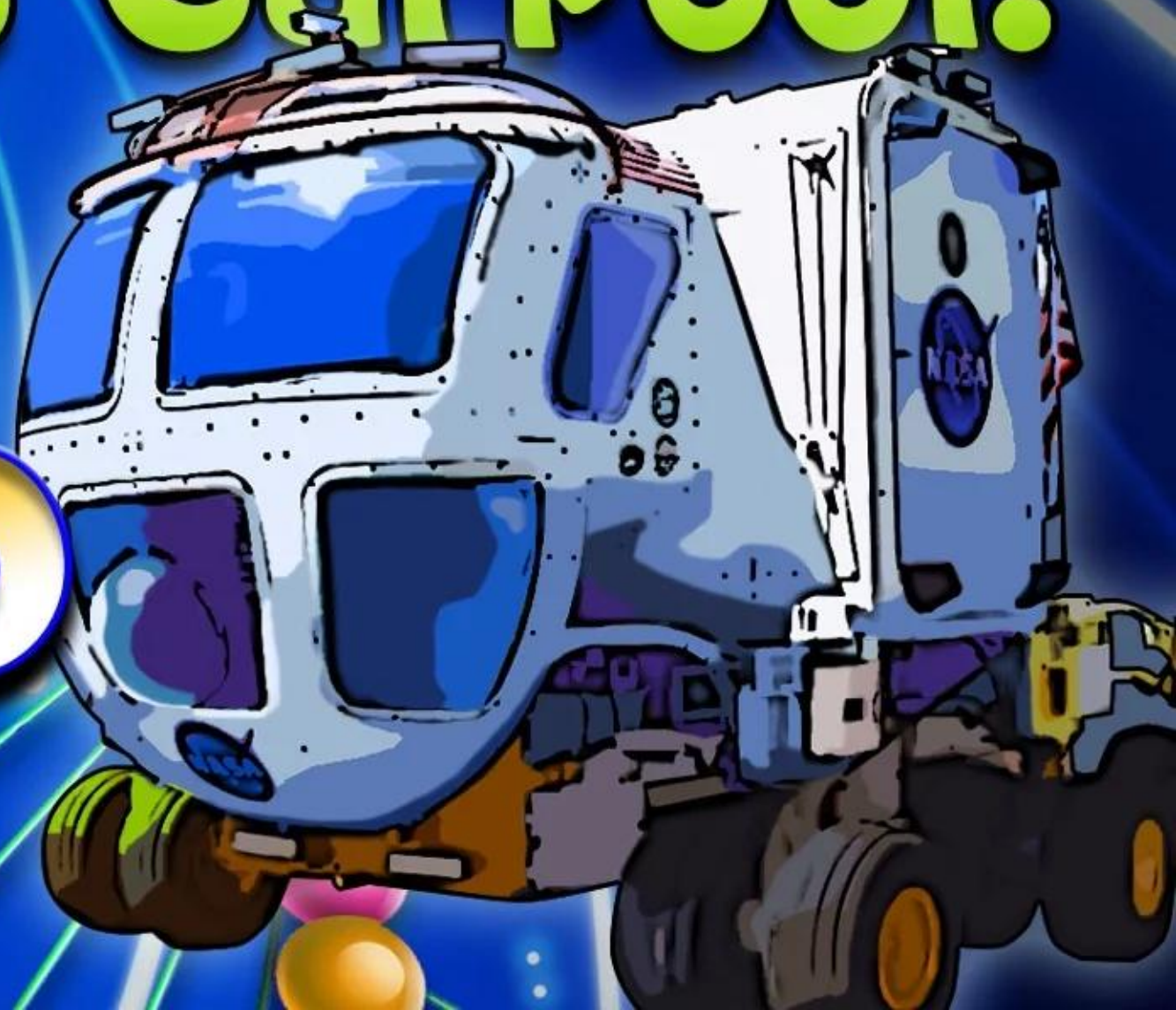


Cosmic Carpool:

**DNA
TO GO**



1
00:00:10,310 --> 00:00:06,789
hi i i'm almost there i'm just i'm stuck

2
00:00:15,190 --> 00:00:10,320
in the most ridiculous traffic

3
00:00:18,470 --> 00:00:16,870
all right i'll be there real soon don't

4
00:00:20,070 --> 00:00:18,480
worry we won't be late i promise i'll be

5
00:00:24,410 --> 00:00:20,080
there real soon i'll pick you guys up on

6
00:00:31,910 --> 00:00:30,470
[Music]

