Swimming Upside-down: A Journey with Fish from Space to Cancer Research

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1) **Space** Experiment  
   Space Shuttle Columbia, STS-107 Mission

2) **Space** Education  
   JAXA Space **Biomedical** Outreach

3) **Biomedical** Research  
   Preventing the Side Effect from the Cancer Drug
The Effect of Microgravity on the Behavior of the Japanese Medaka Fish (Oryzias latipes)
JUSTSAP S*T*A*R*S™ Program

- Ants in Space
- Astrospiders – Space in Space
- The Chemical Garden
- Flight of the Medaka Fish
- Spice Bees in Space
- Silkworm Lifecycle During Space Fright
JUSTSAP S*T*A*R*S™ Program

The Effect of Microgravity on the Behavior of the Japanese Medaka Fish (Oryzias latipes)

- Educational Program
  Simplified ground control

- Real-time Internet meetings
  → Gave the feeling of commitment to the space experiment
Internship at Paragon SDC

Experimental Hardware

- 1.5 W fluorescent bulbs
- Habitat parts
- Habitat lid flame
- Aquatic habitat Ecosystem
- Habitat lid

Isothermal Control Module (ICM)

“Nest” Habitat
Internship at Paragon SDC

Small-packaged Life Support System for Long-lasting Space Experiment

Experimental Design
STS-107 Mission - Space Shuttle Columbia

< Under Microgravity >
- Reduction of activity of embryos
  Lower hatching rate (4/4 on Ground VS 1/4 in Space)
  Lower swimming activity

- Dorsal Light Response: Visual Base Posture Orientation

Ecosystem Provided “Calm” Environment = No Mechanical Agitations
STS-107 Mission - Space Shuttle Columbia
Science: Gravitational Biology - Gravity VS Living things

Space Mission – International Experience, Challenge, Team Work
STS-107 Space Shuttle Columbia

Space Utilization

Science / Technology (Materials, Biomedical, etc…)

Information Technology

Travel

Education

And More…
JAXA: Space Biomedical Outreach in J-SBRO

Exibition Room
Full-scale/Real Model

Classroom Lecture
Special Topics

Interactive Lecture
Experienicial Learning

Effective Education Material using Space Biomedical Research
Mission X; Tran Like an Astronaut  (Pilot Study)

- Encourage proper nutrition and exercise
- Live and eat like astronauts

Good-habit model for healthy life

J-SBRO, JAXA (Japan)

with

Tsukuba Young Astronaut Club

- No Competition
- No School Assistance
- Modified Curriculum
**An Example of the “Mission”**

**BASE STATION WALK-BACK**  
(Target Age: 8–12 years old)

**Introduction; Space Fact**

1. **“Students and Astronauts”**
   - “Astronauts who have a mission on the moon surface should walk more than 10 km to reach the site.”  
   >Movie; Apollo mission

2. “Therefore, astronauts have a training for make higher their VO2 max.”  
   >Movie; Treadmill training with EMU

3. **“Students and Astronauts”**
   - “If you keep longer exercise, the more endurance your lungs and harts.”  
   >Movie; Animation

4. Walking and running are good example of cardiovascular training.  
   >Movie; Comments of physical trainer of NASA

5. **Exercise**
   - Running training starting with 1.6 km and try to make it longer.

http://www.nasa.gov/audience/foreducators/fitexplorer/train/N_Walkback_detail.html
Are you interested in the programs (each mission)?

- Event #1: 24% Strongly Agree, 72% Agree, 4% Neutral, 3% Disagree, 2% Strongly Disagree
- Event #2: 27% Strongly Agree, 67% Agree, 6% Neutral, 3% Disagree, 2% Strongly Disagree
- Event #3: 17% Strongly Agree, 72% Agree, 6% Neutral, 6% Disagree, 2% Strongly Disagree

Did you understand that the proper nutrition is important?

- Event #1: 7% Strongly Agree, 7% Agree, 7% Neutral, 13% Disagree, 83% Strongly Disagree
- Event #2: 13% Strongly Agree, 87% Agree, 3% Neutral, 3% Disagree, 6% Strongly Disagree
- Event #3: 17% Strongly Agree, 83% Agree, 3% Neutral, 6% Disagree, 6% Strongly Disagree

Free Comments
- I understand that there are a lot of things to do and to care in order to become an astronaut.
- Exercises and lectures are a little hard, but I hope that other students can be join this program in the near future.
Do you think that this program can help the improvement of your children’s proper life habits?

- Event #1: 15% Disagree, 50% Agree, 35% Strongly Agree
- Event #2: 47% Disagree, 53% Agree
- Event #3: 33% Disagree, 67% Agree

Do you think that the programs which related to the space biomedical issues are good for your children?

- Event #1: 50% Strongly Agree, 50% Agree
- Event #2: 24% Disagree, 76% Agree
- Event #3: 8% Strongly Disagree, 92% Agree

Free Comments

- It is difficult to say that the children can continuously do like an astronaut after this program, however, they started to have interests in their body and health promotion.
- The other day, my kids asked me “how much oil are included in this deep fry?”, I would like to talk about the proper nutrition at home.
Mission X in the World

2011 Pilot Project Participants

12 Countries
11 Space Agencies
4,164 Students
1 Mission.

More than 130 teams in 40 cities. 6 weeks of training.
18 activities in 7 languages. 8 astronauts

9 countries hosting full challenge teams; USA, Germany, Netherlands, Italy, Spain, France, Colombia, UA and Austria

1 country modifying the challenge locally; Japan

3 countries supporting/observing, but not hosting teams; Russia, Czech Republic, Belgium
Mission X in the World

2011
12 Countries
11 Space Agencies
4,164 Students
1 Mission

2015
28 Countries

http://trainlikeanastronaut.org/
Zebrafish - Novel Model for Ototoxicity Research

The University of Arizona Ear Institute
Department of Otolaryngology
The University of Arizona
What do these images have in common?

Genetics

Aging

Noise

Hearing Loss

Hearing Disorder

Chemotherapy
Cisplatin is used to treat various types of cancers, including sarcomas, some carcinomas (e.g. small cell lung cancer, and ovarian cancer), lymphomas, bladder cancer, cervical cancer, and germ cell tumors. It is used in combinations with bleomycin and vinblastine in testicular cancer.

- Prototypical model for platinum based chemotherapeutics
- Symptoms: Hearing Loss, Tinnitus & Balance dysfunction
- 55% treated with cisplatin develop ototoxicity.
Zebrafish lateral line contains hair cells & supporting cells.
Developmentally, morphologically, and physiologically similar to inner ear hair cells.
Involved in orientation to water flow and predator-prey behavior.
Hair cell bundles called neuromasts are deposited every 5-7 somite intervals
  • Missing neuromasts are easily identified
  • