in so the other thing that she looked at

151

00:05:59,409 --> 00:05:56,610

was the idea of or she looked at amino

152

00:06:03,290 --> 00:05:59,419

acid changes so you have a gene sequence

153

00:06:05,390 --> 00:06:03,300

and cold-adapted proteins will actually

154

00:06:08,209 --> 00:06:05,400

change so essentially if you take a gene

155

00:06:10,249 --> 00:06:08,219

your gene codes for amino acids which

156

00:06:12,170 --> 00:06:10,259

then make a protein and which amino

157

00:06:15,760 --> 00:06:12,180

acids are in that protein can actually

158

00:06:20,029 --> 00:06:15,770

change and so this is the idea of

159

00:06:23,330 --> 00:06:20,039

increasing protein flexibility so if you

160

00:06:25,279 --> 00:06:23,340

look at at these like these to hear what

161

00:06:28,129 --> 00:06:25,289

she essentially found is most of the

162

00:06:30,800 --> 00:06:28,139

genes in panto caucus actually have less

163

00:06:32,959 --> 00:06:30,810

acidic and proline residues so they're

164

00:06:34,430 --> 00:06:32,969

basically cold-adapted because having

165

00:06:36,529 --> 00:06:34,440

less of these gives you increased

166

00:06:39,430 --> 00:06:36,539

protein flexibility so a lot of these

167

00:06:43,879 --> 00:06:39,440

genes are essentially better adapted to

168

00:06:49,999 --> 00:06:48,110

on oops so the next thing that she did

169

00:06:52,010 --> 00:06:50,009

was then transcriptomic analysis she

170

00:06:55,339 --> 00:06:52,020

basically looks at looked at which genes

171

00:06:57,920 --> 00:06:55,349

were active at minus 15 and which genes

172

00:06:59,420 --> 00:06:57,930

were active at a high-salt in which

173

00:07:00,679 --> 00:06:59,430

genes were active at room temperature

174

00:07:03,080 --> 00:07:00,689

and then she compared them to

175

00:07:06,260 --> 00:07:03,090

essentially get a better idea of which

176

00:07:08,830 --> 00:07:06,270

processes inside the cell were were

177

00:07:13,369 --> 00:07:08,840

involved in high salt or minus 15

178

00:07:15,230 --> 00:07:13,379

conditions so the main thing that she

179

00:07:16,550 --> 00:07:15,240

found are these are essentially two of

180

00:07:18,830 --> 00:07:16,560

the main things that she found which is

181

00:07:20,269 --> 00:07:18,840

one there's decreased expression across

182

00:07:22,159 --> 00:07:20,279

functional categories and that just

183

00:07:24,050 --> 00:07:22,169

basically means that in general the

184

00:07:25,580 --> 00:07:24,060

bacteria shuts down most processes that

185

00:07:26,659 --> 00:07:25,590

aren't necessary so a lot of genes that

186

00:07:28,219 --> 00:07:26,669

aren't necessarily they're not going to

187

00:07:30,080 --> 00:07:28,229

be active you don't want to waste energy

188

00:07:33,290 --> 00:07:30,090

having a lot of things active that you

189

00:07:35,209 --> 00:07:33,300

don't need to have so most cellular

190

00:07:37,040 --> 00:07:35,219

functions are repressed but she did find

191

00:07:39,439 --> 00:07:37,050

upregulation of a number of genes

192

00:07:40,850 --> 00:07:39,449

involved in cell wall modifications

193

00:07:43,459 --> 00:07:40,860

which we can expect based on the

194

00:07:45,950 --> 00:07:43,469

pictures that we saw earlier amino acid

195

00:07:47,510 --> 00:07:45,960

metabolism as well as oxidative stress

196

00:07:49,640 --> 00:07:47,520

response which is normal when you're

197

00:07:51,170 --> 00:07:49,650

under stress and changes in

198

00:07:52,790 --> 00:07:51,180

transcriptional regulation or a lot of

199

00:07:55,999 --> 00:07:52,800

transcription transcriptional regulation

200

00:07:59,719 --> 00:07:56,009

so again you can easily shut on and off

201  
00:08:01,579 --> 00:07:59,729  
genes that you need or don't need so

202  
00:08:03,579 --> 00:08:01,589  
this is the last picture that I want to

203  
00:08:06,499 --> 00:08:03,589  
show you guys which kind of looks really

204  
