

Response time: < 1 millisecond

1 ms = 1 million picoseconds

Upon the absorption of light, there is a shift of electron density in rhodopsin which begins the photoisomerization process in about 1.8 picoseconds as measured by a 500 femtosecond laser pulse (Ju et al., 2003)

Recovery time: 300 milliseconds

Bacteriorhodopsin resets itself in about 10 ms, but over 99% of the protein resets in just 20 ms.



1
00:00:03,649 --> 00:00:02,330
you can't really do it in vivo it's not

2
00:00:06,050 --> 00:00:03,659
that not that easy I mean you certainly

3
00:00:07,610 --> 00:00:06,060
can't do it in a human eye and the

4
00:00:09,290 --> 00:00:07,620
rhodopsin has to be considered in many

5
00:00:11,320 --> 00:00:09,300
different lights and so we take a look

6
00:00:13,610 --> 00:00:11,330
at it by putting it on to an inorganic

7
00:00:15,470 --> 00:00:13,620
semiconductor let's just use gallium

8
00:00:17,420 --> 00:00:15,480
arsenide doesn't really matter but it's

9
00:00:20,300 --> 00:00:17,430
attached to a man-made inorganic

10
00:00:21,980 --> 00:00:20,310
semiconductor put the bacteria rhodopsin

11
00:00:23,950 --> 00:00:21,990
up there and take a look at it you shine

12
00:00:25,640 --> 00:00:23,960
light on it what happens a

13
00:00:28,910 --> 00:00:25,650

conformational change in the protein

14

00:00:30,919 --> 00:00:28,920

occurs so far so good and then it's

15

00:00:32,510 --> 00:00:30,929

detected by the inorganic semiconductor

16

00:00:34,100 --> 00:00:32,520

and then amplified for eventual

17

00:00:35,810 --> 00:00:34,110

detection by man sending somewhere in

18

00:00:37,490 --> 00:00:35,820

the laboratory right now well that's

19

00:00:39,770 --> 00:00:37,500

nice and this helps to give us an idea

20

00:00:43,280 --> 00:00:39,780

of how bacterial rhodopsin works and

21

00:00:46,340 --> 00:00:43,290

helps to get us some answers so this has

22

00:00:49,970 --> 00:00:46,350

been suggested thus far rhodopsin is

23

00:00:51,410 --> 00:00:49,980

very well known to be packed into RI why

24

00:00:53,869 --> 00:00:51,420

is that because if you've got a whole

25

00:00:55,639 --> 00:00:53,879

bunch of rays emanating from the back of

26

00:00:57,560 --> 00:00:55,649

the room and they are all parallel and

27

00:00:58,849 --> 00:00:57,570

they're going to hit the wall behind me

28

00:01:01,849 --> 00:00:58,859

how many of them are am I going to

29

00:01:02,990 --> 00:01:01,859

intercept very few no matter how fast I

30

00:01:04,789 --> 00:01:03,000

run back and forth we're not going to

31

00:01:06,710 --> 00:01:04,799

intercept that many the ones that I I

32

00:01:08,270 --> 00:01:06,720

detect great but most of them going to

33

00:01:10,580 --> 00:01:08,280

go to my right to my left to the top

34

00:01:11,899 --> 00:01:10,590

they're going to miss me and therefore I

35

00:01:13,850 --> 00:01:11,909

need to do something I need to clone

36

00:01:15,859 --> 00:01:13,860

myself now no matter how unattractive

37

00:01:17,960 --> 00:01:15,869

this may sound to some of you if i

38

00:01:20,450 --> 00:01:17,970

cloned myself and spread myself out i

39

00:01:21,830 --> 00:01:20,460

will be able to detect more why because

40

00:01:24,109 --> 00:01:21,840

these rays are going to be parallel and

41

00:01:25,789 --> 00:01:24,119

I've now increased my detection level it

42

00:01:27,740 --> 00:01:25,799

has been suggested by German researchers

43

00:01:30,830 --> 00:01:27,750

this is the way it has to be the insect

44

00:01:33,410 --> 00:01:30,840

is so ridiculously sensitive they must

45

00:01:36,520 --> 00:01:33,420

be packed in there the odorant receptors

46

00:01:39,590 --> 00:01:36,530

must be packed so they take a look

47

00:01:42,740 --> 00:01:39,600

immunolabeling they're not there find a

48

00:01:44,749 --> 00:01:42,750

few there's nowhere near what we are

49

00:01:45,950 --> 00:01:44,759

needed and so this is a problem as a

50

00:01:47,810 --> 00:01:45,960

