

0-Week 2020 Special Lecture Series

9 September 2020

Topic: Space Exploration A Source of Technology Transfer in the Canadian Agri-Food Sectors

Presenter: Dr. Mike Dixon

WEBVTT

00:00:12.087 --> 00:00:15.507

name Shari Dorr and I'm the Coordinator of the Undergraduate Academic Information.

00:00:15.507 --> 00:00:18.687

Center. I'm just going to quickly introduce you to Mike.

00:00:18.687 --> 00:00:22.467

Dixon, who is a professor in our school of Environmental Sciences.

00:00:22.467 --> 00:00:25.667

and the director of the controlled environment systems research.

00:00:25.667 --> 00:00:28.827

facility is. Research is focused on plant.

00:00:28.827 --> 00:00:32.307

growth in controlled environment and he specifically interested.

00:00:32.307 --> 00:00:35.907

in developing biological life support systems for applications.

00:00:35.907 --> 00:00:37.517

in space exploration.

00:00:38.247 --> 00:00:41.417

So at this point I'm going to change.

00:00:41.417 --> 00:00:45.087

um the image that you see from mikes picture

00:00:45.087 --> 00:00:48.337

er to his presentation an I'm.

00:00:48.337 --> 00:00:51.397

going to mute my microphone and let Mike take.

00:00:51.397 --> 00:00:54.437

over. You'll notice in the right hand bar that you.

00:00:54.437 --> 00:00:57.747

have access to a Q&A. Please post your questions there.

00:00:57.747 --> 00:01:00.837

an will either answer them along the way or promote them for Mike to.

00:01:00.837 --> 00:01:02.877

answer at the end. Enjoy.

00:01:03.847 --> 00:01:07.257
Sherry, I'm on.

00:01:07.257 --> 00:01:07.257

00:01:09.387 --> 00:01:09.847

00:01:13.607 --> 00:01:17.447
I've gotta stop sharing thing here.

00:01:17.447 --> 00:01:17.447

00:01:19.647 --> 00:01:20.397
How's that?

00:01:21.077 --> 00:01:24.177
I have your screen's live for myself.

00:01:24.177 --> 00:01:27.867
Is that it OK, so.

00:01:27.867 --> 00:01:27.867

00:01:28.857 --> 00:01:31.967
I guess everybody can see this. I have virtual.

00:01:31.967 --> 00:01:35.667
nodding of heads from you all, as Sherry said, I'm Mike Dixon.

00:01:35.667 --> 00:01:39.427
and I've spent the last big.

00:01:39.427 --> 00:01:42.647
chunk of my professional career pursuing space.

00:01:42.647 --> 00:01:45.747
exploration as a research agenda. And what?

00:01:45.747 --> 00:01:49.047
I'm going to talk about today is the role.

00:01:49.047 --> 00:01:52.627
that our program plays in technology.

00:01:52.627 --> 00:01:55.957
transfer to the agrifood sector.

00:01:55.957 --> 00:01:59.427
So food determines.

00:01:59.427 --> 00:01:59.427

00:02:00.347 --> 00:02:03.607

Literally, how far from Earth we can go and how long.

00:02:03.607 --> 00:02:06.647

we can stay. But there are some pretty.

00:02:06.647 --> 00:02:08.807

significant technical challenges.

00:02:10.187 --> 00:02:13.507

I guess I can ask for hands up, but I won't see it, who's?

00:02:13.507 --> 00:02:17.117

seen the Martian with Matt Damon and that movie?

00:02:17.117 --> 00:02:20.497

personified? The challenge?

00:02:20.497 --> 00:02:24.057

of going to space and.

00:02:24.057 --> 00:02:27.077

if you all recall Matt Damon doing?

00:02:27.077 --> 00:02:30.237

arithmetic with the potatoes to determine how long he could

00:02:30.237 --> 00:02:33.737

ould survive and that arithmetic?

00:02:33.737 --> 00:02:36.947

is precisely what we explore in.

00:02:36.947 --> 00:02:41.127

our program at Guelph, the.

00:02:41.127 --> 00:02:41.127

00:02:41.197 --> 00:02:44.427

Life support contributions that plants make it determined.

00:02:44.427 --> 00:02:47.447

by food. Food as I said, determines.

00:02:47.447 --> 00:02:51.377

w far from earth we can go and how long we can stay and

00:02:51.377 --> 00:02:54.647

nd being able to produce food recycle.

00:02:54.647 --> 00:02:58.077

eshwater scrub CO₂ and produce oxygen

00:02:58.077 --> 00:03:01.287

gen. Those are all the contributions that plants make to human life.

00:03:01.287 --> 00:03:04.667

support, and that's exactly what we do everything.

00:03:04.667 --> 00:03:08.247

we do is pulled by that technical challenge, but.

00:03:08.247 --> 00:03:11.047

since today this at this moment.

00:03:11.207 --> 00:03:14.217

I don't yet have a mission to go to the moon or.

00:03:14.217 --> 00:03:17.537

Mars, although that's coming very quickly. I don't yet have a mission.

00:03:17.537 --> 00:03:20.637

to go to the moon or Mars and grow plants for human life support.

00:03:20.637 --> 00:03:23.657

or advance that technology requirement so.

00:03:23.657 --> 00:03:26.687

no mission, no money so.

00:03:26.687 --> 00:03:30.077

all of our work is actually driven by.

00:03:30.077 --> 00:03:33.127

industry partners in the agrifood sector.

00:03:33.127 --> 00:03:36.627

in the aerospace sector, who are sort of feeding on.

00:03:36.627 --> 00:03:39.657

ing edge of technologies as we develop them.

00:03:39.657 --> 00:03:43.897

to overcome the challenges of really harsh environments and.

00:03:43.897 --> 00:03:43.897

00:03:43.947 --> 00:03:47.137

One of the obvious applications that you might.

00:03:47.137 --> 00:03:50.297

be able to consider is food in the north.

00:03:50.297 --> 00:03:53.697

food security in northern Canada or another harsh environments.

00:03:53.697 --> 00:03:56.727

on Earth. The technologies that we developed for.

00:03:56.727 --> 00:03:59.967

the moon and Mars are very at home in A.

00:03:59.967 --> 00:04:03.437

snowbank in Yellowknife and the and the deserts of the Middle East.

00:04:03.437 --> 00:04:03.437

00:04:04.567 --> 00:04:08.187

So this is what we do, investigate contributions.

00:04:08.187 --> 00:04:11.347

and plants to human life support. And remember that food.

00:04:11.347 --> 00:04:14.457

oxygen scrubbing C2 and recycling water, there's going.

00:04:14.457 --> 00:04:18.087

to be a quiz. And here's don't.

00:04:18.087 --> 00:04:21.447

memorize this list. But this exemplifies the.

00:04:21.447 --> 00:04:24.907

challenge, the technical requirements, and just.

00:04:24.907 --> 00:04:28.387

I should highlight the top two mass.

00:04:28.387 --> 00:04:31.797

and energy. They are the Currency.

00:04:31.797 --> 00:04:33.047

of space travel.

00:04:34.237 --> 00:04:37.647

What most people don't appreciate is that you spend the money.

00:04:37.647 --> 00:04:41.487

in the Canadian economy. So our challenge is.

00:04:41.487 --> 00:04:45.497

reduce the mass and energy cost of space exploration.

00:04:45.497 --> 00:04:49.247

So you want everything to be light as possible so that users is little.

00:04:49.247 --> 00:04:52.467

nergy and you want the energy requiring.

00:04:52.467 --> 00:04:56.487

activities like growing plants, for example to.

00:04:56.487 --> 00:04:59.507

e as energy efficient as possible so.

00:04:59.507 --> 00:05:03.347

we do a lot of work developing technologies.

00:05:03.347 --> 00:05:06.657

es. One of the quest first questions we ask over 20 years ago was.

00:05:06.657 --> 00:05:06.657

00:05:06.707 --> 00:05:09.977

How low can you take the atmospheric pressure and?

00:05:09.977 --> 00:05:13.117

still have plans? Pruitt providing all the functions of human.

00:05:13.117 --> 00:05:16.977

life support and that addresses directly the.

00:05:16.977 --> 00:05:20.117

ssue of mass some of the chambers

00:05:20.117 --> 00:05:23.497

rs I'm going to show you the can take.

00:05:23.497 --> 00:05:26.897

the pressure difference between full earth atmosphere.

00:05:26.897 --> 00:05:29.957

and a vacuum, but they small.

00:05:29.957 --> 00:05:33.037

volume that they can grow the chambers way 8.

00:05:33.037 --> 00:05:36.297

tons. So clearly we want to.

00:05:36.297 --> 00:05:36.747

get them.

00:05:36.807 --> 00:05:39.827

Sit down and we do that by reusing the.

00:05:39.827 --> 00:05:43.567

pressure to the point where we can consider, for example.

00:05:43.567 --> 00:05:46.777

inflatable structures. Low mass inflatable.

00:05:46.777 --> 00:05:49.957

structures, such as they would have on Mars.

00:05:49.957 --> 00:05:49.957

00:05:50.867 --> 00:05:54.497

So here's some of the chambers historically.

00:05:54.497 --> 00:05:57.557

I guess if you just go in a bit of a circle, the top.

00:05:57.557 --> 00:06:00.667

left is the first chambers they date back.

00:06:00.667 --> 00:06:03.717

25 years. That's the origin of the salsa.