00:08:08,510 --> 00:08:06,509  
confusing and complicated it's not

205  
00:08:12,559 --> 00:08:08,520  
really well as a sort of this is

206  
00:08:14,510 --> 00:08:12,569  
basically a very it is but it's it's

207  
00:08:16,610 --> 00:08:14,520  
basically a very brief overview of all

208  
00:08:18,529 --> 00:08:16,620  
of the different processes that are

209  
00:08:21,200 --> 00:08:18,539  
happening at any single time inside of

210  
00:08:22,369 --> 00:08:21,210  
self and that's even not even nearly

211  
00:08:25,879 --> 00:08:22,379  
close to everything that's happening

212  
00:08:27,649 --> 00:08:25,889  
inside of a cell but in terms of town of

213  
00:08:30,050 --> 00:08:27,659

chacas what we want to highlight are

214

00:08:32,509 --> 00:08:30,060

basically the genome encoded adaptations

215

00:08:35,389 --> 00:08:32,519

cold adaptations that Nadia found to be

216

00:08:37,670 --> 00:08:35,399

important and so this is just generally

217

00:08:39,589 --> 00:08:37,680

all the main sort of categories of gene

218

00:08:42,409 --> 00:08:39,599

of adaptations that she found in the

219

00:08:44,360 --> 00:08:42,419

genome so she found adaptations in cold

220

00:08:46,490 --> 00:08:44,370

shop genes or cold shock proteins which

221

00:08:48,500 --> 00:08:46,500

would make sense compatible solute

222

00:08:50,509 --> 00:08:48,510

uptake cell envelope modification and

223

00:08:53,569 --> 00:08:50,519

things of that nature but she did find

224

00:08:56,389 --> 00:08:53,579

that some processes were induced more

225

00:08:57,570 --> 00:08:56,399

either by high salt or more by cold and

226

00:09:00,240 --> 00:08:57,580

so these are highlighted

227

00:09:02,910 --> 00:09:00,250

here so things like lipid synthesis and

228

00:09:05,130 --> 00:09:02,920

turnover amino acid turnover oxidative

229

00:09:07,260 --> 00:09:05,140

stress these seem to be more induced by

230

00:09:10,110 --> 00:09:07,270

the high salt conditions and in the

231

00:09:12,540 --> 00:09:10,120

minus 15 conditions she found again

232

00:09:13,740 --> 00:09:12,550

translation transcription and what I

233

00:09:15,960 --> 00:09:13,750

find really interesting which are these

234

00:09:17,430 --> 00:09:15,970

hypothetical proteins so these are

235

00:09:18,840 --> 00:09:17,440

essentially proteins that we've never

236

00:09:20,220 --> 00:09:18,850

characterized before and that actually

237

00:09:23,700 --> 00:09:20,230

might be really really important for

238

00:09:25,020 --> 00:09:23,710

cold survival but we just don't know

239

00:09:26,430 --> 00:09:25,030

what they do because we've never seen

240

00:09:27,990 --> 00:09:26,440

them before and so I think that's one

241

00:09:30,060 --> 00:09:28,000

area of research in the future that'd be

242

00:09:32,010 --> 00:09:30,070

really interesting which is to look into

243

00:09:34,500 --> 00:09:32,020

what these proteins are and what's their

244

00:09:38,880 --> 00:09:34,510

role in cold survival because they may

245

00:09:41,990 --> 00:09:38,890

be really interesting so the current

246

00:09:44,010 --> 00:09:42,000

work that is going on in our laboratory

247

00:09:45,420 --> 00:09:44,020

involves looking at the composition of

248

00:09:47,940 --> 00:09:45,430

the minus 15 envelope which I mentioned

249

00:09:50,880 --> 00:09:47,950

with jen is looking into we're also

250

00:09:52,560 --> 00:09:50,890

doing some proteomics looking at so the

251  
00:09:53,940 --> 00:09:52,570  
next steps we look to genes we looked at

252  
00:09:55,050 --> 00:09:53,950  
which genes are active in which aren't

253  
00:09:56,940 --> 00:09:55,060  
and then we actually want to look at the

254  
00:09:58,800 --> 00:09:56,950  
proteins inside the cells and figure out

255  
00:09:59,970 --> 00:09:58,810  
what's actually going on in terms of the

256  
00:10:02,820 --> 00:09:59,980  
proteins in terms of the molecular

257  
00:10:04,500 --> 00:10:02,830  
