
10
SPACE STATION RESEARCH:
TOP TEN RESULTS

1
00:00:02,629 --> 00:00:03,629
[Music]

2
00:00:03,629 --> 00:00:04,629
>> [Background Music] This is NASA TV.

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00:00:04,629 --> 00:00:05,629
[Music]

4
00:00:05,629 --> 00:00:23,130
>> [Background Music] Here at

5
00:00:23,130 --> 00:00:28,659
NASA Television been observing the 15th Anniversary
of the launch of the first few modules of

6
00:00:28,659 --> 00:00:33,079
the International Space Station back in November
of 1998.

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00:00:33,079 --> 00:00:38,100
In this coming February, it will mark the
13th Anniversary of the arrival of the U.S.

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00:00:38,100 --> 00:00:42,340
Laboratory Destiny to the International Space
Station on a space shuttle mission during

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00:00:42,340 --> 00:00:44,180
Expedition 1.

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00:00:44,180 --> 00:00:48,050
Now science research has been going on on
board the Space Station throughout the assembly

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00:00:48,050 --> 00:00:53,620
process but now that the assembly is essentially
complete the science activity both inside

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00:00:53,620 --> 00:00:59,020
and outside the Space Station is taking the
primary focus of the activity on orbit.

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00:00:59,020 --> 00:01:04,710
A few months ago, the International Astronautical
Federation asked International Space Station

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00:01:04,710 --> 00:01:10,530
Chief Scientist, Julie Robinson, to share
the top 10 research results from the station

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00:01:10,530 --> 00:01:15,119
at the International Astronautical Congress
in Beijing and we're pleased to have her here

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00:01:15,119 --> 00:01:17,560
today to talk about some of those things.

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00:01:17,560 --> 00:01:22,450
Julie, I got to start by asking you to tell
me about the criteria that you use if you

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00:01:22,450 --> 00:01:27,969
go thumbing through all of the science and
research that's been done over all these years.

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00:01:27,969 --> 00:01:30,819
What were you looking for to decide what would
make a top 10 list?

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00:01:30,819 --> 00:01:36,289
>> Julie Robinson: Well it's a hard choice
and fortunately the leaders of the International

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00:01:36,289 --> 00:01:40,819
Astronautical Federation said they could say,
"Why limit it to so few," so that I could

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00:01:40,819 --> 00:01:45,859
actually stretch it a little bit if I wanted
to which I definitely want to.

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00:01:45,859 --> 00:01:49,639
But what I focused on was what they asked
me to focus on which was research results

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00:01:49,639 --> 00:01:51,509
and I looked at a couple of criteria.

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00:01:51,509 --> 00:01:55,759
I looked at research results that had been
published in really important scientific journals;

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00:01:55,759 --> 00:01:58,649
that is always a great measure of a result.

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00:01:58,649 --> 00:02:02,630
I also looked at research results that were
really bringing benefits back here to earth

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00:02:02,630 --> 00:02:06,340
where there were cases where people's lives
have been saved.

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00:02:06,340 --> 00:02:11,040
Somebody was around today that would have
had not been alive or not had a good life

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00:02:11,040 --> 00:02:14,280
if it hadn't been for some of those research
results so I tried to look at both of those

31
00:02:14,280 --> 00:02:15,450
things.

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00:02:15,450 --> 00:02:20,640
And I also looked at the acknowledgements
of their colleagues, so last summer we had

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00:02:20,640 --> 00:02:27,850
some of the results of the last year selected
for awards at the American Astronautical Society,

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00:02:27,850 --> 00:02:33,330
the AAS domestic meeting that we have, and
so I used the inputs of some of the scientists

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00:02:33,330 --> 00:02:36,570
that voted on those awards as well to help
me pick a top 10.

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00:02:36,570 --> 00:02:39,270
And you know a year from now I'd pick a different
top 10 probably...

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00:02:39,270 --> 00:02:40,709
>> Sure. ...because things are changing fast.

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00:02:40,709 --> 00:02:46,180
>> Well is the emphasis on brand new things
that have been discovered, or as opposed to

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00:02:46,180 --> 00:02:48,400
finding ways to apply things that we know?

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00:02:48,400 --> 00:02:52,090
>> Julie Robinson: Well science takes time
so you know the first thing that happens is

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00:02:52,090 --> 00:02:55,650
there will be a publication; sometimes it's
not even recognized that that is a groundbreaking

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00:02:55,650 --> 00:02:57,950
publication until several years later.

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00:02:57,950 --> 00:03:02,870

So I tried to balance between sort of new,
exciting things, but also to look at some

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00:03:02,870 --> 00:03:07,110
of the things that have been gradually evolving
and developing and making things better and

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00:03:07,110 --> 00:03:10,560
better; growing to be something with great
impact.

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00:03:10,560 --> 00:03:13,760
>> Were some of them pretty obvious picks
for you?

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00:03:13,760 --> 00:03:20,030
>> Julie Robinson: Yeah, I probably have in
my own mind a list of my top 30 or 40, and

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00:03:20,030 --> 00:03:23,030
then I really had to go through those and
pick the ones.

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00:03:23,030 --> 00:03:26,760
There are some that I just feel like everybody
needs to know about but then because I restricted

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00:03:26,760 --> 00:03:32,630
myself to research, I didn't talk about some
spin-offs and technologies that we've developed

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00:03:32,630 --> 00:03:35,460
on the Space Station there are also saving
lives all around the world.

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00:03:35,460 --> 00:03:38,980
So I specifically ground-ruled some of those
out and those are great stories in their own

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00:03:38,980 --> 00:03:39,980

right.

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00:03:39,980 --> 00:03:44,020
>> That would be at least one of the reasons
why you wouldn't have picked the actual assembly

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00:03:44,020 --> 00:03:46,290
of the station itself as one of the achievements.

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00:03:46,290 --> 00:03:47,840
>> Julie Robinson: Exactly.

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00:03:47,840 --> 00:03:52,670
You know the Space Station was built for both
advancing, engineering, and our ability to

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00:03:52,670 --> 00:03:53,670
explore space.

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00:03:53,670 --> 00:03:58,690
It was also built for international cooperation
and peaceful use of space around the world

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00:03:58,690 --> 00:04:00,260
for all humanity.

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00:04:00,260 --> 00:04:04,630
And then it was built to be the most amazing
research platform we've ever had in low earth

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00:04:04,630 --> 00:04:05,630
orbit.

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00:04:05,630 --> 00:04:10,420
And so that third area, the research is my
area, but all of those things go together

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00:04:10,420 --> 00:04:14,340
to produce the whole value that the Space

Station provides to the world.

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00:04:14,340 --> 00:04:21,239
>> How many different research projects, science
experiments, technology demonstrations have

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00:04:21,239 --> 00:04:22,780
run through the system in this time?

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00:04:22,780 --> 00:04:27,230
>> Julie Robinson: We've had roughly to date
about 1,500 investigations that have been

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00:04:27,230 --> 00:04:31,720
active on the Space Station and that's not
counting the multi-user instruments where

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00:04:31,720 --> 00:04:35,570
hundreds of people might take advantage of
the data, say earth remote sensing instruments.

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00:04:35,570 --> 00:04:40,051
So we've had a large number of investigations
that have begun or completed on the space

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00:04:40,051 --> 00:04:45,510
station and then there's always a lot of ground
work that follows that on orbit activity and

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00:04:45,510 --> 00:04:50,160
we see the publications come out anywhere
from 3 months to multiple years after the

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00:04:50,160 --> 00:04:51,770
on orbit part is completed.

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00:04:51,770 --> 00:04:54,510
>> And there has been participation literally
all over the world?

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00:04:54,510 --> 00:04:59,280
>> Julie Robinson: Yeah, over 69 countries
have participated in some aspect of either

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00:04:59,280 --> 00:05:01,650
research or education on the Space Station.

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00:05:01,650 --> 00:05:06,770
So even though the partnership is a partnership
of 15 countries, the impact of ISS is truly

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00:05:06,770 --> 00:05:08,199
global.

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00:05:08,199 --> 00:05:09,199
>> Let's look at the list.

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00:05:09,199 --> 00:05:14,600
We go down the list starting at number 10;
preventing loss of bone mass in space through

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00:05:14,600 --> 00:05:17,300
diet and exercise.

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00:05:17,300 --> 00:05:21,620
That sounds to me...that is something that
was all ready a point of interest before the

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00:05:21,620 --> 00:05:23,000
International Space Station, right?

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00:05:23,000 --> 00:05:26,690
>> Julie Robinson: You could go clear back
to the Gemini missions and people were worried

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00:05:26,690 --> 00:05:30,900
about bone loss in astronauts because all
that floating around means there's no forces

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00:05:30,900 --> 00:05:35,430
on your bones and people knew that that would
probably cause astronauts to lose bone right

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00:05:35,430 --> 00:05:37,520
at the beginning of human space flight.

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00:05:37,520 --> 00:05:42,390
What's exciting to me -- and this is why it
was also on the cover of the major bone journal

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00:05:42,390 --> 00:05:46,320
in the country, the Journal of Bone and Mineral
Research -- what's exciting to me about it

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00:05:46,320 --> 00:05:51,740
is that when you study astronauts, you've
got otherwise incredibly healthy, strong,

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00:05:51,740 --> 00:05:57,290
fit people and they go into space and they
have this challenge and they lose bone.

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00:05:57,290 --> 00:06:02,610
And what we found after 15 years of research
on the Space Station -- we started studying

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00:06:02,610 --> 00:06:07,200
bone in Expedition 1, the very first crew
member -- it has taken us several generations

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00:06:07,200 --> 00:06:12,300
of studies, but we have actually found a recipe
where if you have the right exercise regime

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00:06:12,300 --> 00:06:17,380
which includes high intensity resistive exercise,
the right diet, the right number of calories,

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00:06:17,380 --> 00:06:20,880
the right types of calories, and the right
vitamin D supplementation, if you put all

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00:06:20,880 --> 00:06:24,650
those things together, we now have astronauts
that come home from the Space Station for

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00:06:24,650 --> 00:06:28,900
the first time not having lost overall bone
mass density and that's a huge advance.

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00:06:28,900 --> 00:06:33,430
>> And that, in fact, is something that you
had developed over the course of those 15

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00:06:33,430 --> 00:06:37,300
years because the protocols you were using
at the beginning weren't having those kinds

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00:06:37,300 --> 00:06:38,300
of results.

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00:06:38,300 --> 00:06:41,480
>> Julie Robinson: Right, early in the Space
Station, our astronauts were losing 1 and

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00:06:41,480 --> 00:06:45,700
1/2 percent of their bone per month which
is about the same as a woman with osteoporosis

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00:06:45,700 --> 00:06:46,810
would lose in a year.

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00:06:46,810 --> 00:06:47,810
>> Wow!

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00:06:47,810 --> 00:06:52,120
>> Julie Robinson: That's really severe and
that was a big improvement off of how astronauts

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00:06:52,120 --> 00:06:57,440
were doing on Mir so there has been a huge
development of our understanding of bone processes,

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00:06:57,440 --> 00:07:02,770
why astronauts are losing bone, and how the
bone remodels and recycles itself; understanding

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00:07:02,770 --> 00:07:06,810
that process helps us protect astronauts so
that when they land on Mars, they are going

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00:07:06,810 --> 00:07:09,410
to be ready to do a space walk right away
and they're not going to fall and break their

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00:07:09,410 --> 00:07:10,540
hop.