00:06:03.717 --> 00:06:07.217

am space advanced life support agriculture you gotta have

00:06:07.217 --> 00:06:11.677

ta have a sexy acronym in the space program and that's hours and.

00:06:11.677 --> 00:06:15.397

those two chambers exist today. They are the largest.

00:06:15.397 --> 00:06:18.417

completely sealed, controlled environment. And what?

00:06:18.417 --> 00:06:21.897

we do in all of these chambers, they all have the same.

00:06:21.897 --> 00:06:21.897

00:06:21.947 --> 00:06:25.737

Basic fundamental physical configuration.

00:06:25.737 --> 00:06:28.937

in that they can be completely sealed and.

00:06:28.937 --> 00:06:32.067

then we exercise what we call high fidelity.

00:06:32.067 --> 00:06:35.517

environment control of carbon.

00:06:35.517 --> 00:06:38.617

dioxide light not only light intensity.

00:06:38.617 --> 00:06:42.397

but like quality, temperature, humidity, nutrients and.

00:06:42.397 --> 00:06:45.587

water, and those six or seven environment.

00:06:45.587 --> 00:06:48.757

variables comprise basically farming if you think.

00:06:48.757 --> 00:06:51.777

about it and that comprises the story.

00:06:51.777 --> 00:06:52.977

we pursue.

00:06:53.027 --> 00:06:57.257

To create standardized.

00:06:57.257 --> 00:07:00.017

conditions to achieve nutritional.

00:07:01.167 --> 00:07:04.237

Security food security in.

00:07:04.237 --> 00:07:07.597

space exploration, but also now food security in places.

00:07:07.597 --> 00:07:10.737

like northern Canada and whatnot. So these chambers are designed.

00:07:10.737 --> 00:07:13.857

to address exactly how to come up with that.

00:07:13.857 --> 00:07:17.017

environment control recipe now, here's a quick little video.

00:07:17.017 --> 00:07:18.027

I want to show you.

00:07:18.777 --> 00:07:22.107

Where we were looking at that reduced pressure and.

00:07:22.107 --> 00:07:25.227

up in the upper left corner you're going to see a pressure gauge.

00:07:25.227 --> 00:07:28.497

is a really fuzzy video was made long time ago so.

00:07:28.497 --> 00:07:32.127

prior to really good digital technology and.

00:07:32.127 --> 00:07:35.147

what it is, some sweet pepper.

00:07:35.147 --> 00:07:38.177

per plants stuck inside one of our pressurized

00:07:38.177 --> 00:07:41.257

reduced pressure Chambers Hypobaric.

00:07:41.257 --> 00:07:44.287

Chambers so called and we're progressively just.

00:07:44.287 --> 00:07:47.367

dropping the pressure. You'll see the gauge of fuzzy little gauge up in the.

00:07:47.367 --> 00:07:50.607

upper left corner, progressively dropping the pressure.

00:07:50.607 --> 00:07:50.607

00:07:50.657 --> 00:07:53.727

An watching the plants with the.

00:07:53.727 --> 00:07:56.967

camera and trying to figure out whether they like.

00:07:56.967 --> 00:07:58.667

it or not, so here goes this.

00:08:00.477 --> 00:08:03.707

And apologies to Mr Mercury.

00:08:03.707 --> 00:08:03.727

00:08:04.497 --> 00:08:05.267

And others.

00:08:06.857 --> 00:08:07.897

Stealing this song.

00:08:09.497 --> 00:08:13.447

So here we are, full earth atmosphere 100 pascals, roughly.

00:08:13.447 --> 00:08:17.277

o watch that little arrow. Now we've jumped down to 70%.

00:08:18.997 --> 00:08:19.417

Here.

00:08:20.057 --> 00:08:20.557

00:08:21.567 --> 00:08:23.107

And using plants from.

00:08:25.097 --> 00:08:25.887

I don't mind it.

00:08:28.557 --> 00:08:28.727

And.

00:08:29.597 --> 00:08:30.037

Yeah.

00:08:32.247 --> 00:08:33.327
Special teams.

00:08:41.187 --> 00:08:41.467
So.

00:08:44.737 --> 00:08:48.427

00:08:50.757 --> 00:08:51.067

00:08:52.137 --> 00:08:52.387
Yeah.

00:09:03.427 --> 00:09:03.697
Yeah.

00:09:08.567 --> 00:09:08.997
Thanks.

00:09:10.937 --> 00:09:13.017
Now watch this.

00:09:16.067 --> 00:09:17.087
And the client's recovery.

00:09:18.417 --> 00:09:19.937
Entirely, thank you.

00:09:21.307 --> 00:09:21.907
With you.

00:09:24.987 --> 00:09:25.397
This.

00:09:28.347 --> 00:09:28.937
Steps.

00:09:30.467 --> 00:09:33.497
Troll water in the atmosphere the plants.

00:09:33.497 --> 00:09:36.577
wilted and if any of you saw the original.

00:09:36.577 --> 00:09:39.897
Myers movie, what was it with?

00:09:39.897 --> 00:09:43.277
Arnold Schwarzenegger where he fell out of the mars habitat and what do?

00:09:43.277 --> 00:09:46.417
you do? He started to explode, right? 'cause?

00:09:46.417 --> 00:09:49.927
of the pressure difference between him? And they almost vacuum of Mars?

00:09:49.927 --> 00:09:53.047
These plants did exactly the opposite intuitively backwards.

00:09:53.047 --> 00:09:56.177
They collapsed. That was because.

00:09:56.177 --> 00:09:59.197
we weren't controlling vapor pressure. Humidity in the chamber.

00:09:59.197 --> 00:10:00.597
very well at the time.

00:10:00.897 --> 00:10:04.087
And they wilted. So we've.

00:10:04.087 --> 00:10:07.427
since fixed that we can control vapor pressure. We can.

00:10:07.427 --> 00:10:10.487
grow plants at 110th of earths atmosphere. Now you'll be happy.

00:10:10.487 --> 00:10:13.887
to hear and so why

00:10:13.887 --> 00:10:17.407
do I keep this demonstration of our inability technically?

00:10:17.407 --> 00:10:20.867
Because to the nasa engineers.

00:10:20.867 --> 00:10:23.987
who look at plant biology as a vulnerable technology.

00:10:23.987 --> 00:10:27.147
for life support machine, if you will, here's your.

00:10:27.147 --> 00:10:30.457
d production system your oxygen generator

00:10:30.457 --> 00:10:32.167
our C2 scrubber.

00:10:32.217 --> 00:10:35.717
And your fresh water recycling machine, it broke.

00:10:35.717 --> 00:10:35.717

00:10:36.297 --> 00:10:40.387
And it fixed itself. There is no technology.

00:10:40.387 --> 00:10:43.417

it currently in the current in the conventional physical.

00:10:43.417 --> 00:10:46.927

chemical life support systems for space exploration.

00:10:46.927 --> 00:10:50.067

that can do that. So plants are pretty tough.

00:10:50.067 --> 00:10:53.267

and they've demonstrated that here, so we have quite an array.

00:10:53.267 --> 00:10:56.427

of chambers and different lighting systems we developed.

00:10:56.427 --> 00:10:59.487

high intensity customer LED lighting.

00:10:59.487 --> 00:11:02.687

that can generate up to five times the intensity.

00:11:02.687 --> 00:11:05.467

of the Sun, which you don't use but.

00:11:06.287 --> 00:11:09.737

It gives you the experimental.

00:11:09.737 --> 00:11:12.967

power to do some pretty profoundly useful research.

00:11:12.967 --> 00:11:16.427

on how plants respond to lighting.

00:11:16.427 --> 00:11:19.897

spectral quality and intensity, and these chambers.

00:11:19.897 --> 00:11:22.947

are just more of the array. We also.

00:11:22.947 --> 00:11:26.157

have gone into harsh environments on Earth.

00:11:26.157 --> 00:11:29.377

Here's a greenhouse that we built on in the Arctic.

00:11:29.377 --> 00:11:32.537

the high Arctic. It was dubbed the Arthur.

00:11:32.537 --> 00:11:35.677

C Clarke Mars Greenhouse. He allowed us to use his name.

00:11:35.677 --> 00:11:37.367

just before he died, actually.

00:11:37.617 --> 00:11:40.707

So we built a greenhouse in the Arctic and used it to.

00:11:40.707 --> 00:11:44.167
demonstrate remote control.

00:11:44.167 --> 00:11:47.227
an automated activity in a harsh environment.

00:11:47.227 --> 00:11:50.367
so that we could grow plants, grow food.

00:11:50.367 --> 00:11:53.587
grow life, support machines in harsh environments.

00:11:53.587 --> 00:11:56.947
remotely and automatically, and we successfully demonstrated that.

00:11:56.947 --> 00:12:00.127
ran that greenhouse in the Arctic for 10 or 11.

00:12:00.127 --> 00:12:02.877
years in the early part of this century.

00:12:03.957 --> 00:12:06.987
And here we're also in the Antarctic. This is happening.

00:12:06.987 --> 00:12:10.727
right now. There's a project called Eden ISS.

00:12:10.727 --> 00:12:13.387
in collaboration with the European Union.

00:12:14.887 --> 00:12:17.967
Horizon 2020 program. We've collaborated.

00:12:17.967 --> 00:12:21.587
with 14 international institutions around the world.

