Catching Zs in Microgravity.

Getting a good night's sleep is important to our health. This is true not only for people on Earth, but also for people in space. Astronauts aboard the International Space Station experience over a dozen sunrises in a 24-hour period and often find it difficult to reset their internal clocks or circadian rhythm, which helps set our sleep patterns. NASA has ongoing research to help manage this health concern on orbit.

Drager Double Sensor

Measures **core temperature** and **body chemistry** to see how microgravity can alter the circadian rhythm.

AIM TO SLEEP 8.5 HOURS

TEND TO SLEEP 6.0 HOURS

Time for Bed

Crew members aim to get 8 hours of sleep a night, but tend to average 5-6 hours instead.

16 Sunrises

As the space station orbits Earth every 90 minutes, there is a potential for the astronauts to experience up to 16 sunrises each day, which can impact their sleep schedules.

Crew Cabin

Small rooms where astronauts can dim the lights and sleep in bags attached to the cabin wall.

17,500 mph

Space Station Speed on Orbit

Personal Sun

Light-emitting diodes (LEDs) replace fluorescent bulbs, and can easily change color and intensity.

Custom Light

Scientists want to find the optimum setting to improve sleep patterns and cognitive performance throughout the day.

Acti Watch

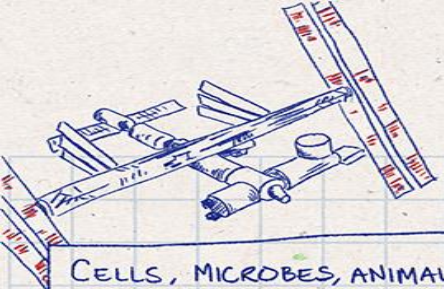
This **fitness tracker** measures the astronaut's activity during wake and sleep hours to see how their body is performing.

Circadian Rhythms

Results could help treat insomnia on Earth and help people who work odd shifts or suffer from jet lag.

24h 39m Martian Day

We need to understand how the human body might adapt, so the first people on the surface of Mars won't fall asleep on the job.



BIOLOGICAL SCIENCES
ON THE INTERNATIONAL SPACE STATION

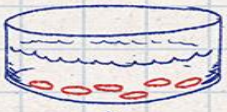
CELLS, MICROBES, ANIMALS AND PLANTS HAVE ALL EVOLVED AND DEVELOPED IN GRAVITY. THE INTERNATIONAL SPACE STATION PROVIDES A UNIQUE PLATFORM IN WHICH SCIENTISTS CAN INVESTIGATE BIOLOGICAL OR LIFE SCIENCES WITHOUT THE CONSTRAINT OF GRAVITY.

RESULTS FROM SUCH RESEARCH COULD HAVE IMPLICATIONS ACROSS EVERYTHING FROM DEVELOPING BETTER MEDICINES ON EARTH TO ENHANCING LIFE SUPPORT CAPABILITIES FOR THE EXPLORATION OF SPACE.

① CELLULAR & MOLECULAR BIOLOGY

μg = "MICROGRAVITY"

1g = EARTH



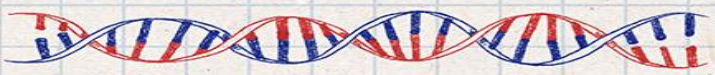
↑
- CELLS ARE FLAT AGAINST SURFACE

μg = ISS

↑
- CELLS ARE SPHERICAL
- FORM AGGREGATES

A) INCLUDES: CELL CULTURE, TISSUE ENGINEERING, AND GENOMIC ANALYSIS OF LIVING SYSTEMS

B) A CHANGE IN GRAVITY CAUSES CHANGES IN THE DYNAMIC FORCES IMPINGING ON CELLS, AND THUS AFFECTS CELL FUNCTION.

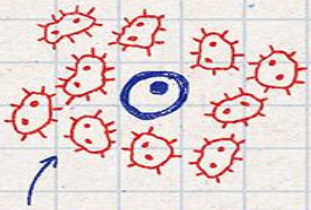


∴ CELLS AND TISSUES IN MICROGRAVITY BEHAVE MORE LIKE THEY DO IN THE HUMAN BODY, SO WE ARE ABLE TO BUILD A MORE COMPLETE UNDERSTANDING OF PROCESSES → MAY LEAD TO ADVANCES IN HEALTH.

② MICROBIAL RESEARCH

A) RESULTS FROM STUDYING MICROBES ABOARD SPACE STATION CAN BE USED TO EVALUATE CLEANING STRATEGIES, AND TO MITIGATE MICROBE-RELATED RISKS TO CREW HEALTH AND SPACECRAFT PERFORMANCE.

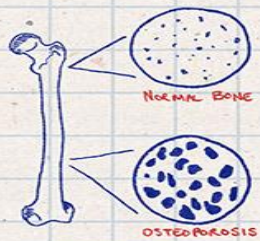
B) IMPLICATIONS FOR EXPLORATION: WE DON'T WANT TO CONTAMINATE OTHER PLANETARY SURFACES.



(MICROBIAL INHABITANTS ON HUMANS OUTNUMBER HUMAN CELLS 10-1)

③ ANIMAL BIOLOGY

A) RESULTS CAN HELP US UNDERSTAND THE EFFECTS OF LONG-DURATION SPACEFLIGHT ON ASTRONAUTS.

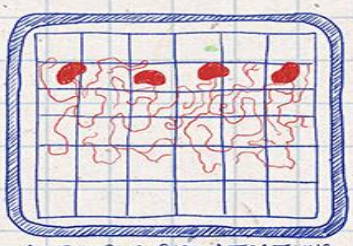


B) RESULTS CAN ALSO INFORM PHARMACEUTICAL DEVELOPMENT FOR BENEFITS ON EARTH.

- OSTEOPOROSIS
- MUSCLE WASTING
- IMMUNE DISFUNCTION

∴ MODEL ORGANISMS SUCH AS RODENTS ALLOW ENTIRE PHYSIOLOGICAL SYSTEMS TO BE STUDIED IN MICROGRAVITY.

④ PLANT BIOLOGY



ARABIDOPSIS ROOT ATTRACTIONS (ROOT GROWTH IN MICROGRAVITY)

A) PLANTS GROW DIFFERENTLY WITHOUT GRAVITATIONAL CUES.

B) ROOTS "SKEW" TO FIND NUTRIENTS.

∴ THIS RESEARCH INCREASES UNDERSTANDING OF FUNDAMENTAL PLANT BIOLOGY ON EARTH, WHICH CAN INFORM AGRICULTURE AND SUSTAINABILITY.

↓ ↓ ↓

THIS KNOWLEDGE IS IMPORTANT FOR FUTURE LIFE SUPPORT SYSTEMS AND NUTRITION SOURCES!

[PLANT GROWTH ON EARTH]