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00:07:10,540 --> 00:07:15,060
But it also has the benefit of giving new
insights into understanding those same processes

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00:07:15,060 --> 00:07:17,960
on earth where so many people are worried
about bone loss.

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00:07:17,960 --> 00:07:24,010
>> In the case of the astronauts, it's the
lack of force on the bones that causes them

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00:07:24,010 --> 00:07:25,010
to weaken?

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00:07:25,010 --> 00:07:28,240
>> Julie Robinson: It is but it's not the
force you think about; it's the lack of forces

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00:07:28,240 --> 00:07:33,840
at an almost cellular scale where a single
cell of a muscle fiber is attached to the

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00:07:33,840 --> 00:07:38,800
bone matrix and those little forces from the
muscles working and carrying yourself around

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00:07:38,800 --> 00:07:43,680
the world are part of the system of bone that
we have that helps our bone recycle.

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00:07:43,680 --> 00:07:47,770
If your bone doesn't recycle all the time,
it becomes brittle and it breaks so you have

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00:07:47,770 --> 00:07:51,990
to break down your bone and rebuild it all
the time; the bone is a living organ.

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00:07:51,990 --> 00:07:55,990
>> And of course you need astronauts with
strong bones to be able to do work.

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00:07:55,990 --> 00:08:01,790
>> Julie Robinson: Exactly and track risks
for human exploration and one of those risks

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00:08:01,790 --> 00:08:06,320
is if you lost too much bone on your want
to Mars, you get to Mars and are running around

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00:08:06,320 --> 00:08:11,020
in a multiple-hundred pound space suit on
very rough terrain, trip and fall and break

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00:08:11,020 --> 00:08:15,840
something, it may not be possible to get back
to the vehicle for example.

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00:08:15,840 --> 00:08:20,419
So these are real risks to astronauts, but
they are also...they connect to real risks

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00:08:20,419 --> 00:08:21,900
to people here on earth.

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00:08:21,900 --> 00:08:26,520
You know when my grandmother fell and broke
her hip, that was an incredible challenge

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00:08:26,520 --> 00:08:30,490
for all of her health and so for the same
reason we don't want astronauts to break their

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00:08:30,490 --> 00:08:34,669
hips on Mars, we really want to take that
knowledge and find ways to feed it back to

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00:08:34,669 --> 00:08:38,250
the really active osteoporosis research community
here on earth.

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00:08:38,250 --> 00:08:42,350
>> And it's a relationship...it's not just
the exercise; its exercise and the diet?

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00:08:42,350 --> 00:08:47,680
>> Julie Robinson: Right and it's really interesting
because vitamin D is one aspect of that diet

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00:08:47,680 --> 00:08:49,040
that's turned out to be important.

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00:08:49,040 --> 00:08:53,880
And NASA had done a study in the Antarctic;
you know a simulated environment, but it gets

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00:08:53,880 --> 00:08:55,010
very dark in the Antarctic.

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00:08:55,010 --> 00:08:56,010
>> Right.

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00:08:56,010 --> 00:08:58,440
>> Julie Robinson: On the Space Station and
spacecraft, astronauts don't have the sun

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00:08:58,440 --> 00:09:03,960
every day and from the results of that Antarctic
study, they determined vitamin D was much

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00:09:03,960 --> 00:09:04,960
more important.

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00:09:04,960 --> 00:09:11,550
That was actually fed into the USRDA reestablishment
of a new level for vitamin D and I talk to

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00:09:11,550 --> 00:09:15,330
people all the time -- I'm one of them -- where
my doctor said, "Ok, we now want you to take

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00:09:15,330 --> 00:09:17,350
more vitamin D than you used to take."

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00:09:17,350 --> 00:09:22,149
And it was that overall study of which the
study with the astronaut simulation study

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00:09:22,149 --> 00:09:25,230
fed into that that leads to that change in
the USRDA.

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00:09:25,230 --> 00:09:30,300
>> Well in fact the next result that you recognized
on your list is something that's related to

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00:09:30,300 --> 00:09:31,300

the 1st one.

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00:09:31,300 --> 00:09:32,300
>> Julie Robinson: Mm-hmm.

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00:09:32,300 --> 00:09:37,690
>> So number 9; understanding mechanisms of
osteoporosis and new drug treatments.

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00:09:37,690 --> 00:09:41,730
I understand that the breakthrough here actually
came in a study using mice?

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00:09:41,730 --> 00:09:43,240
>> Julie Robinson: That's right.

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00:09:43,240 --> 00:09:48,670
So you know mice are a model system that we
use for studying bone; people study bone loss

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00:09:48,670 --> 00:09:51,780
using mice in laboratories all around the
country.

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00:09:51,780 --> 00:09:57,710
And there was a great partnership between
Amgen and BioServe Space Technologies and

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00:09:57,710 --> 00:10:03,790
it started during Shuttle assembly flights
and Amgen flew and used the mice that we flew

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00:10:03,790 --> 00:10:10,100
on these assembly flights to test some drugs
that they had in the process of clinical trials.

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00:10:10,100 --> 00:10:15,160
So they had developed candidate drug treatments,
but they had not yet been approved for FDA

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00:10:15,160 --> 00:10:19,490
use or they were just starting them in those
stage 1 clinical trials and they really wanted

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00:10:19,490 --> 00:10:23,350
to understand the mechanism of how the drug
might be working.

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00:10:23,350 --> 00:10:29,350
The first of these was related to osteoprotegrin
which was...as it sounds like maybe a protein

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00:10:29,350 --> 00:10:30,350
related to the bone.

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00:10:30,350 --> 00:10:31,350
>> Mm-hmm.

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00:10:31,350 --> 00:10:34,830
>> Julie Robinson: And so the idea was to
better understand how that remodeling process

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00:10:34,830 --> 00:10:39,340
works and whether osteoprotegrin inhibition
could be used to slow it down.