00:12:21.587 --> 00:12:25.247
where the only Canadian Group and are we contributed.

00:12:25.247 --> 00:12:30.087
an element of that project. Growing food at the.

00:12:30.087 --> 00:12:34.117
way my are three in the Antarctic, which is a German exploration.

00:12:34.117 --> 00:12:37.167
site. Here's how you get there. Here they are.

00:12:37.167 --> 00:12:40.627
unloading our modules.

00:12:40.627 --> 00:12:44.547
from the ship that takes us down to the Antarctic, and.

00:12:44.547 --> 00:12:44.547

00:12:44.747 --> 00:12:46.477

Here's an aerial view.

00:12:47.297 --> 00:12:50.397

Of the Neumeyer 3 station and the.

00:12:50.397 --> 00:12:54.817

arrow points to that little Eden ISS module.

00:12:54.817 --> 00:12:57.847

stuck in the snow bank half a kilometer from the.

00:12:57.847 --> 00:13:00.887

station and we left a guy down there.

00:13:00.887 --> 00:13:02.027

for a year.

00:13:03.897 --> 00:13:07.407

Running the project and servicing.

00:13:07.407 --> 00:13:10.467

the perishable produce requirements of the.

00:13:10.467 --> 00:13:13.767

crew at Noy Meir 3 so that is still operating.

00:13:13.767 --> 00:13:15.487

at this at this time.

00:13:16.967 --> 00:13:20.027

And then some of the other technologies we've developed.

00:13:20.027 --> 00:13:23.177

is this high density.

00:13:23.177 --> 00:13:27.097

modular food production system that we developed for applications.

00:13:27.097 --> 00:13:30.437

in a wide variety of areas, but especially.

00:13:30.437 --> 00:13:33.617

in the north and in the deserts of the middle.

00:13:33.617 --> 00:13:36.857

East. So this is just a prototype of that system and you'll notice.

00:13:36.857 --> 00:13:40.197

that we're using red, white and blue lights, I mean.

00:13:40.197 --> 00:13:43.837

literally this was just for the heck of it and just to have some green stuff in the picture.

00:13:43.837 --> 00:13:48.317

And we grew this special variety of.

00:13:48.317 --> 00:13:48.317

00:13:48.377 --> 00:13:52.037

Of lettuce that has a little red streak in it, sort of.

00:13:52.037 --> 00:13:55.617

a designer lettuce. We grew it under the red, white or blue lights.

00:13:58.777 --> 00:14:02.127

These are genetically the same.

00:14:02.127 --> 00:14:05.307

They all come from the same seed lot, but.

00:14:05.307 --> 00:14:08.347

they are dramatically different the bio Mass.

00:14:08.347 --> 00:14:11.457

they red light produced the highest bio mass by almost.

00:14:11.457 --> 00:14:14.807

a factor of 2 compared to the blue and the white light and.

00:14:14.807 --> 00:14:17.887

of course there's the obvious differences in coloration.

00:14:17.887 --> 00:14:20.967

of the distribution of anthocyanin in.

00:14:20.967 --> 00:14:24.087

this case, that's what gives the lattices reddish color.

00:14:24.087 --> 00:14:27.387

And of course, the grad students in the lab did a blind taste.

00:14:27.387 --> 00:14:30.827

test an with 100% reliability.

00:14:30.827 --> 00:14:32.167

the students could all.

00:14:32.247 --> 00:14:35.417

Close your eyes and take a bite. All that's the blue.

00:14:35.417 --> 00:14:38.677

one. That's the red one. That's the white one and there.

00:14:38.677 --> 00:14:41.767

were distinctive differences in taste quality, actually.

00:14:41.767 --> 00:14:44.477

this was covered by the nature of things at one point as well.

00:14:45.767 --> 00:14:48.837

So here we have just some.

00:14:48.837 --> 00:14:52.157

subtle variations of the color of the light. All the.

00:14:52.157 --> 00:14:55.527

other environment variables are exactly the same in this production.

00:14:55.527 --> 00:14:58.617

system and just by changing the color of the light.

00:14:58.617 --> 00:15:02.337

I can change the size, shape, taste, color.

00:15:02.337 --> 00:15:05.857

of this plant and what that demonstrates.

00:15:05.857 --> 00:15:09.337

is some control over or.

00:15:09.337 --> 00:15:12.897

the ability to manipulate what are called secondary.

00:15:12.897 --> 00:15:16.277

metabolites. So chemistry that happens.

00:15:16.277 --> 00:15:19.477

downstream from primary photosynthesis where the plant just.

00:15:19.477 --> 00:15:20.727

sucks in C2 and.

00:15:20.857 --> 00:15:23.907

Make carbohydrates secondary metabolites.

00:15:23.907 --> 00:15:27.817

are things like colour and medicinal compounds.

00:15:27.817 --> 00:15:30.847

and nutritional compounds so we have a means now.

00:15:30.847 --> 00:15:34.227

with high fidelity environment control to manipulate.

00:15:34.227 --> 00:15:37.407

those outcomes in.

00:15:37.407 --> 00:15:40.967

producing plants for nutritional or medicinal applications.

00:15:40.967 --> 00:15:40.967

00:15:42.787 --> 00:15:46.017
And then along comes a cannabis.

00:15:46.017 --> 00:15:49.897
in recent times in Canada that changing laws.

00:15:49.897 --> 00:15:52.957
has opened a boom in research and technology development.

00:15:52.957 --> 00:15:56.857
for canvas production. What cannabis.

00:15:56.857 --> 00:16:00.217
shares with virtually all medicinal plants.

00:16:00.217 --> 00:16:03.317
the difficulties and the issue with.

00:16:03.317 --> 00:16:06.417
medicinal plants of any kind, be it cannabis.

00:16:06.417 --> 00:16:09.477
or cancer drugs. We're also working on a couple.

00:16:09.477 --> 00:16:12.677
of cancer drugs in our program, is that?

00:16:12.677 --> 00:16:12.677

00:16:12.957 --> 00:16:13.797
The plant.

00:16:15.167 --> 00:16:18.177
Never or rarely produces exactly the.

00:16:18.177 --> 00:16:21.497
same profile of medicinal compounds or nutritional.

00:16:21.497 --> 00:16:24.657
compounds etc. So we have a program it for the last.

00:16:24.657 --> 00:16:27.797
25 years that has pursued the technological.

00:16:27.797 --> 00:16:31.737
advancement of achieving.

00:16:31.737 --> 00:16:34.867
standardized nutritional composition of.

00:16:34.867 --> 00:16:38.137

food crops for space exploration so that Matt Damon.

00:16:38.137 --> 00:16:41.437
s arithmetic can be reliable in predicting.

00:16:41.437 --> 00:16:44.617
the life support contribution that this.

00:16:44.617 --> 00:16:47.017
nutritional content of these plants will.

00:16:47.097 --> 00:16:50.707
Will yield, we're just taking exactly the same technology.

00:16:50.707 --> 00:16:54.227
and shifting a little bit sideways into the phyto pharmaceutical.

00:16:54.227 --> 00:16:57.307
industry sector and applying exactly the same.

00:16:57.307 --> 00:17:00.947
he same technologies to you'll to yield standardized

00:17:00.947 --> 00:17:03.987
s of medicinal compounds in plants like.

00:17:03.987 --> 00:17:07.727
cannabis. And ultimately then, these.

00:17:07.727 --> 00:17:11.307
lants will achieve the lofty status of a conventional pharmaceutical.

00:17:11.307 --> 00:17:11.997
commodity.

00:17:12.847 --> 00:17:15.917
So we've done some research in collaboration with the industry.

00:17:15.917 --> 00:17:19.837
or using LED lighting too.

00:17:19.837 --> 00:17:19.837

00:17:20.877 --> 00:17:24.527
Injecting lights inside the plant canopy to enhance.

00:17:24.527 --> 00:17:27.787
both productivity and the homogeneity.

00:17:27.787 --> 00:17:30.947
The distribution of medicinal compounds from the top to the bottom.

00:17:30.947 --> 00:17:34.127
of the plant is typically not the same.

00:17:34.127 --> 00:17:37.797

but if you'd put enough light energy and homogenized.

00:17:37.797 --> 00:17:41.017

the environment control then you can yield.

00:17:41.017 --> 00:17:44.147

a homogeneous outcome in medicinal compounds.

00:17:44.147 --> 00:17:45.877

as well. Now here's.

00:17:46.647 --> 00:17:49.697

Pilot scale this is actually in operation in Toronto.

00:17:49.697 --> 00:17:53.057

at the moment. This is a little cartoon version of the system that's in Toronto.

00:17:53.057 --> 00:17:56.317

with a company called we the roots and.

00:17:56.317 --> 00:17:59.497

this is a pilot demonstration of our high.

00:17:59.497 --> 00:18:02.817

density food production system. The one that grew the lettuce.

00:18:02.817 --> 00:18:05.957

in our demonstration of red White.

00:18:05.957 --> 00:18:08.997

and blue. So here's a little video that just shows you.

00:18:08.997 --> 00:18:12.217

how this system works. It's called the gravity flow.

00:18:12.217 --> 00:18:15.237

system. We searched the world over for.

00:18:15.237 --> 00:18:17.697

a manufacturing company.

00:18:17.747 --> 00:18:21.037

To collaborate with us to build this thing and we found.

00:18:21.037 --> 00:18:24.217

them down the street in Aberfoyle little company called.

