

A satellite in space, with the Earth's horizon and atmosphere visible in the background. The satellite's structure, including solar panels and various instruments, is visible in the foreground. The text is overlaid on the left side of the image.

**WE OBSERVED
THOUSANDS
AND THOUSANDS
OF CHANGES AT THE
MOLECULAR
AND GENETIC LEVEL**

1
00:00:00,533 --> 00:00:01,668
>> WE OBSERVED THOUSANDS

2
00:00:01,668 --> 00:00:02,902
AND THOUSANDS OF CHANGES

3
00:00:02,902 --> 00:00:04,104
AT THE MOLECULAR AND GENETIC

4
00:00:04,104 --> 00:00:05,238
LEVEL WHEN SCOTT KELLY

5
00:00:05,238 --> 00:00:06,206
WAS IN SPACE.

6
00:00:07,273 --> 00:00:10,243
[MUSIC]

7
00:00:10,243 --> 00:00:11,745
WE OBSERVED CHANGES IN SMALL

8
00:00:11,745 --> 00:00:13,146
MOLECULES IN THE BLOOD STREAM,

9
00:00:13,146 --> 00:00:14,381
CHANGES IN HOW GENES GO UP

10
00:00:14,381 --> 00:00:16,316
AND GO DOWN, UH, CHANGES

11
00:00:16,316 --> 00:00:18,118
IN HOW DNA WAS PACKAGED.

12
00:00:18,118 --> 00:00:19,719
THE TELOMERES GOT LONGER.

13
00:00:19,719 --> 00:00:20,887

THE MICROBIOME IN THE GUT

14

00:00:20,887 --> 00:00:21,855
CHANGED.

15

00:00:21,855 --> 00:00:22,956
WE SAW STRESSORS IN THE BODY,

16

00:00:22,956 --> 00:00:24,557
CHANGES IN HIS VISION.

17

00:00:24,557 --> 00:00:25,558
AND ALSO, WE'VE BEEN LOOKING

18

00:00:25,558 --> 00:00:27,127
INTENSELY AT IMMUNE CELLS,

19

00:00:27,127 --> 00:00:28,795
WHICH ARE NOTORIOUSLY ADAPTIVE.

20

00:00:28,795 --> 00:00:29,929
AND SO WE KNOW THAT

21

00:00:29,929 --> 00:00:31,297
THESE CELLS ARE EXPECTED

22

00:00:31,297 --> 00:00:32,132
TO CHANGE.

23

00:00:32,999 --> 00:00:35,068
[MUSIC]

24

00:00:35,068 --> 00:00:36,603
>> THIS IS THE FIRST TIME EVER

25

00:00:36,603 --> 00:00:38,004
THAT WE'VE STUDIED

26

00:00:38,004 --> 00:00:39,406

A TWIN IN SPACE FLIGHT

27

00:00:39,406 --> 00:00:41,374

AND ONE ON THE GROUND.

28

00:00:41,374 --> 00:00:42,609

SO WE HAVE THE SAME GENETIC

29

00:00:42,609 --> 00:00:44,277

BACKGROUND IN BOTH INDIVIDUALS,

30

00:00:44,277 --> 00:00:45,044

AND ARE NOW LOOKING AT

31

00:00:45,044 --> 00:00:46,546

HOW THE ENVIRONMENT, UH,

32

00:00:46,546 --> 00:00:47,947

CHANGES THINGS-- IN THIS CASE,

33

00:00:47,947 --> 00:00:48,815

SPACE FLIGHT.

34

00:00:48,815 --> 00:00:50,083

THE GENE EXPRESSION

35

00:00:50,083 --> 00:00:52,886

IN SCOTT'S WHITE BLOOD CELLS

36

00:00:52,886 --> 00:00:53,920

CHANGED IN FLIGHT.

37

00:00:53,920 --> 00:00:56,089

7% OF THE GENE EXPRESSION

38

00:00:56,089 --> 00:00:57,390

PERSISTED SIX MONTHS AFTER

39

00:00:57,390 --> 00:00:58,925
HIS FLIGHT.

40

00:00:58,925 --> 00:01:00,794
SO GENES ARE NOT ON OR OFF.

41

00:01:00,794 --> 00:01:02,061
THEY'RE THROTTLED, LIKE

42

00:01:02,061 --> 00:01:03,696
YOUR AUTOMOBILE ENGINE.

43

00:01:03,696 --> 00:01:05,265
7% OF 'EM WERE THROTTLED

44

00:01:05,265 --> 00:01:06,299
IN A DIFFERENT POSITION

45

00:01:06,299 --> 00:01:08,301
EVEN SIX MONTHS AFTER FLIGHT.