7
00:00:34,470 --> 00:00:31,920
oh sarah

8
00:00:37,510 --> 00:00:34,480
aaron guys i'm sorry traffic was insane

9
00:00:39,990 --> 00:00:37,520
understood come on in

10
00:00:42,549 --> 00:00:40,000
so i heard you guys are working on the

11
00:00:44,069 --> 00:00:42,559
biomolecule sequencer now

12
00:00:46,630 --> 00:00:44,079
i mean what the heck is that it sounds

13
00:00:48,709 --> 00:00:46,640

like something off of a superheroes

14

00:00:51,270 --> 00:00:48,719

utility belt or something

15

00:00:52,790 --> 00:00:51,280

yeah well basically um there's a little

16

00:00:54,549 --> 00:00:52,800

portable sequencer you know that we

17

00:00:55,510 --> 00:00:54,559

happen to bring with us we're basically

18

00:00:57,910 --> 00:00:55,520

just trying to make it so you can

19

00:01:00,150 --> 00:00:57,920

sequence dna anywhere whether that's in

20

00:01:01,750 --> 00:01:00,160

a rover going to the meeting or

21

00:01:03,430 --> 00:01:01,760

on the planet mars or on the

22

00:01:05,830 --> 00:01:03,440

international space station

23

00:01:08,950 --> 00:01:05,840

sequencing dna real quick high school

24

00:01:12,390 --> 00:01:08,960

science question what does dna stand for

25

00:01:14,310 --> 00:01:12,400

dna is deoxyribonucleic acid

26

00:01:16,469 --> 00:01:14,320

and it's basically the molecule where

27

00:01:18,950 --> 00:01:16,479

cells contain all the instructions for

28

00:01:20,870 --> 00:01:18,960

life so every everything that a that a

29

00:01:22,710 --> 00:01:20,880

cell needs to do every function is

30

00:01:24,630 --> 00:01:22,720

contained in its dna

31

00:01:29,190 --> 00:01:24,640

can you spell that

32

00:01:33,749 --> 00:01:31,590

uh space acid acid

33

00:01:35,030 --> 00:01:33,759

color me impress

34

00:01:37,109 --> 00:01:35,040

all right so

35

00:01:38,469 --> 00:01:37,119

sarah sequencing dna what is what does

36

00:01:39,270 --> 00:01:38,479

that mean like what are you what are you

37

00:01:42,550 --> 00:01:39,280

guys

38

00:01:44,310 --> 00:01:42,560

doing with that so every organism has as

39

00:01:47,270 --> 00:01:44,320

aaron said this dna and it's the

40

00:01:49,590 --> 00:01:47,280

sequence of the a's g's t's and c's or

41

00:01:51,670 --> 00:01:49,600

the dna bases that make us up and make

42

00:01:54,630 --> 00:01:51,680

up our cells and encode all of the

43

00:01:56,469 --> 00:01:54,640

things we need to live so by sequencing

44

00:01:58,870 --> 00:01:56,479

it we're determining that order of the

45

00:02:01,109 --> 00:01:58,880

nucleotide bases to figure out what

46

00:02:02,630 --> 00:02:01,119

organisms are in our sample and things

47

00:02:04,870 --> 00:02:02,640

like that that we can use to gain more

48

00:02:07,109 --> 00:02:04,880

information about biological life so

49

00:02:08,949 --> 00:02:07,119

basically you take this dna and by

50

00:02:10,630 --> 00:02:08,959

reading those different letters i

51
00:02:12,309 --> 00:02:10,640
already forgot them you can figure out

52
00:02:13,589 --> 00:02:12,319
you know what something is so you can

53
00:02:14,630 --> 00:02:13,599
take an unknown sample and figure out

54
00:02:16,949 --> 00:02:14,640
what it is

55
00:02:18,949 --> 00:02:16,959
that's correct okay

56
00:02:21,910 --> 00:02:18,959
why i mean why why do we need to do

57
00:02:23,270 --> 00:02:21,920
something like that well if there's a

58
00:02:25,270 --> 00:02:23,280
contaminating

59
00:02:26,949 --> 00:02:25,280
fungus that's on the iss we want to know

60
00:02:28,390 --> 00:02:26,959
what it is so we can best recommend how

61
00:02:30,949 --> 00:02:28,400
to clean it up and right now we don't

62
00:02:32,710 --> 00:02:30,959
have a way to do that on the iss so it

63
00:02:34,390 --> 00:02:32,720

would be cool if we could take

64

00:02:35,670 --> 00:02:34,400

real samples from the iss we could

65

00:02:37,350 --> 00:02:35,680

figure out all the different microbes

66

00:02:39,589 --> 00:02:37,360

that are in them so we can use it to

67

00:02:40,790 --> 00:02:39,599

find out if stuff's growing in a space

68

00:02:42,150 --> 00:02:40,800

station but

69

00:02:44,309 --> 00:02:42,160

you just said you can use it to like

70

00:02:46,949 --> 00:02:44,319

find life we can use this to find life

71

00:02:49,270 --> 00:02:46,959

outside of earth possibly yeah so we

72

00:02:50,869 --> 00:02:49,280

have mars meteorites on earth which

73

00:02:52,869 --> 00:02:50,879

means that little pieces of mars have

74

00:02:54,790 --> 00:02:52,879

been impacted and then flown through

75

00:02:56,550 --> 00:02:54,800

space and landed on the earth and so

76

00:02:57,509 --> 00:02:56,560

it's very possible that pieces of early

77

00:02:59,190 --> 00:02:57,519

earth

78

00:03:01,990 --> 00:02:59,200

got released and made their way out to

79

00:03:03,190 --> 00:03:02,000

mars so the most likely candidate

80

00:03:05,670 --> 00:03:03,200

to have life

81

00:03:07,110 --> 00:03:05,680

uh is mars and it could have life that

82

00:03:09,030 --> 00:03:07,120

started on earth

83

00:03:11,509 --> 00:03:09,040

or life on earth could have started on

84

00:03:13,750 --> 00:03:11,519

mars and so if there is a common uh

85

00:03:15,670 --> 00:03:13,760

ancestry then we could be able to detect

86

00:03:18,229 --> 00:03:15,680

it with a sequencer like this

87

00:03:20,149 --> 00:03:18,239

you mean we haven't already found aliens

88

00:03:24,320 --> 00:03:20,159

uh we have not no

89

00:03:29,350 --> 00:03:27,670

[Music]