00:18:24.217 --> 00:18:27.817

TCA so they do the manufacturing.

00:18:27.817 --> 00:18:31.617

They build the robots at each end. These lifting systems.

00:18:31.617 --> 00:18:34.767

and so here you're producing let's.

00:18:34.767 --> 00:18:37.787

say it's romaine lettuce on the top shelf then.

00:18:37.787 --> 00:18:40.997

from start to finish it would be an 8 or 9.

00:18:40.997 --> 00:18:42.047

week cycle.

00:18:42.957 --> 00:18:46.007

If you're growing microgreens on one shelf it would be.

00:18:46.007 --> 00:18:49.207

less than that, it would be a 10 day cycle for example so.

00:18:49.207 --> 00:18:52.847

you load seeds on one end and they displace.

00:18:52.847 --> 00:18:56.007

the harvested crop at the other end and depending.

00:18:56.007 --> 00:18:59.547

on what you're you can have different chrome oddities on each level.

00:18:59.547 --> 00:19:02.717

responding to different environment cues.

00:19:02.717 --> 00:19:05.827

and the variation of this is sort.

00:19:05.827 --> 00:19:09.447

of a pilot scale, not necessarily commercially.

00:19:09.447 --> 00:19:12.607

viable, but it is operating in a commercial environment.

00:19:12.607 --> 00:19:14.457

in downtown Toronto in.

00:19:14.707 --> 00:19:17.867

In a warehouse as we speak, so here's where.

00:19:17.867 --> 00:19:21.157

that technology is headed this particular.

00:19:21.157 --> 00:19:24.457

system I don't have a video of it is under construction.

00:19:24.457 --> 00:19:28.347

Almost finished construction actually in Welland ON.

00:19:28.347 --> 00:19:31.457

just outside Saint Catherines. And basically this is.

00:19:31.457 --> 00:19:34.537
a large scale application commercial.

00:19:34.537 --> 00:19:37.677
scale application of that pilot system that.

00:19:37.677 --> 00:19:38.667
I just showed you.

00:19:39.307 --> 00:19:42.337
And finally, we have an outreach.

00:19:42.337 --> 00:19:45.377
element to our program that has this is.

00:19:45.377 --> 00:19:48.737
actually 20 years now since we launched.

00:19:48.737 --> 00:19:52.337
this. It's a project called tomato sphere where.

00:19:52.337 --> 00:19:55.417
we at the top middle picture is.

00:19:55.417 --> 00:19:58.517
Marc Garneau. When he's a little younger and he took our.

00:19:58.517 --> 00:20:01.897
first bag of seeds up on the space shuttle and.

00:20:01.897 --> 00:20:03.157
they went around the Earth.

00:20:04.427 --> 00:20:07.657
Two dozen times and came back and then the middle picture.

00:20:07.657 --> 00:20:10.717
is my good friend Bob Thirsk retired.

00:20:10.717 --> 00:20:14.277
d astronaut and then at the bottom my good friend she, Chris Hadfield.

00:20:14.277 --> 00:20:17.847
These are retired Canadian astronauts and they.

00:20:17.847 --> 00:20:21.167
all had our seeds up on the space station.

00:20:21.167 --> 00:20:24.597
or on the shuttle, mostly.

00:20:24.597 --> 00:20:28.077
on the space station these days, nasa or spacex.

00:20:28.077 --> 00:20:31.517
or whoever our flight partner is.

00:20:31.517 --> 00:20:34.597
takes the seeds up. We're just actually getting.

00:20:34.597 --> 00:20:36.877
struck up a deal with blue origin.

00:20:37.237 --> 00:20:40.367
Jeff Bezos company to put some seeds into.

00:20:40.367 --> 00:20:42.087
space in.

00:20:43.657 --> 00:20:46.777
Next month, I believe so the seeds for next.

00:20:46.777 --> 00:20:49.967
year's school project because these seeds come back.

00:20:49.967 --> 00:20:53.097
to Earth. We distribute them to classrooms across Canada.

00:20:53.097 --> 00:20:56.397
usually between 2030 thousand classrooms.

00:20:56.397 --> 00:20:59.737
across North America. Engage in Germination.

00:20:59.737 --> 00:21:02.757
experiments. I bet there's somebody in the audience who's actually.

00:21:02.757 --> 00:21:04.817
done this project in grade school.

00:21:05.927 --> 00:21:08.997
But if you haven't shame on you so.

00:21:08.997 --> 00:21:12.257
this is our outreach project and it's.

00:21:12.257 --> 00:21:15.337
in it's 20 years. Now we're just planning.

00:21:15.337 --> 00:21:19.207
the 20th year celebration, so the take home message.

00:21:19.207 --> 00:21:19.207

00:21:20.057 --> 00:21:23.177
It is, as I've been describing, the.

00:21:23.177 --> 00:21:26.547
technical pull of the challenge of going into space.

00:21:26.547 --> 00:21:30.307
and providing life support requirements for humans.

00:21:30.307 --> 00:21:33.457
is what we do. This is our.

00:21:33.457 --> 00:21:36.537
whole program is based on this, but as I.

00:21:36.537 --> 00:21:39.817
said, I don't have a mission to do that yet. That's coming very.

00:21:39.817 --> 00:21:43.407
quickly actually and that mission so.

00:21:43.407 --> 00:21:47.357
in the absence of that mission, we.

00:21:47.357 --> 00:21:50.877
collaborate with industry partners who leverage funding from.

00:21:50.877 --> 00:21:50.877

00:21:50.937 --> 00:21:54.007
Various provincial and federal institutions.

00:21:54.007 --> 00:21:58.107
to support the operations. The green, the.

00:21:58.107 --> 00:22:01.427
chamber technology development, and of.

00:22:01.427 --> 00:22:04.837
course, paying for graduate students and undergraduate interns.

00:22:04.837 --> 00:22:07.957
So I suspect I'll bump into some of you at some point.

00:22:07.957 --> 00:22:11.827
especially when we can all get back together on the campus and.

00:22:11.827 --> 00:22:11.827

00:22:12.707 --> 00:22:16.067
That's what I have for you. So now I'll rely.

00:22:16.067 --> 00:22:18.937
on Sherry to bring me back to life.

00:22:22.267 --> 00:22:25.397

OK, I'm just going to put.

00:22:25.397 --> 00:22:28.457
just, so I'm going to send my Clive.

00:22:28.457 --> 00:22:28.457

00:22:29.527 --> 00:22:32.547
Here's a bit of a delay. You should see him now, so you.

00:22:32.547 --> 00:22:35.887
ee a doctor. Dixon live and in person in his.

00:22:35.887 --> 00:22:39.087
living room. I believe this is not formal.

00:22:39.087 --> 00:22:42.387
formal presentation venue. I have two, two or three others.

00:22:42.387 --> 00:22:45.447
on in the house here. Various depending on what.

00:22:45.447 --> 00:22:48.047
the meeting is, but this is the best.

00:22:49.347 --> 00:22:52.367
So at this point in your.

00:22:52.367 --> 00:22:55.867
Q&A, I've had some I've been answering some questions.

00:22:55.867 --> 00:22:59.467
there that were more private academically.

00:22:59.467 --> 00:23:02.767
related. Does anybody have any questions that they would like to put in?

00:23:02.767 --> 00:23:05.887
the Q&A there for Doctor Dixon to?

00:23:05.887 --> 00:23:09.067
address if you put them there? I'll read them out loud.

00:23:09.067 --> 00:23:12.347
about his presentation and then Doctor Dixon can respond.

00:23:12.347 --> 00:23:15.637
to them. I'd be interested in knowing if anyone.

00:23:15.637 --> 00:23:18.647
in the audience has actually participated in tomato.

00:23:18.647 --> 00:23:19.427
sphere.

00:23:19.487 --> 00:23:22.597

In there over the last, anytime in the last.

00:23:22.597 --> 00:23:23.407

20 years.

00:23:24.337 --> 00:23:27.397

So Mike, just for my clarification, tomatoes fear was.

00:23:27.397 --> 00:23:31.427

when your lab or your collaboration.

00:23:31.427 --> 00:23:34.877

distributed seeds to classrooms across Canada.

00:23:34.877 --> 00:23:35.427

That's right now.

00:23:36.977 --> 00:23:40.307

Firms their hind seeds, we, hines.

00:23:40.307 --> 00:23:43.427

s one of our partners at the Canadian Space Agency, of course.

00:23:43.427 --> 00:23:46.647

and Stoke seeds, so we'd package up these seas.

00:23:46.647 --> 00:23:49.907

ship 'em up to the space station, bring him back and distribute them.

00:23:49.907 --> 00:23:53.467

to classrooms across Canada and the US and.

00:23:53.467 --> 00:23:56.727

they would do a germination experiment and.

00:23:56.727 --> 00:23:59.897

report their results on the website an we would.

00:23:59.897 --> 00:24:03.447

see if space exposure had any.

00:24:03.447 --> 00:24:06.707

negative effects on C Germination.

00:24:06.707 --> 00:24:08.617

or seed quality or whatever, and.

00:24:08.917 --> 00:24:11.937

Happily, after 20 years of.

00:24:11.937 --> 00:24:15.817

investigation, we have discovered that space exposure.

00:24:15.817 --> 00:24:19.417
does not harm tomato seeds great.

00:24:19.417 --> 00:24:22.597
I do have a question here. From Sequoia it says.