matter of fact we found more other

51
00:01:50,210 --> 00:01:47,820
proteins than we found of the putative

52
00:01:51,649 --> 00:01:50,220
odorant receptors sensory neuron

53
00:01:54,050 --> 00:01:51,659
membrane proteins are found in a higher

54
00:01:57,289 --> 00:01:54,060
concentration than the putative odorant

55
00:01:58,730 --> 00:01:57,299
receptors this is a problem what is

56
00:02:01,300 --> 00:01:58,740
going on here based on the current

57
00:02:03,469 --> 00:02:01,310
paradigm I've got my son Silla a

58
00:02:06,109 --> 00:02:03,479
pheromone comes in it's going to impact

59
00:02:07,760 --> 00:02:06,119
at a specific point that specific point

60
00:02:08,990 --> 00:02:07,770
is going to be right there it's not

61
00:02:10,550 --> 00:02:09,000
going to be on the other side it's only

62
00:02:12,260 --> 00:02:10,560
going to be at that specific point that

63
00:02:13,790 --> 00:02:12,270

pheromone will go through a pore at that

64

00:02:14,900 --> 00:02:13,800

specific point

65

00:02:16,370 --> 00:02:14,910

that pheromone will then hit the

66

00:02:18,800 --> 00:02:16,380

dendrite very close to that particular

67

00:02:21,860 --> 00:02:18,810

point it's a point effect is this the

68

00:02:23,630 --> 00:02:21,870

way an antenna works no and antenna

69

00:02:25,460 --> 00:02:23,640

works if you've got an electromagnetic

70

00:02:27,890 --> 00:02:25,470

frequency and the antenna is detecting

71

00:02:29,990 --> 00:02:27,900

it is not a point affect the whole

72

00:02:32,630 --> 00:02:30,000

antenna will light up in a more or less

73

00:02:34,400 --> 00:02:32,640

fashion like this so if it's based upon

74

00:02:35,510 --> 00:02:34,410

antenna theory which I'm espousing right

75

00:02:38,510 --> 00:02:35,520

now you're going to have a different way

76

00:02:40,100 --> 00:02:38,520

of detecting it a conductor is a

77

00:02:42,440 --> 00:02:40,110

substance or body capable of

78

00:02:47,510 --> 00:02:42,450

transmitting electricity heat or sound

79

00:02:49,940 --> 00:02:47,520

the antonym would be an insulator but a

80

00:02:52,240 --> 00:02:49,950

semi conductor any of a class of solids

81

00:02:54,830 --> 00:02:52,250

whose electrical conductivity is between

82

00:02:56,120 --> 00:02:54,840

that of a conductor in an insulator and

83

00:02:58,210 --> 00:02:56,130

this is what we're dealing with right

84

00:03:00,350 --> 00:02:58,220

now at least that's what I'm proposing a

85

00:03:02,680 --> 00:03:00,360

protein semiconductor is a semi

86

00:03:06,050 --> 00:03:02,690

conductor god bless you with a protein

87

00:03:07,340 --> 00:03:06,060

constituent a protein constituent so

88

00:03:09,800 --> 00:03:07,350

proteins are able to detect

89

00:03:12,260 --> 00:03:09,810

electromagnetic frequencies well known

90

00:03:13,550 --> 00:03:12,270

great field going on out there so I told

91

00:03:16,250 --> 00:03:13,560

you what response time of one

92

00:03:19,220 --> 00:03:16,260

millisecond one millisecond equals 1

93

00:03:20,810 --> 00:03:19,230

million picoseconds the researchers have

94

00:03:22,580 --> 00:03:20,820

taken a look at this upon the absorption

95

00:03:25,160 --> 00:03:22,590

of light there is a shift of electron

96

00:03:28,660 --> 00:03:25,170

density in rhodopsin which begins the

97

00:03:31,880 --> 00:03:28,670

photoisomerization process and about 1.6

98

00:03:33,949 --> 00:03:31,890

picoseconds as measured by a 500m to a

99

00:03:35,870 --> 00:03:33,959

second laser well that's great that's

100

00:03:37,490 --> 00:03:35,880

plenty of time may now I've got a

101
00:03:38,870 --> 00:03:37,500
mechanism that works within the time

102
00:03:41,120 --> 00:03:38,880
period that I need which is one

103
00:03:42,979 --> 00:03:41,130
millisecond Alonso take to recover it's

104
00:03:45,199 --> 00:03:42,989
about 300 milliseconds what about

105
00:03:47,420 --> 00:03:45,209
bacteria rhodopsin resets itself in