90

00:03:30,869 --> 00:03:29,360

hey aaron you want to sequence some dna

91

00:03:32,390 --> 00:03:30,879

in a rover

92

00:03:35,110 --> 00:03:32,400

so you can do it like right here like

93

00:03:37,350 --> 00:03:35,120

that's it yeah it's exactly small

94

00:03:39,830 --> 00:03:37,360

that's insane okay so what like what's

95

00:03:42,949 --> 00:03:39,840

actually happening so i have a sample

96

00:03:44,949 --> 00:03:42,959

here that contains dna from a mouse a

97

00:03:46,630 --> 00:03:44,959

virus and a bacteria it's the same

98

00:03:48,149 --> 00:03:46,640

samples that are on the iss that have

99

00:03:50,309 --> 00:03:48,159

been sequenced

100

00:03:53,270 --> 00:03:50,319

and i'm injecting them

101
00:03:54,789 --> 00:03:53,280
into this miniature dna sequencer

102
00:03:56,470 --> 00:03:54,799
and we are actually going to start

103
00:03:58,470 --> 00:03:56,480
collecting the sequences while we're

104
00:04:00,390 --> 00:03:58,480
roving around this has never been done

105
00:04:02,070 --> 00:04:00,400
in a rover before correct i think it's

106
00:04:03,350 --> 00:04:02,080
safe to say never been done in a row

107
00:04:05,589 --> 00:04:03,360
there you go

108
00:04:07,670 --> 00:04:05,599
breaking new ground here

109
00:04:10,070 --> 00:04:07,680
nothing is so small like what what magic

110
00:04:12,550 --> 00:04:10,080
is happening now

111
00:04:15,110 --> 00:04:12,560
um so in this little window here there's

112
00:04:16,789 --> 00:04:15,120
a bunch of what are called nanopores so

113
00:04:19,830 --> 00:04:16,799

they're biological

114

00:04:21,670 --> 00:04:19,840

proteins that exist in normal cells and

115

00:04:23,189 --> 00:04:21,680

they allow ions to flow through and it's

116

00:04:25,270 --> 00:04:23,199

just big enough to let a single strand

117

00:04:26,629 --> 00:04:25,280

of dna actually pass through the pore

118

00:04:29,110 --> 00:04:26,639

when there's nothing in the pore you get

119

00:04:30,950 --> 00:04:29,120

a certain fixed current

120

00:04:32,390 --> 00:04:30,960

and then as dna passes through it the

121

00:04:34,070 --> 00:04:32,400

pore gets blocked and the current is

122

00:04:36,790 --> 00:04:34,080

reduced and so it's that change in

123

00:04:39,350 --> 00:04:36,800

current that tells you what the sequence

124

00:04:41,110 --> 00:04:39,360

of dna flowing through it is so you guys

125

00:04:43,270 --> 00:04:41,120

so let's say i'm on a space station or

126
00:04:44,310 --> 00:04:43,280
i'm on the surface of mars i scoop up a

127
00:04:45,830 --> 00:04:44,320
sample

128
00:04:47,590 --> 00:04:45,840
i put it in there and that thing can

129
00:04:49,350 --> 00:04:47,600
actually tell me what it is

130
00:04:50,629 --> 00:04:49,360
that's the idea there's a few more steps

131
00:04:52,230 --> 00:04:50,639
in there

132
00:04:53,189 --> 00:04:52,240
so you have to extract cells from the

133
00:04:54,629 --> 00:04:53,199
dirt

134
00:04:56,629 --> 00:04:54,639
then you have to get the dna out of the

135
00:04:58,469 --> 00:04:56,639
cells and then do a little bit of uh

136
00:04:59,990 --> 00:04:58,479
library preparation

137
00:05:01,990 --> 00:05:00,000
but there's a number of teams and people

138
00:05:03,749 --> 00:05:02,000

that are working on ways to have either

139

00:05:05,270 --> 00:05:03,759

robots do that or to make it really easy

140

00:05:06,870 --> 00:05:05,280

for humans to do it so we got the

141

00:05:08,950 --> 00:05:06,880

sequencer in here with us is that one

142

00:05:10,870 --> 00:05:08,960

has that one been used before have you

143

00:05:12,390 --> 00:05:10,880

have you used it anywhere as cool as the

144

00:05:15,110 --> 00:05:12,400

rover yet

145

00:05:17,590 --> 00:05:15,120

almost as cool this one was used in the

146

00:05:19,830 --> 00:05:17,600

aquarius habitat as part of the nemo

147

00:05:21,430 --> 00:05:19,840

mission that's about 62 feet at the

148

00:05:23,830 --> 00:05:21,440

bottom of the ocean off the coast of key

149

00:05:26,150 --> 00:05:23,840

largo florida oh wow so we uh had the

150

00:05:27,830 --> 00:05:26,160

aquanauts last july collect samples from

151
00:05:29,590 --> 00:05:27,840
their habitat prepare those samples for

152
00:05:31,830 --> 00:05:29,600
sequencing and then sequence what they

153
00:05:34,310 --> 00:05:31,840
found all right so we've sequenced dna

154
00:05:36,230 --> 00:05:34,320
underwater we've now done it in a rover

155
00:05:38,950 --> 00:05:36,240
but this thing's in space right now like

156
00:05:40,550 --> 00:05:38,960
how has it been working in space from

157
00:05:42,070 --> 00:05:40,560
what we could tell so far it's working

158
00:05:43,830 --> 00:05:42,080
even better in space

159
00:05:45,749 --> 00:05:43,840
so we've really exceeded our wildest

160
00:05:47,590 --> 00:05:45,759
expectations we actually had a pretty

161
00:05:49,510 --> 00:05:47,600
big milestone the other day where we

162
00:05:52,469 --> 00:05:49,520
passed our billionth base of dna

163
00:05:53,830 --> 00:05:52,479

sequencing space billion with a b yes

164

00:05:55,350 --> 00:05:53,840

billion with a b

165

00:05:58,150 --> 00:05:55,360

so the human genome is about three

166

00:05:59,430 --> 00:05:58,160

billion base pairs um and so for us to

167

00:06:01,590 --> 00:05:59,440

get a billion

168

00:06:04,469 --> 00:06:01,600

uh bases in space really gets us on that

169

00:06:06,390 --> 00:06:04,479

same scale which is pretty amazing

170

00:06:08,309 --> 00:06:06,400

all right we're here we made it to the

171

00:06:09,830 --> 00:06:08,319

meeting guys thanks so much for driving

172

00:06:12,230 --> 00:06:09,840

along with me makes it drive a whole lot

173

00:06:14,070 --> 00:06:12,240

more fun and awesome project can't wait

174

00:06:15,670 --> 00:06:14,080

to see more yeah thank you all right

175

00:06:18,300 --> 00:06:15,680

well we got our dna sequences so we're

176

00:06:25,270 --> 00:06:18,310

going to go analyze awesome all right

177

00:06:27,920 --> 00:06:25,280

[Music]