1
00:00:02,769 --> 00:00:20,920
■ Music

2
00:00:21,721 --> 00:00:22,856
Narrator: On Earth,

3
00:00:22,856 --> 00:00:24,257
it's easy to take for granted

4
00:00:24,257 --> 00:00:25,525
the most basic things

5
00:00:25,525 --> 00:00:27,927
we need to live.

6
00:00:27,927 --> 00:00:30,430
But in space--air, water,

7
00:00:30,430 --> 00:00:31,398
and food--

8
00:00:31,398 --> 00:00:32,799
the ingredients of life--

9
00:00:32,799 --> 00:00:34,968
must be transported from Earth.

10
00:00:36,469 --> 00:00:38,038
As we do research aboard

11
00:00:38,038 --> 00:00:39,873
the International Space Station

12
00:00:39,873 --> 00:00:41,975
and go further into space,

13
00:00:41,975 --> 00:00:43,777

we learn more about life

14
00:00:43,777 --> 00:00:45,245
and how it's changed

15
00:00:45,245 --> 00:00:47,414
by spaceflight, and the

16
00:00:47,414 --> 00:00:49,549
knowledge we gain improves

17
00:00:49,549 --> 00:00:51,651
the way we live on Earth.

18
00:00:51,651 --> 00:00:52,752
Richard Hieb: It's important

19
00:00:52,752 --> 00:00:54,087
to remember our journey

20
00:00:54,087 --> 00:00:55,755
begins right here on Earth

21
00:00:57,724 --> 00:00:56,790
with the work we do at NASA, in

22
00:00:57,724 --> 00:01:00,060
the Space Biosciences Division.

23
00:01:00,927 --> 00:01:02,662
Narrator: Life support in space

24
00:01:02,662 --> 00:01:03,797
means we have to supply

25
00:01:03,797 --> 00:01:05,298
astronauts with sustainable

26
00:01:05,298 --> 00:01:07,967
sources of air, water, and food

27
00:01:07,967 --> 00:01:09,335
as well as finding ways

28
00:01:09,335 --> 00:01:11,404
to turn waste back into products

29
00:01:11,404 --> 00:01:12,472
that can be used

30
00:01:12,472 --> 00:01:14,240
again and again.

31
00:01:15,141 --> 00:01:16,643
In space, the air quickly

32
00:01:16,643 --> 00:01:18,011
becomes polluted by our own

33
00:01:18,011 --> 00:01:20,180
breath in the form of CO2.

34
00:01:20,180 --> 00:01:21,681
At high levels,

35
00:01:21,681 --> 00:01:23,817
CO2 can become deadly.

36
00:01:23,817 --> 00:01:26,352
We're working on ways to remove

37
00:01:26,352 --> 00:01:27,787
poisonous carbon dioxide from

38
00:01:27,787 --> 00:01:29,656

the cabin, pressurize it,

39
00:01:29,656 --> 00:01:30,990
and convert it back

40
00:01:30,990 --> 00:01:33,093
to pure oxygen.

41
00:01:33,093 --> 00:01:34,494
The same concept

42
00:01:34,494 --> 00:01:35,995
works for water.

43
00:01:35,995 --> 00:01:37,497
We treat wastewater

44
00:01:37,497 --> 00:01:38,998
and transform it

45
00:01:38,998 --> 00:01:42,035
into pure drinking water.

46
00:01:42,035 --> 00:01:43,436
Onboard a spacecraft,

47
00:01:43,436 --> 00:01:46,539
every inch is vital.

48
00:01:46,539 --> 00:01:48,641
The trash astronauts create

49
00:01:48,641 --> 00:01:50,477
would fill the entire station

50
00:01:50,477 --> 00:01:52,112
in no time.

51
00:01:52,112 --> 00:01:54,013
So we've developed a tool to

52
00:01:54,013 --> 00:01:55,882
compact solid waste, using heat

53
00:01:55,882 --> 00:01:57,684
that melts it into a brick

54
00:01:57,684 --> 00:02:00,453
the size of a Frisbee.

55
00:02:00,453 --> 00:02:02,055
This doesn't just work

56
00:02:02,055 --> 00:02:04,023
in space--heat melt compactors

57
00:02:04,023 --> 00:02:06,025
can be used for trash on Earth

58
00:02:06,025 --> 00:02:07,694
to prevent ocean dumping

59
00:02:07,694 --> 00:02:09,829
and huge landfills.