106
00:03:48,979 --> 00:03:47,430
about 10 milliseconds well this is great

107
00:03:50,390 --> 00:03:48,989
this again gives me plenty of time

108
00:03:52,190 --> 00:03:50,400
because ninety eight percent of it is

109
00:03:54,740 --> 00:03:52,200
going to be reset in just 20

110
00:03:57,560 --> 00:03:54,750
milliseconds so it's fast detection it's

111
00:03:59,390 --> 00:03:57,570
fast recovery this is looking good it

112
00:04:01,280 --> 00:03:59,400
has been shown now for some of you may

113
00:04:02,540 --> 00:04:01,290

not think well this is this is nice Tom

114

00:04:04,490 --> 00:04:02,550

but this is I need some more evidence

115

00:04:06,680 --> 00:04:04,500

can you give me something more I'll be

116

00:04:10,070 --> 00:04:06,690

happy to it has been shown that upon

117

00:04:13,910 --> 00:04:10,080

strong illumination rhabdo meter real

118

00:04:15,410 --> 00:04:13,920

skeleton shows structural changes so

119

00:04:18,020 --> 00:04:15,420

they take the light and they hit the RAB

120

00:04:19,699 --> 00:04:18,030

de marde this causes structural changes

121

00:04:21,349 --> 00:04:19,709

in the cytoskeleton it's a very

122

00:04:23,750 --> 00:04:21,359

interesting response it's not really

123

00:04:26,480 --> 00:04:23,760

seen that much but it's an interesting

124

00:04:27,770 --> 00:04:26,490

characteristic Kumar and killed two

125

00:04:29,450 --> 00:04:27,780

german researchers of

126

00:04:31,820 --> 00:04:29,460

on that pheromone stimulation not just

127

00:04:34,820 --> 00:04:31,830

any stimulation but high pheromone

128

00:04:37,400 --> 00:04:34,830

stimulation induces cytoskeletal changes

129

00:04:39,500 --> 00:04:37,410

in olfactory dendrites of the male

130

00:04:41,240 --> 00:04:39,510

Saturn I at Moss beautiful I've got

131

00:04:43,159 --> 00:04:41,250

another connection let me give you

132

00:04:45,409 --> 00:04:43,169

another connection g-protein coupled

133

00:04:47,510 --> 00:04:45,419

receptors proteins belong to many

134

00:04:48,950 --> 00:04:47,520

different families one of the more

135

00:04:51,170 --> 00:04:48,960

common ones are the g-protein coupled

136

00:04:53,240 --> 00:04:51,180

receptors they are known as seven

137

00:04:55,340 --> 00:04:53,250

transmembrane alpha helix structures

138

00:04:58,159 --> 00:04:55,350

they pass through the membrane seven

139

00:05:00,350 --> 00:04:58,169

times the g-protein coupled receptors I

140

00:05:02,240 --> 00:05:00,360

talked about in human olfaction is the

141

00:05:04,520 --> 00:05:02,250

same thing as what you find in the

142

00:05:06,680 --> 00:05:04,530

insects the odorant receptors are the

143

00:05:08,630 --> 00:05:06,690

same and so when I'm proposing on this

144

00:05:10,159 --> 00:05:08,640

last slide right now is when the

145

00:05:12,500 --> 00:05:10,169

pheromone molecules get close to the

146

00:05:14,659 --> 00:05:12,510

sencilla they light up as detected by

147

00:05:17,420 --> 00:05:14,669

protein semiconductors and this is how

148

00:05:18,830 --> 00:05:17,430

my theory is now being put forward thank

149

00:05:27,200 --> 00:05:18,840

you very much for your time appreciate

150

00:05:28,820 --> 00:05:27,210

it okay we have a few minutes for

151

00:05:37,040 --> 00:05:28,830

questions and I already see one arm

152

00:05:39,620 --> 00:05:37,050

raised Francesca McCartney hi Francesca

153

00:05:42,140 --> 00:05:39,630

I would you comment or do you have a

154

00:05:44,029 --> 00:05:42,150

comment on Luca turns off faction

155

00:05:45,830 --> 00:05:44,039

research I'd be happy to comment on that

156

00:05:47,990 --> 00:05:45,840

Luca torrents olfaction research is

157

00:05:49,940 --> 00:05:48,000

based upon the vibrational energy the

158

00:05:51,950 --> 00:05:49,950

same as the insects the problem is that

159

00:05:53,750 --> 00:05:51,960

Luca turns Theory looks at electron

160

00:05:55,219 --> 00:05:53,760