00:24:22.597 --> 00:24:25.857
Why were the seeds chosen to journey into space?

00:24:25.857 --> 00:24:28.417
with Blue Origin and not SpaceX?

00:24:29.517 --> 00:24:33.567
Because that's a good one because.

00:24:33.567 --> 00:24:36.607
the spacex launch we do.

00:24:36.607 --> 00:24:39.767
have some seeds going on a spacex launch.

00:24:39.767 --> 00:24:42.987
but they wouldn't be going in time and coming.

00:24:42.987 --> 00:24:46.027
back in time to be distributed next.

00:24:46.027 --> 00:24:49.387
class here in the next school year and 20.

00:24:49.387 --> 00:24:52.847
So blue origin we.

00:24:52.847 --> 00:24:56.247
reached out. My colleague Tom Graham, and.

00:24:56.247 --> 00:24:59.547
are reasonably connected in the space.

00:24:59.547 --> 00:25:02.737
exploration and research community around the world, but especially.

00:25:02.737 --> 00:25:03.377
ally at NASA.

00:25:03.867 --> 00:25:06.997
Kennedy space center and elsewhere. And we reached out to.

00:25:06.997 --> 00:25:10.367
our contacts in the space exploration community.

00:25:10.367 --> 00:25:13.577
and the folks at Blue Origin have.

00:25:13.577 --> 00:25:17.077

just launched an education outreach component.

00:25:17.077 --> 00:25:20.647
of their program and they.

00:25:20.647 --> 00:25:23.847
jumped at the opportunity to get into.

00:25:23.847 --> 00:25:27.457
bed with a seasoned outreach and education.

00:25:27.457 --> 00:25:31.357
program like tomatoes, fear, and hope.

00:25:31.357 --> 00:25:34.117
There sailed to our little wagon and.

00:25:34.417 --> 00:25:37.597
And collaborate with us. So we've struck up a new relationship with blue.

00:25:37.597 --> 00:25:41.037
Origin. And there you?

00:25:41.037 --> 00:25:44.227
I still continue to participate with nasa.

00:25:44.227 --> 00:25:49.587
and spacex's because.

00:25:49.587 --> 00:25:52.607
Blue Origin currently doesn't go to the space station.

00:25:52.607 --> 00:25:56.887
They just go into low Earth orbit. Anyway, that's.

00:25:56.887 --> 00:25:56.887

00:25:57.567 --> 00:26:00.837
That's why this particular year, great thanks.

00:26:00.837 --> 00:26:04.297
Mike. I have comments here from both Gabrielan Adam.

00:26:04.297 --> 00:26:07.477
Gabriel said. I think I did tomato sphere in Elementary.

00:26:07.477 --> 00:26:10.777
school and Adam Week said just wanted to say my high school.

00:26:10.777 --> 00:26:13.877
did the tomatoes fear germination experiment last year.

00:26:13.877 --> 00:26:18.037
so you got a couple people our next question.

00:26:18.037 --> 00:26:21.237

comes from an anonymous person and it says what courses?

00:26:21.237 --> 00:26:22.197

do you teach?

00:26:23.217 --> 00:26:26.267

Teach I co teach a course with Tom.

00:26:26.267 --> 00:26:29.367

Graham. He and I developed it together. He's the new.

00:26:29.367 --> 00:26:32.757

kid in our program in the controlled environment systems.

00:26:32.757 --> 00:26:35.847

facility program. The new the newest.

00:26:35.847 --> 00:26:39.607

faculty member. So I could teach a course ENVS.

00:26:39.607 --> 00:26:42.627

3300 which is introductory controlled.

00:26:42.627 --> 00:26:45.807

environment systems in which we.

00:26:45.807 --> 00:26:49.127

highlight almost all of the stuff I've just told you about.

00:26:49.127 --> 00:26:52.727

We get into a little more detail in all of those and where we.

00:26:52.727 --> 00:26:54.397

have just developed a new.

00:26:54.467 --> 00:26:55.927

4th year course.

00:26:56.877 --> 00:27:00.377

That is advanced controlled environment systems which.

00:27:00.377 --> 00:27:03.687

we were going to introduce this.

00:27:03.687 --> 00:27:06.817

school year so this fall or would probably

00:27:06.817 --> 00:27:09.957

winter 21, but it's been delayed by this.

00:27:09.957 --> 00:27:13.697

infernal pestilence that has descended on the planet.

00:27:13.697 --> 00:27:17.017
so we're going to have to install that a little bit.

00:27:17.017 --> 00:27:19.967
But I also teach a first year course.

00:27:21.237 --> 00:27:24.367
And it's entitled, how are we going to eat?

00:27:24.367 --> 00:27:27.427
on Mars? And I think I've.

00:27:27.427 --> 00:27:29.417
given some of the answers today.

00:27:32.587 --> 00:27:35.907
Our next question let.

00:27:35.907 --> 00:27:38.367
me just I'm scrolling here. Just a sack.

00:27:39.017 --> 00:27:39.627

00:27:40.357 --> 00:27:40.797
Let's see.

00:27:44.777 --> 00:27:47.827
And it's from Ryan and Ryan said anyone done?

00:27:47.827 --> 00:27:51.747
experiments with plants under under centrifuge.

00:27:51.747 --> 00:27:51.747

00:27:52.937 --> 00:27:54.127
Yes.

00:27:54.947 --> 00:27:58.447
But the issue there is.

00:27:58.447 --> 00:27:58.447

00:27:59.987 --> 00:28:03.937
Hypergravity, so in a centrifuge.

00:28:03.937 --> 00:28:07.347
you have more than 1G.

00:28:07.347 --> 00:28:10.677
G of gravity and the application of that.

00:28:10.677 --> 00:28:13.757

other than during the brief minutes.

00:28:13.757 --> 00:28:16.917
of launch the.

00:28:16.917 --> 00:28:20.617
experiencing hyper gravity is.

00:28:20.617 --> 00:28:24.017
quite rare and unusual, so most of the attention.

00:28:24.017 --> 00:28:27.797
has been on hypo gravity or microgravity.

00:28:27.797 --> 00:28:29.467
such as the space station.

00:28:30.027 --> 00:28:33.157
Which is erroneously called 0 gravity, but.

00:28:33.157 --> 00:28:36.637
it's just a teeny weeny bitter gravity.

00:28:36.637 --> 00:28:39.977
so we've done a lot of work.

00:28:39.977 --> 00:28:43.207
in collaboration with nasa and the University of Florida.

00:28:43.207 --> 00:28:43.207

00:28:44.317 --> 00:28:47.627
On the International Space Station.

00:28:47.627 --> 00:28:50.907
plant growth, I participated in some work.

00:28:50.907 --> 00:28:54.127
down back when I was on sabbatical at Kennedy Space Center some years.

00:28:54.127 --> 00:28:57.767
ago. Growing wheat on the space station and.

00:28:57.767 --> 00:29:01.277
A and a good friend of ours, gioia Massa from nasa.

00:29:01.277 --> 00:29:04.767
runs the veggie project, but.

00:29:04.767 --> 00:29:08.767
these are all reduced gravity applications.

00:29:08.767 --> 00:29:12.917
We've done. Of course, reduced pressure work.

00:29:12.917 --> 00:29:17.397
but hypergravity, excessive centrifuge gravity.

00:29:17.397 --> 00:29:17.397

00:29:17.547 --> 00:29:20.557
That high levels of gravity, it has a very limited.

00:29:20.557 --> 00:29:23.757
application and space exploration, so the.

00:29:23.757 --> 00:29:26.397
amount of information there is probably quite limited.

00:29:27.947 --> 00:29:31.497
Thank you our next question. I just gotta get back.

00:29:31.497 --> 00:29:34.737
with you. I'm going to stop saying who's ask the?

00:29:34.737 --> 00:29:37.777
questions 'cause I have to scroll back through to find them. So I'll.

00:29:37.777 --> 00:29:40.797
do this. I'll do it a different way, but sorry.

00:29:40.797 --> 00:29:43.897
next question is why did you choose?

00:29:43.897 --> 00:29:47.577
to use tomato seeds over other vegetables or plants?

00:29:47.577 --> 00:29:50.697
I guess.

00:29:50.697 --> 00:29:54.157
uess it's small P political I had

00:29:54.157 --> 00:29:57.197
ned to be in then we're talking. This is over 20 years.

00:29:57.197 --> 00:29:57.957
ago now.

00:29:58.067 --> 00:30:01.077
In 1999, when Bob Thirsk and I

00:30:01.077 --> 00:30:04.257
first got together, he was still a

00:30:04.257 --> 00:30:07.277
full fledged Canadian astronaut at the time.

00:30:07.277 --> 00:30:10.317

and he had done an.

00:30:10.317 --> 00:30:13.887

experiment where they took canola seeds up into space.

00:30:13.887 --> 00:30:17.677

and experiment called Kennel Lab and.

00:30:17.677 --> 00:30:20.797

it generated quite a bit of excitement and.

00:30:20.797 --> 00:30:23.937

enthusiasm, but it was just a flash, just one time.

00:30:23.937 --> 00:30:27.057

and that was it, so that he came to.

00:30:27.057 --> 00:30:30.887

me through the AG Canada. There was a number of people involved.

00:30:30.887 --> 00:30:30.887

00:30:30.937 --> 00:30:34.007

And a guy named Ron Thorpe who.