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00:10:39,340 --> 00:10:43,900
And that's a whole new line of...a whole pathway
of a pharmaceutical treatment for bone loss;

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00:10:43,900 --> 00:10:48,241
that's a new one and that's what Amgen tested
in one of their mice flights to the Space

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00:10:48,241 --> 00:10:49,241
Station.

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00:10:49,241 --> 00:10:52,910
>> And I understand they were doing that in

order to back-up some research along that

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00:10:52,910 --> 00:10:55,130
same line that was already underway on the
ground?

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00:10:55,130 --> 00:10:56,519
>> Julie Robinson: Right, exactly.

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00:10:56,519 --> 00:11:00,709
So it's not that they went to the Space Station
and just invented the drug; what they did

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00:11:00,709 --> 00:11:05,560
is they used the fact that space flight has
such dramatic effects on bone loss.

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00:11:05,560 --> 00:11:10,440
To really amp-up the effects on mice and to
be able to take a lot measurements that they

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00:11:10,440 --> 00:11:12,010
couldn't get any other way.

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00:11:12,010 --> 00:11:13,899
>> And that's led to a drug that's on the
market?

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00:11:13,899 --> 00:11:14,899
>> Julie Robinson: That's right.

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00:11:14,899 --> 00:11:15,899
That's right.

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00:11:15,899 --> 00:11:18,450
The drug is called Denosumab [assumed spelling].

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00:11:18,450 --> 00:11:19,640
It's under a trade name; Prolia.

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00:11:19,640 --> 00:11:20,640
>> Prolia.

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00:11:20,640 --> 00:11:24,110
>> Julie Robinson: And that trade name or
that drug is now on the market.

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00:11:24,110 --> 00:11:26,180
It has some warnings; all drugs have side
effects.

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00:11:26,180 --> 00:11:27,180
>> Sure.

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00:11:27,180 --> 00:11:31,220
>> Julie Robinson: But doctors are finding
that for some patients who can't take Alendronate

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00:11:31,220 --> 00:11:36,180
which is the primary drug that most patients
take today for osteoporosis, some patients

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00:11:36,180 --> 00:11:38,210
can't tolerate that; they get stomach upset
and things.

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00:11:38,210 --> 00:11:41,280
And this provides an alternative for some
of those patients.

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00:11:41,280 --> 00:11:47,000
>> Is this a good example of the interest
that's being shown by private companies into

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00:11:47,000 --> 00:11:49,680
getting involved in research on board the
station?

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00:11:49,680 --> 00:11:53,720
>> Julie Robinson: Yeah when you think about
it, this is really a novel kind of a public/private

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00:11:53,720 --> 00:12:00,140
partnership for advancing human health and
even our economy here on earth to have commercial

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00:12:00,140 --> 00:12:05,480
companies to have the opportunity to go to
this discovery zone where you can make extraordinary

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00:12:05,480 --> 00:12:09,100
advancements, really study something you can't
do anywhere else, take that knowledge back

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00:12:09,100 --> 00:12:14,170
down to earth, and use it to keep a competitive
edge to develop a new solution to a problem,

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00:12:14,170 --> 00:12:16,290
and then to be able to market that.

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00:12:16,290 --> 00:12:22,290
That's part of why the Space Station was designated
a National Laboratory back in 2005 and then

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00:12:22,290 --> 00:12:28,010
in 2011, a nonprofit organization called the
Center for the Advancement of Science in Space

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00:12:28,010 --> 00:12:31,240
was selected by NASA in a cooperative agreement.

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00:12:31,240 --> 00:12:35,440
That cooperative agreement let's CASIS, which
is what we call them for short, go out and

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00:12:35,440 --> 00:12:39,630
work with other pharmaceutical companies that

might be interested in trying something in

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00:12:39,630 --> 00:12:42,959
space, but of course working with NASA is
not been something that pharm has been doing

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00:12:42,959 --> 00:12:47,890
over the years so it's very new and its really
exciting to be working with CASIS as they

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00:12:47,890 --> 00:12:51,710
start bringing in some of these customers
and they find ways to take advantage of the

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00:12:51,710 --> 00:12:53,100
platform that we have.

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00:12:53,100 --> 00:12:57,470
>> Since you brought it up, what does it mean
for the International Space Station or at

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00:12:57,470 --> 00:13:00,660
least the U.S. part of it to be designated
a National Laboratory?

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00:13:00,660 --> 00:13:04,140
>> Julie Robinson: Well you know there are
other National Laboratories around the country

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00:13:04,140 --> 00:13:12,480
-- Argonne, Brookhaven, Savannah River, Livermore
-- and usually you have sort of one government

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00:13:12,480 --> 00:13:14,920
agency that needs 90 percent of the laboratory.

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00:13:14,920 --> 00:13:19,529
But they often will offer other government
agencies, the private sector, the opportunity

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00:13:19,529 --> 00:13:23,149
to come in and use those unique facilities
because a National Laboratory means it's a

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00:13:23,149 --> 00:13:28,630
faculty that the nation needs to advance its
research and its opened up to all; not just

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00:13:28,630 --> 00:13:30,530
the one agency that's operating the lab.

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00:13:30,530 --> 00:13:34,740
And that's exactly what the Space Station
means as a National Laboratory means as well.

216
00:13:34,740 --> 00:13:39,540
The really great thing about it is so many
other government agencies and entities in

217
00:13:39,540 --> 00:13:43,730
the private sector can take advantage of it
because there are so many different kinds

218
00:13:43,730 --> 00:13:45,570
of research that we can do there.

219
00:13:45,570 --> 00:13:51,640
>> The next thing on your list has to do with
something that has been taken advantage of

220
00:13:51,640 --> 00:13:52,880
in this way.

221
00:13:52,880 --> 00:13:56,170
The next result on the list, a different kind
of thing though than what we've been talking

222
00:13:56,170 --> 00:14:01,829
about, number 8; hyperspectral imaging for

water quality in coastal bays.