tunneling which is a fundamentally

161

00:05:57,320 --> 00:05:55,229

different theory than the dielectric

162

00:06:00,529 --> 00:05:57,330

antenna theory and so if you take a look

163

00:06:02,480 --> 00:06:00,539

at how these two mechanisms lineup they

164

00:06:03,860 --> 00:06:02,490

don't they're still looking at the

165

00:06:05,420 --> 00:06:03,870

vibrational energy but it's two

166

00:06:07,730 --> 00:06:05,430

different ways of looking at the

167

00:06:08,930 --> 00:06:07,740

vibrational energies on the two even

168

00:06:10,610 --> 00:06:08,940

though I support what he's doing and

169

00:06:11,960 --> 00:06:10,620

I've communicated with them we don't

170

00:06:15,140 --> 00:06:11,970

have much to talk about because we're

171

00:06:18,650 --> 00:06:15,150

looking at two different things next

172

00:06:22,700 --> 00:06:18,660

question / yes Glen Rhine I assume that

173

00:06:26,120 --> 00:06:22,710

bugs can smell in the dark yes so your

174

00:06:28,940 --> 00:06:26,130

theory requires light activation of the

175

00:06:31,070 --> 00:06:28,950

semi conductor mechanism no I never said

176

00:06:33,950 --> 00:06:31,080

that because you told us a lot about how

177

00:06:35,660 --> 00:06:33,960

light activates the semiconductors so

178

00:06:37,730 --> 00:06:35,670

that's one half of the question

179

00:06:39,970 --> 00:06:37,740

the other half of the question is why do

180

00:06:42,560 --> 00:06:39,980

you need an intimate intermediary

181

00:06:44,870 --> 00:06:42,570

protein molecule to act as the

182

00:06:47,540 --> 00:06:44,880

transducer when electromagnetic fields

183

00:06:49,580 --> 00:06:47,550

can directly affect receptors at least

184

00:06:51,020 --> 00:06:49,590

in mammalian systems and an

185

00:06:54,200 --> 00:06:51,030

electromagnetic field can propagate

186

00:06:55,910 --> 00:06:54,210

right through the whole center part of

187

00:06:58,790 --> 00:06:55,920

whatever you called it and activate the

188

00:07:00,080 --> 00:06:58,800

cytoplasmic receptor yes it is still

189

00:07:01,670 --> 00:07:00,090

possible that that is happening the

190

00:07:03,560 --> 00:07:01,680

reason why I consider that unlikely is

191

00:07:05,930 --> 00:07:03,570

because the neuronal response is so

192

00:07:07,970 --> 00:07:05,940

clean and so basic that it I do believe

193

00:07:10,490 --> 00:07:07,980

that a protein is allowing ions to enter

194

00:07:12,290 --> 00:07:10,500

a neuronal response is all about I on

195

00:07:14,930 --> 00:07:12,300

interchange calcium influx was talked

196

00:07:16,220 --> 00:07:14,940

about in Lucas's talk earlier on is

197

00:07:17,420 --> 00:07:16,230

really nothing different here and

198

00:07:20,690 --> 00:07:17,430

therefore you're going to need a protein

199

00:07:22,760 --> 00:07:20,700

in order to have ions come in and set

200

00:07:24,350 --> 00:07:22,770

the normal neuronal response so

201
00:07:28,120 --> 00:07:24,360
therefore I do believe that proteins are

202
00:07:31,700 --> 00:07:28,130
involved however it's not necessary um

203
00:07:34,880 --> 00:07:31,710
is short antenna theory small antenna

204
00:07:38,360 --> 00:07:34,890
much smaller than wavelength resonant

205
00:07:41,120 --> 00:07:38,370
antennas part of this no actually these

206
00:07:43,880 --> 00:07:41,130
antennae or sencilla are set up at about

207
00:07:45,230 --> 00:07:43,890
the right wavelength for the infrared

208
00:07:47,060 --> 00:07:45,240
frequencies which are coming from the

209
00:07:48,470 --> 00:07:47,070
vibrational molecules now as you know

210
00:07:49,610 --> 00:07:48,480
they don't have to line up or as you

211
00:07:51,380 --> 00:07:49,620
mate I'm not sure what your background

212
00:07:52,310 --> 00:07:51,390
is but they don't have to line up

213
00:07:53,990 --> 00:07:52,320

perfectly doesn't have to be a

214

00:07:57,290 --> 00:07:54,000

one-to-one but it has to be pretty close