00:30:34.007 --> 00:30:37.127

was the chief administrator at the Marc Garneau.

00:30:37.127 --> 00:30:40.647

ollegiate institute in toronto who I knew reasonably

00:30:40.647 --> 00:30:44.177

from meetings. So he got us all together.

00:30:44.177 --> 00:30:47.477

and I just happened to be have just.

00:30:47.477 --> 00:30:50.627

completed a research project with the Heinz.

00:30:50.627 --> 00:30:53.907

company looking at tomatoes and.

00:30:53.907 --> 00:30:57.067

seed and how to increase the dry.

00:30:57.067 --> 00:31:00.397

matter of processing tomatoes so that you get more ketchup.

00:31:00.397 --> 00:31:01.487

bottle. One tomato.

00:31:01.707 --> 00:31:05.367

And so I got to know the Heinz people quite well.

00:31:05.367 --> 00:31:08.527
so if.

00:31:08.527 --> 00:31:11.617
you're going to have Hines as your industry sponsor for a.

00:31:11.617 --> 00:31:15.117
seed project in space, it's tomatoes.

00:31:15.117 --> 00:31:15.117

00:31:16.727 --> 00:31:20.087
Great, our next question says what plant?

00:31:20.087 --> 00:31:22.857
would be the most interesting to grow in space?

00:31:23.717 --> 00:31:24.287

00:31:27.227 --> 00:31:30.957
As I said, food drives.

00:31:30.957 --> 00:31:34.467
the equation. It has to be inedible.

00:31:34.467 --> 00:31:37.657
plant. When I first joined.

00:31:37.657 --> 00:31:40.677
there's a committee. There's an international committee that.

00:31:40.677 --> 00:31:43.747
it's called the candidate crop selection.

00:31:43.747 --> 00:31:46.997
committee and I joined it in 1990.

00:31:46.997 --> 00:31:50.377
and as my inaugural presentation

00:31:50.377 --> 00:31:53.647
to that committee I proposed roses.

00:31:53.647 --> 00:31:54.867
and barley.

00:31:56.707 --> 00:32:00.097
Rose is because of their psychological benefit, imagine.

00:32:00.097 --> 00:32:02.137
that first dozen roses from the moon.

00:32:03.457 --> 00:32:06.527

But you can't eat roses so.

00:32:06.527 --> 00:32:09.617

they were rejected out of hand. You can't avoid, you can't.

00:32:09.617 --> 00:32:12.807

afford the mass and energy cost of growing a plant that you can't.

00:32:12.807 --> 00:32:16.247

eat. So I said barley and.

00:32:16.247 --> 00:32:19.447

unfortunately I used for my rationale.

00:32:19.447 --> 00:32:22.617

for barley. The fact that.

00:32:22.617 --> 00:32:26.107

humans in all of their history recorded.

00:32:26.107 --> 00:32:29.247

or otherwise always end up.

00:32:29.247 --> 00:32:32.467

making alcohol, and I decided it would be the good.

00:32:32.467 --> 00:32:35.767

stuff as an aficionado of single malt whiskey, 'cause in 19.

00:32:35.767 --> 00:32:38.027

5 I had just been appointed.

00:32:38.077 --> 00:32:41.107

One of the conveners of the malt whisky tasting.

00:32:41.107 --> 00:32:44.367

Society of Canada. So I had a soft spot for barley.

00:32:44.367 --> 00:32:47.587

and what I did not appreciate it at the time.

00:32:47.587 --> 00:32:50.897

was that the chairman of the committee was a.

00:32:50.897 --> 00:32:54.057

venerable a researcher called.

00:32:54.057 --> 00:32:57.527

the Frank Salisbury. He's recently.

00:32:57.527 --> 00:33:01.147

passed away, unfortunately, is a gradle guy, but I.

00:33:01.147 --> 00:33:04.337

didn't appreciate that he was a teetotal Mormon.

00:33:04.337 --> 00:33:07.367

So when I proposed barley and rationalized it on the

00:33:07.367 --> 00:33:10.407

basis of alcohol production, he didn't even laugh.

00:33:10.407 --> 00:33:10.407

00:33:10.457 --> 00:33:13.707

And a struct Burley, off the list, but.

00:33:13.707 --> 00:33:17.417

you'll find that barley is now officialy.

00:33:17.417 --> 00:33:20.687

on the candidate crop list for human space.

00:33:20.687 --> 00:33:24.067

exploration an I colluded with my buddy.

00:33:24.067 --> 00:33:27.487

ray Wheeler, who's the head of the life support and life sciences program.

00:33:27.487 --> 00:33:30.997

at Kennedy Space Center. He is now the chairman of that committee.

00:33:30.997 --> 00:33:34.067

and I colluded with him and we.

00:33:34.067 --> 00:33:37.147

have put barley officialy on the list I.

00:33:37.147 --> 00:33:40.387

also have a collaborator in the Glenlivet distillery in.

00:33:40.387 --> 00:33:43.667

Scotland, and we're putting barley on the space station.

00:33:43.667 --> 00:33:43.667

00:33:43.807 --> 00:33:46.997

Outside the space station this coming.

00:33:46.997 --> 00:33:50.277

January, and ultimately we've just.

00:33:50.277 --> 00:33:53.397

proposed to the Canadian space agency last week.

00:33:53.397 --> 00:33:55.587

to put barley on the moon.

00:33:56.657 --> 00:33:58.637

So apparently is my winner.

00:34:00.087 --> 00:34:03.167

So our next question, and I'm going to give you a tidbit of.

00:34:03.167 --> 00:34:06.417

information after I read it, but it says have you met chris?

00:34:06.417 --> 00:34:09.787

Hadfield and actually I'm going to tell you mike, that.

00:34:09.787 --> 00:34:13.377

I actually met Marc Garneau when I was in public school.

00:34:13.377 --> 00:34:16.397

and I met Chris Hadfield when.

00:34:16.397 --> 00:34:19.447

I was in just starting my undergraduate degree.

00:34:19.447 --> 00:34:22.717

both through things where students were nominated.

00:34:22.717 --> 00:34:25.957

to go to speaking events to meet them, right because?

00:34:25.957 --> 00:34:29.857

since I was a small child, I wanted to be an astronaut.

00:34:29.857 --> 00:34:29.857

00:34:30.337 --> 00:34:33.527

What the heck are you doing? In my broadcaster didn't follow.

00:34:33.527 --> 00:34:36.567

that path. A man that was derailed when.

00:34:36.567 --> 00:34:39.847

challenger blew up. That was a very scary.

00:34:39.847 --> 00:34:43.097

event for a kid. Exploring that at that.

00:34:43.097 --> 00:34:46.267

time, but I thought that was an interesting question and just.

00:34:46.267 --> 00:34:49.727

st a little bit of tidbit of my background in interest in

00:34:49.727 --> 00:34:53.267

ace. I know all most.

00:34:53.267 --> 00:34:56.767

ll most of the canadian astronauts of that vintage so mark

00:34:56.767 --> 00:34:59.867

b Thirsk and Chris Hadfield and Bernie.

00:34:59.867 --> 00:35:00.767

Tryggvason.

00:35:00.857 --> 00:35:01.497

00:35:02.517 --> 00:35:05.887

And we should mention.

00:35:05.887 --> 00:35:09.707

Roberta Bondar as fast as I Guelph Grad.

00:35:09.707 --> 00:35:12.787

d, and lots. Of course, maybe we'll give a nod to.

00:35:12.787 --> 00:35:15.967

my friend and I think yours is well.

00:35:15.967 --> 00:35:18.237

Scott Van Bommel.

00:35:19.477 --> 00:35:22.847

The finalists for the last astronaut searching.

00:35:22.847 --> 00:35:26.067

Canada, and is a more recent.

00:35:26.067 --> 00:35:29.087

PHD graduate from the University of Guelph, so then I'll let you answer.

00:35:29.087 --> 00:35:32.287

the question about Chris Hadfield and Matt.

00:35:32.287 --> 00:35:33.937

Vamsi was a finalist.

00:35:35.187 --> 00:35:38.197

As a Guelph Alumnus who he was my PHD student he.

00:35:38.197 --> 00:35:41.337

was a finalist for the last selection as well.

00:35:41.337 --> 00:35:44.677

but am Dave Williams.

00:35:44.677 --> 00:35:47.767

is also a bad vintage, but.

00:35:47.767 --> 00:35:50.917

yeah, Chris is actually a pretty good friend of mine now. I work with.

00:35:50.917 --> 00:35:54.337

him regularly in.

00:35:54.337 --> 00:35:57.577

what's called a creative destruction lab, which is a business.

00:35:57.577 --> 00:35:57.577

00:36:00.307 --> 00:36:01.227

Sort of.

00:36:02.827 --> 00:36:05.917

A business incubator, if you will, for.

00:36:05.917 --> 00:36:09.067

space science entrepreneurs around.

00:36:09.067 --> 00:36:12.077

Canada and the US so and we meet.

00:36:12.077 --> 00:36:15.347

in Toronto couple of times a year at the business school.

00:36:15.347 --> 00:36:18.567

there, but Bob Thirsk.

00:36:18.567 --> 00:36:21.907

and I remain in steady contact.

00:36:21.907 --> 00:36:25.387

with the tomatoes fair project. He and I are the science.

00:36:25.387 --> 00:36:28.867

subcommittee for the tomato sphere program, which is now licensed.

00:36:28.867 --> 00:36:32.307

to let's talk science in Canada, so.

00:36:32.307 --> 00:36:34.107

we have regular.

00:36:34.157 --> 00:36:37.267

Regular interactions so that whole.

00:36:37.267 --> 00:36:41.237

group is still very active in Canadian.

00:36:41.237 --> 00:36:44.487

stem projects, and.

00:36:44.487 --> 00:36:46.767

utreach, so it's a good group of guys.

00:36:47.727 --> 00:36:50.997

Great, so our next question is what is the job?

00:36:50.997 --> 00:36:54.237

market like in Canada for these studies and prominent canadian?

00:36:54.237 --> 00:36:55.097

companies?

00:36:56.077 --> 00:36:59.247

In the I can tell you the job market.

00:36:59.247 --> 00:37:02.697

students coming out of our program is instant.

00:37:04.607 --> 00:37:07.977

The recent recent

00:37:07.977 --> 00:37:11.137

PHD graduate, Darren Kaplan was quite.

00:37:11.137 --> 00:37:14.637

literally just stepping off the podium, having given his.

00:37:14.637 --> 00:37:17.687

presentation in his thesis defense.

00:37:17.687 --> 00:37:20.837

seminar an was hired on the spot by.

00:37:20.837 --> 00:37:23.897

a company in British Columbia.

00:37:23.897 --> 00:37:27.297

to run their research program in controlled environment agriculture.

00:37:27.297 --> 00:37:30.477

An another graduate student who just defended.

00:37:30.477 --> 00:37:33.837

his Masters successfully last week, Dan.

00:37:33.837 --> 00:37:36.917

got was offered a job again immediately.

00:37:36.917 --> 00:37:36.917

00:37:36.967 --> 00:37:40.037

In the controlled environment agriculture sector.

00:37:40.037 --> 00:37:43.157

so controlled environment agriculture so called vertical.

00:37:43.157 --> 00:37:46.227
farming the cannabis sector, the medicinal.

00:37:46.227 --> 00:37:49.337
plants sector his suffers.

00:37:49.337 --> 00:37:52.487
from one major limitation right now.

00:37:52.487 --> 00:37:55.817
and that is to highly qualified personnel and.

00:37:55.817 --> 00:37:59.267
so people who come out of programs like ours in Guelph.

00:37:59.267 --> 00:38:02.567
that address the technological.

00:38:02.567 --> 00:38:05.837
advancements and horticultural management strategies.

00:38:05.837 --> 00:38:09.507
and appreciate the interactions of technology and or end.

00:38:09.507 --> 00:38:09.507

00:38:09.557 --> 00:38:12.567
Agriculture if you will, in.

00:38:12.567 --> 00:38:16.167
this new World Order of controlled environment systems.

00:38:16.167 --> 00:38:16.167

00:38:17.877 --> 00:38:21.157
There is no you have your choice.

00:38:21.157 --> 00:38:24.337
across a pretty broad spectrum of.

00:38:24.337 --> 00:38:26.217
job opportunities.

00:38:27.237 --> 00:38:30.367
Thank you, our next question is.

00:38:30.367 --> 00:38:33.687
to how much does it cost to build or design?

00:38:33.687 --> 00:38:36.947
one of the controlled environment systems that you talked about.

00:38:36.947 --> 00:38:36.947

00:38:38.807 --> 00:38:41.857

They are too.

00:38:41.857 --> 00:38:45.777

expensive to be commercially useful other in a research application.

00:38:45.777 --> 00:38:48.817

The original chambers I remember those.

00:38:48.817 --> 00:38:50.797

blue boxes as we call them.

00:38:51.957 --> 00:38:55.477

In fact, we have trademarked.

00:38:55.477 --> 00:38:58.597

trademarked the Guelph Blue Box Chamber and the.

00:38:58.597 --> 00:39:02.277

blue box notion comes from the fact that it recycles everything.

00:39:02.277 --> 00:39:05.777

cycles all the atmosphere and water etc

00:39:05.777 --> 00:39:08.977

etc. But I recall back 20 years ago when.

00:39:08.977 --> 00:39:13.217

we were designing that original system when.

00:39:13.217 --> 00:39:16.337

the price tag on one of those chambers got to.

00:39:16.337 --> 00:39:19.947

\$400,000. We had to say, OK.

00:39:19.947 --> 00:39:23.857

stop everything and we had to redesign the whole darn thing.

00:39:23.857 --> 00:39:23.857

00:39:24.027 --> 00:39:27.467

And get the price tag down because we wanted.

00:39:27.467 --> 00:39:30.887

a multiple number of these chambers and.

00:39:30.887 --> 00:39:34.247

they were going to consume far too much of the construction.

00:39:34.247 --> 00:39:37.287

budget. Now, having said that, we have since gone.

00:39:37.287 --> 00:39:40.647
through several generations of new technology.

00:39:40.647 --> 00:39:43.787
advanced technology and controlled environment chamber.

00:39:43.787 --> 00:39:47.427
systems and we have now just.

00:39:47.427 --> 00:39:51.047
licensed the most recent generation.

00:39:51.047 --> 00:39:55.217
which we're calling a PS2000 photo system.

00:39:55.217 --> 00:39:55.217

00:39:55.487 --> 00:39:58.647
There is a PS1000 in a PS2000.

00:39:58.647 --> 00:40:02.007
and these are on the order.

00:40:02.007 --> 00:40:05.357
of about between 75 and 100,000.

00:40:05.357 --> 00:40:06.417
each.

00:40:06.787 --> 00:40:09.797
But that sounds like a.

00:40:09.797 --> 00:40:13.207
ridiculously large amount of money for a small little box.

00:40:13.207 --> 00:40:16.297
But remember these are research tools these.

00:40:16.297 --> 00:40:19.387
are really powerful research tools you can ask.

00:40:19.387 --> 00:40:22.717
some extremely direct and sensitive questions.

00:40:22.717 --> 00:40:26.157
of plant physiology and get an immediate answer.

00:40:26.157 --> 00:40:29.277
by manipulating the environment control recipe and.

00:40:29.277 --> 00:40:32.697
coming away because every second you're monitoring photosynthesis.

00:40:32.697 --> 00:40:36.157
respiration transpiration, and.

00:40:37.617 --> 00:40:40.827
So it's an extremely powerful research technology.

00:40:40.827 --> 00:40:44.027
that we've developed here. And by the way, where?

00:40:44.027 --> 00:40:47.367
the only place on the planet right now that exploits this.

00:40:47.367 --> 00:40:51.027
high fidelity environment control technology to.

00:40:51.027 --> 00:40:52.347
the extent that we do.

00:40:54.387 --> 00:40:57.897
OK, my next question to us does genetic.

00:40:57.897 --> 00:41:01.737
modification have any current role in plants grown in space?

00:41:01.737 --> 00:41:01.737

00:41:03.427 --> 00:41:06.907
That is a potentially.

00:41:06.907 --> 00:41:10.717
divisive issue, depending on where you are on the planet.

00:41:10.717 --> 00:41:10.717

00:41:12.097 --> 00:41:15.347
But at the moment I would say no. I would it.

00:41:15.347 --> 00:41:18.727
if this was ten years ago. I might, I might.

00:41:18.727 --> 00:41:21.747
have argued that it would. I might have even argued that.

00:41:21.747 --> 00:41:24.867
if you're sensitive to GM owes then stay.

00:41:24.867 --> 00:41:27.927
on planet Earth because we're not getting off the planet without them.

00:41:27.927 --> 00:41:31.447
I don't think that's true anymore. I think we have demonstrated.

00:41:31.447 --> 00:41:36.127
especially in the last decade, that environment.

00:41:36.127 --> 00:41:39.727
the controlled environment trumps the genetics.

00:41:39.727 --> 00:41:42.917
as I've demonstrated with the lettuce.

00:41:42.917 --> 00:41:42.917

00:41:42.967 --> 00:41:45.977
example I can take any

00:41:45.977 --> 00:41:49.297
y genetic complement and twisted.

00:41:49.297 --> 00:41:52.417
around and make it change its size, shape, color.

00:41:52.417 --> 00:41:55.707
taste, whatever, just by manipulating.

00:41:55.707 --> 00:41:59.277
high fidelity environment control. So I would say.

00:41:59.277 --> 00:42:02.977
that environment control technology has.

00:42:02.977 --> 00:42:06.617
made it so that you don't need genetic.

00:42:06.617 --> 00:42:09.887
modifications to adapt to the challenging.

00:42:09.887 --> 00:42:13.117
environments that we'll see in space or in northern Canada.

00:42:13.117 --> 00:42:14.007
or elsewhere.

00:42:16.097 --> 00:42:19.167
Ryans submitted a follow up question to.

00:42:19.167 --> 00:42:22.187
us question about centrifuge, he said.

00:42:22.187 --> 00:42:25.197
he was asking about centrifuge under zero gravity and.

00:42:25.197 --> 00:42:28.637
I don't know if that changes what we taught. What you?

00:42:28.637 --> 00:42:31.657

spoke too, but I thought you give him the opportunity to ask.

00:42:31.657 --> 00:42:34.697
that question. Yeah, they use centrifuges on the.

00:42:34.697 --> 00:42:38.027
space station to mimic lunar.

00:42:38.027 --> 00:42:41.257
gravity, for example, which is 1/6 of earth or Mars.

00:42:41.257 --> 00:42:44.817
Martian gravity, which is 1/3 of earth or full earth gravity.

00:42:44.817 --> 00:42:46.237
1G.

00:42:46.357 --> 00:42:50.247
So centrifuges in the Micro G environment.

00:42:50.247 --> 00:42:53.367
of the space station are the only.

00:42:53.367 --> 00:42:56.567
way that you can get an up and a down in that.

00:42:56.567 --> 00:43:00.287
research environment. However, they are.

00:43:00.287 --> 00:43:03.527
ty nontrivial mass and energy.

00:43:03.527 --> 00:43:06.747
cost to creating a specific environment.

00:43:06.747 --> 00:43:06.747

00:43:08.037 --> 00:43:11.437
The issue of Microgravity.

00:43:11.437 --> 00:43:14.577
is probably a pretty profound one, but plants don't.

00:43:14.577 --> 00:43:17.737
really care that much. They interpret up.

00:43:17.737 --> 00:43:20.697
is where the light is. An down is where the water is.

00:43:21.907 --> 00:43:25.957
The pursuit of technological advancements in.

00:43:25.957 --> 00:43:29.337
artificial gravity spinning the spacecraft.

00:43:29.337 --> 00:43:32.627
or something like that will come up most likely.

00:43:32.627 --> 00:43:37.157
as a result of the requirements of us humans we.

00:43:37.157 --> 00:43:40.367
tend to suffer a bit in extended periods.

00:43:40.367 --> 00:43:43.707
in Microgravity, and so will.

00:43:43.707 --> 00:43:46.827
develop the technology to spend the spacecraft or have some.

00:43:46.827 --> 00:43:50.647
sort of a centrifical system to.

00:43:50.647 --> 00:43:52.287
give us artificial gravity.

00:43:52.507 --> 00:43:55.637
For long periods in space, short periods in space.

00:43:55.637 --> 00:43:56.487
that's alright.

00:43:57.547 --> 00:44:00.777
Hey Mike, I have two more questions in our last five.

00:44:00.777 --> 00:44:04.087
minutes here. The first one of the two.

00:44:04.087 --> 00:44:07.177
is do you think people will be able to live on Mars within the.

00:44:07.177 --> 00:44:10.657
next century? Absolutely we.

00:44:10.657 --> 00:44:13.897
will all see boots on Mars within.

00:44:13.897 --> 00:44:16.937
it, probably in the 30s this year.

00:44:16.937 --> 00:44:20.497
This in this century we.

00:44:20.497 --> 00:44:23.757
will hit you heard it here first we will discover.

00:44:23.757 --> 00:44:26.717
either life or the vestiges of some.

00:44:27.687 --> 00:44:30.887

Some life form on Mars without any.

00:44:30.887 --> 00:44:34.057

question whatsoever there is.

00:44:34.057 --> 00:44:37.087

some form of microbial life in the.

00:44:37.087 --> 00:44:40.227

deep frozen lakes on Mars there's.

00:44:40.227 --> 00:44:43.267

lots of water there. There's lots of carbon dioxide.

00:44:43.267 --> 00:44:46.287

luckily, so those are the only two things I need.

00:44:46.287 --> 00:44:49.767

to grow plants and give me some energy and away we go.

00:44:49.767 --> 00:44:53.067

So yeah, the near term exploration.

00:44:53.067 --> 00:44:56.297

of Mars will almost certainly find some.

00:44:56.297 --> 00:44:59.627

vestiges, some fossils of some microbial.

00:44:59.627 --> 00:45:01.507

life form at the very least.

00:45:02.047 --> 00:45:05.117

And you heard it here first. Great, OK, and our.

00:45:05.117 --> 00:45:08.397

last question. And then I'm going to cut it off. So we had done time.

00:45:08.397 --> 00:45:11.717

cause we do have another session starting in about 10 minutes.

00:45:11.717 --> 00:45:15.097

What is your stance on GMO's and the possible?

00:45:15.097 --> 00:45:18.757

unknown risks of all involved? Well.

00:45:18.757 --> 00:45:21.917

us plant scientists made the big.

00:45:21.917 --> 00:45:25.087

mistake flip 50 years ago or so.

00:45:25.087 --> 00:45:28.437

of exploring.

00:45:28.437 --> 00:45:31.697

the technology of genetic modification in food crops.

00:45:31.697 --> 00:45:33.677

We should have done it with roses or something.

00:45:33.727 --> 00:45:37.297

You don't eat and make all the mistakes there.

00:45:37.297 --> 00:45:40.357

I don't have a particularly.

00:45:40.357 --> 00:45:44.257

profound ethical stance on genetic modification.

00:45:44.257 --> 00:45:44.257

00:45:45.777 --> 00:45:49.167

I guess I draw the line at taking animal genetics and stick him.

00:45:49.167 --> 00:45:50.387

into plants, but.

00:45:51.987 --> 00:45:55.717

Let's just be sensible, not necessarily ethical.

00:45:55.717 --> 00:45:59.017

but as I said, I think the work.

00:45:59.017 --> 00:46:02.027

that we've done, especially here at 12 in the.

00:46:02.027 --> 00:46:05.577

last decade on high fidelity environment control.

00:46:05.577 --> 00:46:08.937

trumps the genetic modification issues.

00:46:08.937 --> 00:46:12.837

and the requirements for a genetic modification to.

00:46:12.837 --> 00:46:16.737

achieve adaptations to and acclamations.

00:46:16.737 --> 00:46:19.917

to really strange environments that you'll find in space.

00:46:19.917 --> 00:46:19.917

00:46:23.687 --> 00:46:26.697

Great, so I think that kind of brings.

00:46:26.697 --> 00:46:30.657
us to a close here. We've got 3 minutes. I don't know if my.

00:46:30.657 --> 00:46:32.837
queue of any final comments.

00:46:33.867 --> 00:46:36.987
No, I'm good, I'm I really.

00:46:36.987 --> 00:46:38.217
don't like this.

00:46:39.257 --> 00:46:40.987
Way of doing business.

00:46:42.317 --> 00:46:45.347
Is so unsatisfactory, not.

00:46:45.347 --> 00:46:48.457
o have the physical feedback and.

00:46:48.457 --> 00:46:51.497
eye contact with the people you're talking to.

00:46:51.497 --> 00:46:51.497

00:46:52.657 --> 00:46:55.737
I concur, it's a tough environment, but.

00:46:55.737 --> 00:46:55.737

00:46:56.567 --> 00:46:59.997
So I think this will change this.

00:46:59.997 --> 00:47:03.727
too shall pass and hopefully I love the opportunity.

00:47:03.727 --> 00:47:06.907
to get close and personal with some.

00:47:06.907 --> 00:47:09.947
of you at some point. If you either in my classroom.

00:47:09.947 --> 00:47:12.987
or visit the control environment, facility it.

00:47:12.987 --> 00:47:16.337
is unique on the planet. I have to tell you I just.

00:47:16.337 --> 00:47:19.847
took a VIP visitor through the place this morning.

00:47:19.847 --> 00:47:22.987

An people.

00:47:22.987 --> 00:47:26.147

never fail to get blown away by the level of the technology.

00:47:29.087 --> 00:47:32.497

So it's great fun.

00:47:32.497 --> 00:47:35.737

trying to really high level high caliber of graduate student.

00:47:35.737 --> 00:47:38.977

and we also have undergraduate interns.

00:47:38.977 --> 00:47:42.617

ular basis, usually in the summer time, but volunteers.

00:47:42.617 --> 00:47:46.497

and Whatnot. So we have a lot of a lot of people that scatter across.

00:47:46.497 --> 00:47:50.387

the campus that get involved in stuff that we do in our facility.

00:47:50.387 --> 00:47:50.387

00:47:51.477 --> 00:47:54.667

And like I said, OK. If people have questions beyond now, is it OK?

00:47:54.667 --> 00:47:57.717

if they email you absolutely? It's almost.

00:47:57.717 --> 00:48:00.927

impossible to get it all in this.

00:48:00.927 --> 00:48:04.307

sort of third person kind.

00:48:04.307 --> 00:48:07.677

of interactions here so.

00:48:07.677 --> 00:48:08.827

I'm easy to find.

00:48:10.287 --> 00:48:13.447

So I want to be on behalf of the.

00:48:13.447 --> 00:48:16.467

office of the associate vice president academic an the undergraduate.

00:48:16.467 --> 00:48:19.627

academic Information Center. Mike, thank you very very much for.

00:48:19.627 --> 00:48:22.647

once again this year, giving us your time.

00:48:22.647 --> 00:48:27.367

to do this, and especially in a new environment an hopefully soon.

00:48:27.367 --> 00:48:30.407

we'll all be able to do something in person so we can get.

00:48:30.407 --> 00:48:33.807

those looks about the excited faces.

00:48:33.807 --> 00:48:37.667

of the possibilities, what exists going forward and research.

00:48:37.667 --> 00:48:40.747

And because I think that we all.

00:48:40.747 --> 00:48:41.787

benefit from that.

00:48:42.317 --> 00:48:45.447

Excellent, thanks Sherry. Thanks for inviting Maine thank.

00:48:45.447 --> 00:48:47.277

you very much. Everybody. Have a great day.

00:48:48.077 --> 00:48:49.577

Bye now bye.

00:48:53.437 --> 00:48:59.607

00:48:59.607 --> 00:49:06.807