46

00:01:08,301 --> 00:01:09,769
>> YOU KNOW, 7% OF GENES

47

00:01:09,769 --> 00:01:10,670
SOUNDS LIKE A LOT, BUT

48

00:01:10,670 --> 00:01:11,504
IT'S IMPORTANT TO REMEMBER

49

00:01:11,504 --> 00:01:12,405
THAT IT'S THE GENES

50

00:01:12,405 --> 00:01:13,573
JUST CHANGING THEIR EXPRESSION,

51
00:01:13,573 --> 00:01:14,374
GOING UP AND DOWN.

52
00:01:14,374 --> 00:01:16,176
SO SCOTT AND MARK KELLY

53
00:01:16,176 --> 00:01:17,744
ARE STILL IDENTICAL TWINS.

54
00:01:17,744 --> 00:01:18,812
UH, THEY MAY HAVE HAD CHANGES

55
00:01:18,812 --> 00:01:19,646
IN THEIR CHROMOSOMES--

56
00:01:19,646 --> 00:01:20,980
SO HOW DNA IS PACKAGED--

57
00:01:20,980 --> 00:01:22,148
BUT AT THE END OF THE DAY,

58
00:01:22,148 --> 00:01:22,816
THEY'RE STILL GONNA LOOK LIKE

59
00:01:22,816 --> 00:01:23,817
EACH OTHER.

60
00:01:23,817 --> 00:01:25,652
THEY'RE DEFINITELY STILL TWINS.

61
00:01:25,652 --> 00:01:26,820
THE REALLY BIG QUESTION IS,

62
00:01:26,820 --> 00:01:27,654
WHAT ABOUT THREE YEARS?

63
00:01:27,654 --> 00:01:29,389

DOES-- SHOULD WE EXPECT TO SEE,

64
00:01:29,389 --> 00:01:30,590
YOU KNOW, BASICALLY THREE TIMES

65
00:01:30,590 --> 00:01:31,524
THE NUMBER OF CHANGES,

66
00:01:31,524 --> 00:01:33,393
TEN TIMES THE NUMBER OF CHANGES?

67
00:01:33,393 --> 00:01:34,627
REALLY, WE-WE DON'T KNOW

68
00:01:34,627 --> 00:01:35,595
AT THIS POINT, 'CAUSE THIS IS

69
00:01:35,595 --> 00:01:37,130
THE FIRST STUDY OF ITS KIND.

70
00:01:37,130 --> 00:01:38,431
THIS SETS THE BEDROCK

71
00:01:38,431 --> 00:01:39,899
OF KNOWLEDGE FOR ALL THE FUTURE

72
00:01:39,899 --> 00:01:41,067
ASTRONAUT STUDIES.

73
00:01:41,067 --> 00:01:41,968
THE VISION OF THE FUTURE

74
00:01:41,968 --> 00:01:43,269
WOULD BE YOU LOOK AT

75
00:01:43,269 --> 00:01:44,404
THE ENTIRE GENETIC CODE,

76
00:01:44,404 --> 00:01:45,738
ALL THE MOLECULAR STRUCTURES

77
00:01:45,738 --> 00:01:47,807
AND CHANGES IN AN INDIVIDUAL,

78
00:01:47,807 --> 00:01:48,942
AND THEN CUSTOMIZE

79
00:01:48,942 --> 00:01:49,976
WHAT HE OR SHE WILL NEED

80
00:01:49,976 --> 00:01:51,144
FOR LONG-TERM MISSIONS.

81
00:01:51,144 --> 00:01:52,445
SO THIS COULD BE PHYSICAL

82
00:01:52,445 --> 00:01:53,313
CHANGES TO HOW THEY DO

83
00:01:53,313 --> 00:01:55,081
EXERCISE, AND ALSO EVEN JUST

84
00:01:55,081 --> 00:01:56,382
HOW THEY, UH, TAKE VITAMINS,

85
00:01:56,382 --> 00:01:57,250
AND HOW THEY EVEN DO--

86
00:01:57,250 --> 00:01:58,384
MANAGE THEIR MICROBIOME.

87
00:01:58,384 --> 00:01:59,919
REALLY, EVERY MOLECULE

88
00:01:59,919 --> 00:02:01,354

IS FAIR GAME FOR MAKING SURE

89

00:02:01,354 --> 00:02:02,222

IT'S CUSTOMIZED

90

00:02:02,222 --> 00:02:03,223

FOR EACH ASTRONAUT.

91

00:02:04,157 --> 00:02:06,326

[MUSIC]

92

00:02:06,326 --> 00:02:07,861

>> THIS RESEARCH HELPS US

93

00:02:07,861 --> 00:02:10,230

IN EXPLORATION BY UNDERSTANDING

94

00:02:10,230 --> 00:02:12,532

HOW THE HUMAN BODY AND MIND

95

00:02:12,532 --> 00:02:13,800

RESPONDS TO SPACE FLIGHT.

96

00:02:13,800 --> 00:02:14,634

THE SPACE STATION IS

97

00:02:14,634 --> 00:02:15,969

OUR STEPPING STONE

98

00:02:15,969 --> 00:02:16,836

TO FURTHER JOURNEYS