mechanisms inside the cell and then also

258  
00:10:06,540 --> 00:10:04,510  
looking at compatible solute so figuring

259  
00:10:08,760 --> 00:10:06,550  
out how planet caucus is actually able

260  
00:10:10,860 --> 00:10:08,770  
to tolerate such high salt what which

261  
00:10:14,270 --> 00:10:10,870  
saw what solute sit actually accumulates

262  
00:10:26,700 --> 00:10:14,280  
inside the cell for salt tolerance and

263  
00:10:28,470 --> 00:10:26,710

that's it so questions for Isabel have

264

00:10:30,210 --> 00:10:28,480

you thought of like over expressing some

265

00:10:32,150 --> 00:10:30,220

of these proteins and like e.coli or

266

00:10:34,740 --> 00:10:32,160

something and seeing if they enable

267

00:10:37,230 --> 00:10:34,750

maybe I called education medical

268

00:10:40,140 --> 00:10:37,240

proteins well more you could

269

00:10:42,300 --> 00:10:40,150

hypothetical but more safely some of the

270

00:10:43,770 --> 00:10:42,310

ones that affect like the lipid membrane

271

00:10:45,360 --> 00:10:43,780

and stuff like that oh yeah for sure

272

00:10:47,010 --> 00:10:45,370

that's there's so many things that you

273

00:10:49,260 --> 00:10:47,020

can do with the organism at this point

274

00:10:50,940 --> 00:10:49,270

yeah um and so we're just at the

275

00:11:01,680 --> 00:10:50,950

beginning of looking at this more but

276

00:11:07,450 --> 00:11:04,780

it was my turn our online turn is your

277

00:11:08,950 --> 00:11:07,460

organism genetically tractable what do

278

00:11:10,510 --> 00:11:08,960

you mean by tonight sorry I mean are you

279

00:11:12,970 --> 00:11:10,520

able to do genetics with your organism

280

00:11:15,400 --> 00:11:12,980

like meat make mutants with it wow you

281

00:11:17,110 --> 00:11:15,410

sure you could okay I was just wondering

282

00:11:18,610 --> 00:11:17,120

if your lab also makes mutants with the

283

00:11:20,170 --> 00:11:18,620

organism to investigate like the

284

00:11:22,000 --> 00:11:20,180

function of like the hypothetical

285

00:11:27,579 --> 00:11:22,010

proteins oh yeah no we haven't done that

286

00:11:35,940 --> 00:11:27,589

yet but we definitely could okay cool so

287

00:11:40,810 --> 00:11:38,740

okay this is from batoul our first

288

00:11:44,320 --> 00:11:40,820

question is why is protein flexibility

289

00:11:47,310 --> 00:11:44,330

beneficial in cold environments and so I

290

00:11:50,740 --> 00:11:47,320

guess this is sort of the idea that that

291

00:11:52,600 --> 00:11:50,750

with the cold you want to have proteins

292

00:11:54,880 --> 00:11:52,610

that are very flexible it's easier to

293

00:11:56,769 --> 00:11:54,890

buy into your substrate if you're not so

294

00:11:58,150 --> 00:11:56,779

rigid which is probably what's going to

295

00:12:00,430 --> 00:11:58,160

happen at lower temperatures so

296

00:12:03,670 --> 00:12:00,440

something like proline creates kinks and

297

00:12:05,470 --> 00:12:03,680

rigidity in an amino acid so you want to

298

00:12:07,240 --> 00:12:05,480

have you rather not have that so that

299

00:12:09,160 --> 00:12:07,250

you're more flexible and when you have

300

00:12:10,750 --> 00:12:09,170

the cold which tends to kind of wants to

301  
00:12:14,380 --> 00:12:10,760  
slow you down and essentially allows you

302  
00:12:16,510 --> 00:12:14,390  
to better bind to your substrate okay

303  
00:12:18,370 --> 00:12:16,520  
and our second one is could you tell

304  
00:12:23,820 --> 00:12:18,380  
which proteins involved in cell wall

305  
00:12:28,180 --> 00:12:26,110  
could you tell which proteins involved

306  
00:12:31,930 --> 00:12:28,190  
in cell wall membrane regulation are

307  
00:12:32,740 --> 00:12:31,940  
adapted you mean cold-adapted or I don't

308  
00:12:34,150 --> 00:12:32,750  
think we've looked into that

309  
00:12:35,230 --> 00:12:34,160  
specifically but that's definitely

310  
00:12:36,760 --> 00:12:35,240  
something that that we're gonna look