223
00:14:01,829 --> 00:14:05,930
Now I'll admit at first blush, this was counterintuitive
to me.

224
00:14:05,930 --> 00:14:09,790
I think you could learn more about the water
being right there and sampling the water.

225
00:14:09,790 --> 00:14:11,350
>> Julie Robinson: Other than going up into
space [laughs]?

226
00:14:11,350 --> 00:14:12,350
>> Other than going up into space.

227
00:14:12,350 --> 00:14:13,350
>> Julie Robinson: [Laughs]

228
00:14:13,350 --> 00:14:16,069
>> What is it that you can learn from an instrument
on orbit?

229
00:14:16,069 --> 00:14:20,180
>> Julie Robinson: Yeah so the thing about
the Space Station is it's about half the altitude

230
00:14:20,180 --> 00:14:25,450
of most remote sensing satellites and it has
extraordinary power and data.

231
00:14:25,450 --> 00:14:28,880
And so there are a number of locations that
we built here when the Space Station was designed,

232
00:14:28,880 --> 00:14:33,190
over 30 of them, where instruments can be
attached to observe the earth or to observe

233
00:14:33,190 --> 00:14:34,190
space.

234
00:14:34,190 --> 00:14:37,521
And one of those instruments is called the
hyperspectral imager for the coastal ocean.

235
00:14:37,521 --> 00:14:44,830
It's the first hyperspectral imager ever flown
in space that is tuned to looking at the colors

236
00:14:44,830 --> 00:14:49,530
in the ocean; the different wave lengths of
light that are going to reflect the best and

237
00:14:49,530 --> 00:14:50,530
give you the most information.

238
00:14:50,530 --> 00:14:54,350
And so it was really designed to help you
distinguish...if you're looking down at the

239
00:14:54,350 --> 00:14:59,480
ocean to distinguish between sediment and
algae and all of those other things; the bottom

240
00:14:59,480 --> 00:15:03,631
signature and all of those things to really
tease apart the signal that you get when you

241
00:15:03,631 --> 00:15:05,200
look at the water.

242
00:15:05,200 --> 00:15:07,570
And it was built by the Naval Research Laboratory.

243
00:15:07,570 --> 00:15:11,971
It was used for a number of years; primarily
for the Naval Research Laboratory but they

244
00:15:11,971 --> 00:15:16,390
offered a little bit of access to other scientists.

245
00:15:16,390 --> 00:15:22,380
And this year in January, we converted that
to a fully operational part of the Space Station

246
00:15:22,380 --> 00:15:26,980
infrastructure, so we made it part of the
National Laboratory so that not just the Navy

247
00:15:26,980 --> 00:15:30,810
but all of our NASA scientists could access
it and request imagery.

248
00:15:30,810 --> 00:15:36,889
And one of the great uses that came from its
early phase was the Navy had worked with the

249
00:15:36,889 --> 00:15:41,500
EPA and the EPA would coordinate the data
collections from the Space Station with times

250
00:15:41,500 --> 00:15:44,600
when they were going to been in the water
in bays around Florida.

251
00:15:44,600 --> 00:15:48,850
And those waters are incredibly complicated
because you know there are subtropical waters,

252
00:15:48,850 --> 00:15:55,100
they've got a lot of algae, a lot of plankton,
there's a lot of sediment running off into

253
00:15:55,100 --> 00:15:59,089
the bays from the land, there's a lot of fertilizer
running off into the bays from the land.

254
00:15:59,089 --> 00:16:03,230
So they were interested in seeing if they
could tune a hyperspectral algorithm to actually

255
00:16:03,230 --> 00:16:07,620
tell them what the water quality was and the
reason you want to do that is because you

256
00:16:07,620 --> 00:16:09,940
can't always be everywhere in the water.

257
00:16:09,940 --> 00:16:13,530
Those sampling...when you send out boats full
of scientists to sample the water, that's

258
00:16:13,530 --> 00:16:15,310
an extraordinary field effort.

259
00:16:15,310 --> 00:16:19,220
And so if you could develop the right algorithm,
then your hyperspectral instrument can actually

260
00:16:19,220 --> 00:16:22,690
look down and you could predict what the water
quality is without being there.

261
00:16:22,690 --> 00:16:30,870
And now the EPA, that won an award for innovative
science at the EPA and now they're working

262
00:16:30,870 --> 00:16:35,710
on developing an app so that they can then
have kind of real time information about the

263
00:16:35,710 --> 00:16:39,329
water quality in some of the bays around the
Florida coast.

264
00:16:39,329 --> 00:16:43,529

>> It's also a good example of research being
done on the Station that doesn't really require

265
00:16:43,529 --> 00:16:45,440
the participation of the human crew.

266
00:16:45,440 --> 00:16:46,820
>> Julie Robinson: That's right.

267
00:16:46,820 --> 00:16:51,470
You know crew time is really important because
having the human there interacting with the

268
00:16:51,470 --> 00:16:55,490
experiments, talking to the investigators
on the ground; all of that is very important

269
00:16:55,490 --> 00:16:59,610
for parts of the science, but these instrument
opportunities are also extraordinary.

270
00:16:59,610 --> 00:17:07,200
>> Let's move on to the next in our countdown;
number 7 is colloid self-assembly; using electrical

271
00:17:07,200 --> 00:17:10,010
fields for nanomaterials.

272
00:17:10,010 --> 00:17:13,059
There are 2 terms here already that I need
definitions for.

273
00:17:13,059 --> 00:17:14,059
>> Julie Robinson: [Laughs]

274
00:17:14,059 --> 00:17:15,169
>> What are colloids; what are nanomaterials?

275
00:17:15,169 --> 00:17:16,169

>> Julie Robinson: Yeah.

276
00:17:16,169 --> 00:17:21,490
So colloids are any mixture of a solid and
a liquid that stay in suspension together.