60
00:02:11,664 --> 00:02:13,066
Scientists at NASA's

61
00:02:13,066 --> 00:02:15,034
Omega Project are studying

62
00:02:15,034 --> 00:02:16,870
the use of algae

63
00:02:16,870 --> 00:02:18,738

to clean up wastewater.

64
00:02:18,738 --> 00:02:21,007
As the algae grows, it can be

65
00:02:21,007 --> 00:02:22,509
harvested to provide a food

66
00:02:22,509 --> 00:02:24,043
source or to provide

67
00:02:24,043 --> 00:02:26,012
aviation biofuel.

68
00:02:26,012 --> 00:02:28,047
This discovery not only

69
00:02:28,047 --> 00:02:29,916
presents huge possible benefits

70
00:02:29,916 --> 00:02:31,050
for air travel,

71
00:02:31,050 --> 00:02:32,552
it's being tried in waste

72
00:02:32,552 --> 00:02:34,053
treatment plants on Earth to

73
00:02:34,053 --> 00:02:36,556
help clean up the environment.

74
00:02:37,991 --> 00:02:40,059
At NASA we pride ourselves on

75
00:02:40,059 --> 00:02:41,928
the ability to invent solutions

76
00:02:41,928 --> 00:02:43,897
using tools, hardware,

77
00:02:43,897 --> 00:02:45,698
and ingenuity,

78
00:02:45,698 --> 00:02:47,233
but some of our most ingenious

79
00:02:47,233 --> 00:02:49,669
tools don't involve wrenches.

80
00:02:49,669 --> 00:02:51,171
NASA scientists are building

81
00:02:51,171 --> 00:02:53,239
synthetic biological systems

82
00:02:53,239 --> 00:02:54,574
to help meet the demands

83
00:02:54,574 --> 00:02:56,209
for recycling waste while

84
00:02:56,209 --> 00:02:58,077
generating useful resources

85
00:02:58,077 --> 00:03:00,280
like clean air and water,

86
00:03:00,280 --> 00:03:01,114
and new materials

87
00:03:01,114 --> 00:03:03,616
for construction.

88
00:03:03,616 --> 00:03:05,585

By combining products made by

89
00:03:05,585 --> 00:03:07,954
engineered bacteria, with dust

90
00:03:07,954 --> 00:03:10,089
and rock on the moon and Mars,

91
00:03:10,089 --> 00:03:11,758
astronauts could one day make

92
00:03:11,758 --> 00:03:13,560
building materials for landing

93
00:03:13,560 --> 00:03:15,128
pads and shelter

94
00:03:15,128 --> 00:03:17,397
from extreme environments.

95
00:03:19,265 --> 00:03:21,134
For tens of thousands of years,

96
00:03:21,134 --> 00:03:23,069
human beings have thrived

97
00:03:23,069 --> 00:03:24,571
while living with the consistent

98
00:03:24,571 --> 00:03:27,774
force of gravity on Earth.

99
00:03:27,774 --> 00:03:30,210
But in space, people experience

100
00:03:30,210 --> 00:03:32,378
a variety of gravity levels--

101
00:03:32,378 --> 00:03:34,147
from the rocket launch

102
00:03:34,147 --> 00:03:35,949
to floating in a spacecraft

103
00:03:35,949 --> 00:03:37,217
orbiting Earth

104
00:03:37,217 --> 00:03:40,920
to walking on other worlds.

105
00:03:40,920 --> 00:03:42,422
The centrifuge helps us

106
00:03:42,422 --> 00:03:44,290
understand how the human body

107
00:03:44,290 --> 00:03:45,792
responds to these changes

108
00:03:45,792 --> 00:03:47,126
in gravity.

109
00:03:47,126 --> 00:03:48,795
This knowledge helps us develop

110
00:03:48,795 --> 00:03:50,630
countermeasures to ensure

111
00:03:50,630 --> 00:03:53,499
astronauts come home healthy.

112
00:03:53,900 --> 00:03:55,768
NASA is also developing tools

113
00:03:55,768 --> 00:03:56,970

that can monitor the health of

114
00:03:56,970 --> 00:03:58,738
astronauts in space,

115
00:03:58,738 --> 00:04:00,106
including medical equipment

116
00:04:00,106 --> 00:04:01,808
like the portable Ultrasound

117
00:04:01,808 --> 00:04:05,144
imaging device onboard the ISS.