215

00:07:59,420 --> 00:07:57,300

and they are close good question good

216

00:08:03,080 --> 00:07:59,430

antenna question can you relate this to

217

00:08:06,800 --> 00:08:03,090

the the way the dendrites on neural

218

00:08:08,120 --> 00:08:06,810

neurons in the brain work related to

219

00:08:11,600 --> 00:08:08,130

wood that way neurons in the brain

220

00:08:15,050 --> 00:08:11,610

actually yeah actually this is a

221

00:08:16,910 --> 00:08:15,060

question which is outside the my talk it

222

00:08:19,250 --> 00:08:16,920

would not be easy to do so because the

223

00:08:21,710 --> 00:08:19,260

vertebrate neuron is much much much

224

00:08:25,490 --> 00:08:21,720

simpler than the insect neuron and I'm

225

00:08:27,350 --> 00:08:25,500

so happy to say that insect neurons are

226

00:08:28,820 --> 00:08:27,360

far more complicated vertebrate neurons

227

00:08:30,290 --> 00:08:28,830

are very simple that just you know

228

00:08:32,120 --> 00:08:30,300

you'll have you know billions of them

229

00:08:33,350 --> 00:08:32,130

whereas the insect neurons because

230

00:08:35,870 --> 00:08:33,360

there's only a few hundred thousand of

231

00:08:37,490 --> 00:08:35,880

them are much more diverse and have very

232

00:08:39,500 --> 00:08:37,500

different capabilities so to make a

233

00:08:42,230 --> 00:08:39,510

comparison I just can't I just can't and

234

00:08:44,540 --> 00:08:42,240

I'm sorry Tom and your last slide here

235

00:08:46,760 --> 00:08:44,550

it seems to me you're showing pheromone

236

00:08:48,860 --> 00:08:46,770

molecules directly simulating the

237

00:08:51,650 --> 00:08:48,870

antenna but surely you mean

238

00:08:54,740 --> 00:08:51,660

electromagnetic emission or property of

239

00:08:56,570 --> 00:08:54,750

the ligand stimulating the antenna can

240

00:08:58,310 --> 00:08:56,580

you explain what you mean exactly well

241

00:09:02,570 --> 00:08:58,320

not a ligand in the sense that there is

242

00:09:03,860 --> 00:09:02,580

binding ligan would suggest binding yeah

243

00:09:05,240 --> 00:09:03,870

yeah what these are these are fair and

244

00:09:07,430 --> 00:09:05,250

more molecules that are impacting the

245

00:09:08,690 --> 00:09:07,440

outside of the sencilla what I am saying

246

00:09:11,570 --> 00:09:08,700

is that the pheromone is not actually

247

00:09:13,910 --> 00:09:11,580

getting inside the sencilla which is a

248

00:09:16,010 --> 00:09:13,920

necessary prerequisite in order for the

249

00:09:17,810 --> 00:09:16,020

dendrite to detect it according to the

250

00:09:19,850 --> 00:09:17,820

current theory of insect olfaction

251
00:09:21,950 --> 00:09:19,860
because they need the lock and key that

252
00:09:23,420 --> 00:09:21,960
pheromone needs to get in there with my

253
00:09:25,360 --> 00:09:23,430
system it just it needs to get on the

254
00:09:28,070 --> 00:09:25,370
outside of it or in very close proximity

255
00:09:30,320 --> 00:09:28,080
set off the antenna and boom the antenna

256
00:09:33,829 --> 00:09:30,330
lights up in this beautiful display that

257
00:09:36,530 --> 00:09:33,839
I've set before you right now Jim

258
00:09:38,390 --> 00:09:36,540
beekler couldn't you test this by

259
00:09:39,950 --> 00:09:38,400
getting rid of pheromones and finding

260
00:09:41,690 --> 00:09:39,960
the resonant frequency and just seeing

261
00:09:44,329 --> 00:09:41,700
the antenna with that resonant frequency

262
00:09:46,220 --> 00:09:44,339
and see how the insects react I can't do

263
00:09:47,810 --> 00:09:46,230

that great question though it's been

264

00:09:49,519 --> 00:09:47,820

talked about for many many years the

265

00:09:51,079 --> 00:09:49,529

reason why is if you take a look at the

266

00:09:52,640 --> 00:09:51,089

vibrational frequencies of a given

267

00:09:54,590 --> 00:09:52,650

pheromone molecule does more than one

268

00:09:57,980 --> 00:09:54,600

there's more than two there's more than