277
00:17:21,490 --> 00:17:24,250
And that sounds real goofy, but think of paint.

278
00:17:24,250 --> 00:17:28,820
You know paint is all your pigment particles
and they're mixed into a water and oil base

279
00:17:28,820 --> 00:17:31,160
and they stay together and you could use them.

280
00:17:31,160 --> 00:17:38,059
Another great example of a colloid are some
shampoos or fabric softener are colloids where

281
00:17:38,059 --> 00:17:41,880
you've got the softening particles distributed
in the liquid matrix that you can then measure

282
00:17:41,880 --> 00:17:42,880
out and pour.

283
00:17:42,880 --> 00:17:45,970
>> And these could be things that are for
any number of different applications?

284
00:17:45,970 --> 00:17:46,970
>> Julie Robinson: Right, right.

285
00:17:46,970 --> 00:17:47,970
>> I mean it is all still colloids?

286
00:17:47,970 --> 00:17:48,970
>> Julie Robinson: Right.

287
00:17:48,970 --> 00:17:52,830
And so when you work with colloids in earth
whenever you have differences in densities,

288
00:17:52,830 --> 00:17:55,970
things will settle out and eventually sediment.

289
00:17:55,970 --> 00:18:01,080
And so one of the interests that you have
is in having paint not settle out before its

290
00:18:05,370 --> 00:18:02,080
time.

291
00:18:05,370 --> 00:18:10,250
You know if a medicine settles and the consumer
doesn't shake it up, then they might draw

292
00:18:10,250 --> 00:18:11,320
the wrong dose out.

293
00:18:11,320 --> 00:18:12,320
>> Mm-hmm.

294
00:18:12,320 --> 00:18:14,900
>> Julie Robinson: So keeping colloids in
suspension and really understanding those

295
00:18:14,900 --> 00:18:21,820
is a really important part of an area of materials
or physical science research and what nanomaterials

296
00:18:21,820 --> 00:18:26,380
are is another area of material science that
interfaces with the colloids work.

297
00:18:26,380 --> 00:18:30,790
So nanomaterials are those materials that

you assemble together where you can actually

298
00:18:30,790 --> 00:18:35,780
get the structure you want, but you're paying
attention to that structure molecule by molecule.

299
00:18:35,780 --> 00:18:41,130
And since we don't have molecule sized you
know tools for putting those together, you

300
00:18:41,130 --> 00:18:45,510
have to find ways to get those materials to
assemble themselves in the way that you want

301
00:18:47,530 --> 00:18:46,510
them.

302
00:18:47,530 --> 00:18:48,530
>> Julie Robinson: Right.

303
00:18:48,530 --> 00:18:49,530
>> ...on orbit?

304
00:18:49,530 --> 00:18:50,530
>> Julie Robinson: Right.

305
00:18:50,530 --> 00:18:52,710
But on earth or in space, you have to be clever
about how you manipulate them.

306
00:18:52,710 --> 00:18:56,880
You can use electronic fields, you can use...you
know try to use all the tricks you have to

307
00:18:56,880 --> 00:19:00,910
get the molecules to line up the way you want,
to lattice in and form a structure the way

308
00:19:00,910 --> 00:19:01,910

you want.

309
00:19:01,910 --> 00:19:05,340
If you can control your smart materials, you
can make amazing things.

310
00:19:05,340 --> 00:19:09,980
And so a lot of people now don't know what
nanomaterials are, but they've heard of them

311
00:19:09,980 --> 00:19:14,820
because they're providing all kinds of innovations
in industry; better filters, better...you

312
00:19:14,820 --> 00:19:19,169
know all kinds of different things you can
use if you can get those molecules to be arranged

313
00:19:19,169 --> 00:19:20,780
the way that you want them.

314
00:19:20,780 --> 00:19:24,890
>> In this particular case you've got something
of a breakthrough because of the human participation.

315
00:19:24,890 --> 00:19:28,580
You had a little serendipity with one of the
crew members, right?

316
00:19:28,580 --> 00:19:29,580
>> Julie Robinson: Right.

317
00:19:29,580 --> 00:19:37,110
So we had a study going on early on ISS that
was starting to look at magnetorheological

318
00:19:37,110 --> 00:19:38,110
fluids.

319

00:19:38,110 --> 00:19:41,410
Those are fluids that get thicker or thinner
when you put them in a magnetic field.

320
00:19:41,410 --> 00:19:47,809
And those are important fuilds for shock absorbers,
bridges, they can be put in a building and

321
00:19:47,809 --> 00:19:51,210
they can be firmer and then if there's an
earthquake, they can relax and let the building

322
00:19:51,210 --> 00:19:53,690
flex a little bit and then firm up again when
the earthquake is over.

323
00:19:53,690 --> 00:19:55,750
They are really amazing materials.

324
00:19:55,750 --> 00:19:56,750
>> Yeah.

325
00:19:56,750 --> 00:20:00,580
>> Julie Robinson: And we had a scientist,
Dr. Eric Furst, who was doing a study with

326
00:20:00,580 --> 00:20:06,160
a very simple system at first and in those
first experiments, Peggy Whitson on orbit

327
00:20:06,160 --> 00:20:09,450
was setting up the settings for what the electromagnetic
field would be.

328
00:20:09,450 --> 00:20:13,210
She was basically setting the current and
he had these different mixtures of particles

329
00:20:13,210 --> 00:20:19,050
in liquid and she accidently got a setting

a little off and all of a sudden the field

330
00:20:19,050 --> 00:20:23,980
started pulsing so that the particles instead
of just ling up in nice little chains which

331
00:20:23,980 --> 00:20:28,320
is what they had been doing, they started
ling up, breaking apart, ling up, breaking

332
00:20:28,320 --> 00:20:29,320
apart.

333
00:20:29,320 --> 00:20:33,710
And so that was exciting; the investigator
on the ground didn't know what it was.