118
00:04:05,144 --> 00:04:06,813
Ultrasound techniques

119
00:04:06,813 --> 00:04:07,814
developed by NASA

120
00:04:07,814 --> 00:04:09,315
for soft tissue imaging

121
00:04:09,315 --> 00:04:10,984
and next generation science

122
00:04:10,984 --> 00:04:12,952
experiments are also used

123
00:04:12,952 --> 00:04:14,354
to help diagnose injuries

124
00:04:14,354 --> 00:04:15,989
and broken bones in

125
00:04:15,989 --> 00:04:17,357
remote medical clinics where

126
00:04:17,357 --> 00:04:20,326
X-ray machines are unavailable.

127
00:04:20,994 --> 00:04:22,829
The further out into

128
00:04:22,829 --> 00:04:24,964
space we go, the more we need

129
00:04:24,964 --> 00:04:26,332
to explore the science of

130
00:04:26,332 --> 00:04:28,201
life itself.

131
00:04:28,201 --> 00:04:29,969
As we study how the lack

132
00:04:29,969 --> 00:04:31,671
of gravity and higher levels of

133
00:04:31,671 --> 00:04:34,540
radiation affect life in space,

134
00:04:34,540 --> 00:04:36,676
we begin to understand why bones

135
00:04:36,676 --> 00:04:39,045
and muscles weaken, how plants

136
00:04:39,045 --> 00:04:40,980
grow differently, and why

137
00:04:40,980 --> 00:04:43,883
microbes become more infectious.

138
00:04:43,883 --> 00:04:45,852

We research how human cells

139
00:04:45,852 --> 00:04:47,353
respond to long periods of

140
00:04:47,353 --> 00:04:49,188
low gravity and perform

141
00:04:49,188 --> 00:04:50,957
experiments on fruit flies

142
00:04:50,957 --> 00:04:52,292
to help scientists better

143
00:04:52,292 --> 00:04:55,228
understand infectious diseases.

144
00:04:56,062 --> 00:04:57,997
New systems being developed at

145
00:04:57,997 --> 00:04:59,899
NASA are enabling further

146
00:04:59,899 --> 00:05:02,068
breakthroughs in science.

147
00:05:02,068 --> 00:05:03,369
Biological experiments

148
00:05:03,369 --> 00:05:04,704
involving mice on the

149
00:05:04,704 --> 00:05:06,339
International Space Station

150
00:05:06,339 --> 00:05:08,041
are telling us how animals

151
00:05:08,041 --> 00:05:09,976
change and adapt to being in

152
00:05:09,976 --> 00:05:12,979
space for weeks and months.

153
00:05:12,979 --> 00:05:14,747
What we learn will keep

154
00:05:14,747 --> 00:05:16,549
astronauts healthy and strong

155
00:05:16,549 --> 00:05:18,151
during their long journeys

156
00:05:18,151 --> 00:05:20,553
into space.

157
00:05:22,155 --> 00:05:23,723
Beyond the safe embrace

158
00:05:23,723 --> 00:05:25,558
of Earth, the men and women

159
00:05:25,558 --> 00:05:27,327
who journey to deep space

160
00:05:27,327 --> 00:05:28,561
must be protected from

161
00:05:28,561 --> 00:05:31,164
extremes of heat and cold,

162
00:05:31,164 --> 00:05:32,932
from the invisible but deadly

163
00:05:32,932 --> 00:05:35,535

effects of solar radiation,

164
00:05:35,535 --> 00:05:37,904
and from the lack of gravity,

165
00:05:37,904 --> 00:05:40,206
air, water, and food.

166
00:05:40,206 --> 00:05:40,907
Richard Hieb: It's important

167
00:05:40,907 --> 00:05:42,075
to remember our journey

168
00:05:42,075 --> 00:05:43,576
begins right here on Earth

169
00:05:43,576 --> 00:05:46,045
with the work we do at NASA.

170
00:05:46,045 --> 00:05:47,413
Narrator: Our work enables us

171
00:05:47,413 --> 00:05:48,915
to support long-term

172
00:05:48,915 --> 00:05:50,883
human space exploration,

173
00:05:50,883 --> 00:05:52,752
and the discoveries we make

174
00:05:52,752 --> 00:05:54,420
will have profound impacts

175
00:05:54,420 --> 00:05:56,356
on our journey through space