334
00:20:33,710 --> 00:20:34,710
It wasn't expected.

335
00:20:34,710 --> 00:20:37,520
We wound up doing a lot more runs than where
ever expected.

336
00:20:37,520 --> 00:20:41,000
Now he's I think on to his third separately
funded project.

337
00:20:41,000 --> 00:20:46,320
You know that was a decade ago and now he's
working with these incredibly sophisticated

338
00:20:46,320 --> 00:20:51,500
colloid mixes where he's designing the particles
that are floating in this liquid and using

339
00:20:51,500 --> 00:20:56,240
special mixes and then seeing if he can apply
the fields to make them self-assemble in the

340
00:20:56,240 --> 00:20:57,240
way that he wants.

341
00:20:57,240 --> 00:21:01,020
And he's had some really important publications
that have come from that work in the Proceedings

342
00:21:01,020 --> 00:21:04,150
of the National Academy of Sciences and so
that was one of the ones that I definitely

343
00:21:04,150 --> 00:21:05,480
wanted to call out for this top 10.

344
00:21:05,480 --> 00:21:06,520
>> That's very interesting.

345
00:21:06,520 --> 00:21:09,770
And next on our list is another result that's
in the physical sciences.

346
00:21:09,770 --> 00:21:15,470
This is number 6; a new process of cool flame
combustion.

347
00:21:15,470 --> 00:21:19,120
And I believe this one is like a brand new
discovery.

348
00:21:19,120 --> 00:21:21,120
Start by explaining what is a cool flame?

349
00:21:21,120 --> 00:21:25,169
>> Julie Robinson: Yeah, I had to find that
out myself because I don't think of flames

350
00:21:25,169 --> 00:21:26,169
as ever being cool.

351
00:21:26,169 --> 00:21:27,169
>> No.

352
00:21:27,169 --> 00:21:29,761
>> Julie Robinson: And in fact a cool flame
is you know roughly a 600 degree Celsius flame

353
00:21:29,761 --> 00:21:31,580
so it's still pretty hot.

354
00:21:31,580 --> 00:21:36,440
But what...you know we have this great combustion
facility on the Space Station.

355
00:21:36,440 --> 00:21:40,580
Many people don't realize; they think of fires
in space as being bad and of course an uncontrolled

356
00:21:40,580 --> 00:21:42,080
fire in space is very bad.

357
00:21:42,080 --> 00:21:47,290
But we have a facility where almost all the
time we're burning different materials and

358
00:21:47,290 --> 00:21:51,000
the reason we do that is because just like
I mentioned there was no sedimentation, well

359
00:21:51,000 --> 00:21:53,179
there's also no convection in orbit.

360
00:21:53,179 --> 00:21:57,840
So when you...if you were to burn a candle
on the Space Station, instead of getting a

361
00:21:57,840 --> 00:22:02,780
nice little candle shaped flame, instead you're
going to get this glowing blue ball with no

362
00:22:02,780 --> 00:22:05,400
warm air rising off the top of it.

363
00:22:05,400 --> 00:22:10,740
And what that means from a scientific perspective
is you can model combustion in much simpler

364
00:22:10,740 --> 00:22:15,860
set of mathematics on the Space Station because
you don't have all this mixing that can feed

365
00:22:15,860 --> 00:22:17,590
the flame, disrupt the flame.

366
00:22:17,590 --> 00:22:20,049
So if you think about...another way to think
about it is when you know you teach a boy

367
00:22:20,049 --> 00:22:23,420
scout to build a fire, you teach them to make
sure you've got the right openings for air

368
00:22:23,420 --> 00:22:24,420
to flow through the fire.

369
00:22:24,420 --> 00:22:25,420
>> Right.

370
00:22:25,420 --> 00:22:28,020
>> Julie Robinson: Because that's...but that's
a very complex process.

371
00:22:28,020 --> 00:22:31,720
The math behind that is incredibly difficult
to model.

372
00:22:31,720 --> 00:22:37,240
So what combustion scientists do on the Space

Station is they try to simplify the system

373
00:22:37,240 --> 00:22:43,310
by taking all that convection mixing out of
the system and then study combustion in its

374
00:22:43,310 --> 00:22:48,110
purest form and that has some great advantages
mathematically but mathematical advantages

375
00:22:48,110 --> 00:22:52,900
also turn into the knowledge that can help
you innovate and develop more efficient combustion

376
00:22:52,900 --> 00:22:53,900
engines.

377
00:22:53,900 --> 00:22:58,679
>> Well you're trying to find out why things
burn, but also what causes the burning to

378
00:22:58,679 --> 00:22:59,679
stop, right?

379
00:22:59,679 --> 00:23:04,200
>> Julie Robinson: Right and you're even trying
to understand you know exactly how that burning

380
00:23:04,200 --> 00:23:07,630
functions as a system and describe that mathematically.

381
00:23:07,630 --> 00:23:09,530
So the cold flame...

382
00:23:09,530 --> 00:23:10,530
>> Right.

383
00:23:10,530 --> 00:23:13,220
>> Julie Robinson: ...discovery was another

big surprise that came.

384
00:23:13,220 --> 00:23:20,240
And what happened is we have a droplet combustion
apparatus and we were basically taking little

385
00:23:20,240 --> 00:23:25,179
bits of things like heptane, you know liquid
fuels, and in heating them up and in burning

386
00:23:25,179 --> 00:23:30,450
up this little droplet and watching it and
collecting data on the temperature, the gasses

387
00:23:30,450 --> 00:23:35,400
that were coming off, how long it took, and
we were controlling different flow rates and

388
00:23:35,400 --> 00:23:40,720
what was discovered was there was a set of
conditions where after the normal blue ball

389
00:23:40,720 --> 00:23:44,960
occurred, then that blue ball kind of suffocates
in its own gasses.

390
00:23:44,960 --> 00:23:45,960
>> The flame goes out?

391
00:23:45,960 --> 00:23:46,960
>> Julie Robinson: The flame goes out.

392
00:23:46,960 --> 00:23:52,910
And then afterwards there was this glow that
reignited, but it wasn't the same blue flame

393
00:23:52,910 --> 00:23:55,330
that you had seen before; the same hot flame.

394

00:23:55,330 --> 00:24:02,299
Instead it this cool reddish flame and it
turns out that there is a secondary combustion

395
00:24:02,299 --> 00:24:06,289
process that was not predicted by any of the
existing combustion theories.

396
00:24:06,289 --> 00:24:09,460
So it's this brand new novel process and the
scientists called it cool flame because it's

397
00:24:09,460 --> 00:24:12,090
much cooler than the primary flame was in
the beginning.

398
00:24:12,090 --> 00:24:14,370
>> Is it...spontaneous combustion is almost
what it's like.

399
00:24:14,370 --> 00:24:16,620
>> Julie Robinson: Well it actually hadn't
quite finished.

400
00:24:16,620 --> 00:24:17,620
>> Ok.

401
00:24:17,620 --> 00:24:21,600
>> Julie Robinson: People thought it had quenched
and stopped, but there was a little bit of

402
00:24:21,600 --> 00:24:26,169
time and then there was another chemical process
that could come in and in an additional set

403
00:24:26,169 --> 00:24:27,350
of combustion.

404
00:24:27,350 --> 00:24:31,810
>> Additional research than I'm sure is being

done based on these findings?

405
00:24:31,810 --> 00:24:32,850
>> Julie Robinson: That's right.

406
00:24:32,850 --> 00:24:33,850
That's right.

407
00:24:33,850 --> 00:24:39,320
So you know basically this facility is operating
whenever we can in the background going through

408
00:24:39,320 --> 00:24:45,630
different gasses, different flow rates, different
combustion settings, collecting all this priceless

409
00:24:45,630 --> 00:24:49,850
data that's never been known before, and then
all of that data feeds into models that will

410
00:24:49,850 --> 00:24:55,350
help us both to better design combustion engines
in general, but then to also better understand

411
00:24:55,350 --> 00:25:00,150
how things burn in orbit and that helps us
provide fire safety for future spacecraft

412
00:25:00,150 --> 00:25:01,150
as well.

413
00:25:01,150 --> 00:25:06,200
>> And in fact there are several...I think
several different kind of combustion experiments

414
00:25:06,200 --> 00:25:09,130
that are going on beyond just the one that
lead to this?

415

00:25:09,130 --> 00:25:10,130
>> Julie Robinson: That's right.

416
00:25:10,130 --> 00:25:15,520
We have an experiment called BASS -- Burning
and Suppression of Solids -- where we're burning

417
00:25:15,520 --> 00:25:20,340
all the different materials that could catch
fire in a spacecraft and seeing what happens

418
00:25:20,340 --> 00:25:21,590
when they actually burn in space.

419
00:25:21,590 --> 00:25:26,419
And what we're finding is all the standards
we had used for space call flammability were

420
00:25:26,419 --> 00:25:30,660
assuming that they burn the same on earth
as they do in space and they don't.

421
00:25:30,660 --> 00:25:33,930
So there are certain things that are more
flammable in space than we thought they would

422
00:25:33,930 --> 00:25:35,890
be and other things that are less flammable.

423
00:25:35,890 --> 00:25:36,890
>> Mm-hmm.

424
00:25:36,890 --> 00:25:39,030
>> Julie Robinson: And in the end, I think
the work that we're doing on the Space Station

425
00:25:39,030 --> 00:25:43,619
is going to completely rewrite the fire safety
manuals for space craft.

426
00:25:43,619 --> 00:25:48,580
>> You're finding out why things burn but
also I guess some insight into how to stop

427
00:25:48,580 --> 00:25:49,860
fires that you don't want?

428
00:25:49,860 --> 00:25:53,750
>> Julie Robinson: Right, and even insights
into how to detect fires because smoke detectors

429
00:25:53,750 --> 00:25:58,070
are assuming that smoke looks like something,
its detectable at certain sizes.

430
00:25:58,070 --> 00:26:03,850
And it turns out particles are a lot bigger
in space than anybody thought.

431
00:26:03,850 --> 00:26:09,030
>> Julie, this is great and I want to thank
you for helping me make sense of all of that.

432
00:26:09,030 --> 00:26:14,230
The things that you wouldn't think about before
and those things are just half of our top

433
00:26:14,230 --> 00:26:15,230
10 list.

434
00:26:15,230 --> 00:26:18,490
In our next program, we're going to discuss
numbers 5 through 1.

435
00:26:18,490 --> 00:26:24,450
That means we're going to learn about advances
into how genes turn on bacteria, advances

436
00:26:24,450 --> 00:26:29,429

in neurosurgery, in the study of dark matter,
we're going to look at how the station is

437
00:26:29,429 --> 00:26:34,890
reaching students of all ages all over the
world, as well as potential advances in the

438
00:26:34,890 --> 00:26:36,640
treatment of cancer.

439
00:26:36,640 --> 00:26:41,810
All of those are among the top 10 research
results from the International Space Station.

440
00:26:41,810 --> 00:26:42,850
[Music]

441
00:26:42,850 --> 00:26:54,320
>> Read Dr. Robinson's Blog, A Lab Aloft,
online at blogs.NASA.gov.

442
00:26:54,320 --> 00:27:00,990
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Facebook at Facebook.com/ISS.

443
00:27:00,990 --> 00:27:11,159
See the International Space Station as it
orbits above your location; logon to SpotTheSAtation.NASA.gov.

444
00:27:11,159 --> 00:27:17,770
And you can follow the mission; watch Space
Station Live weekdays on NASA Television and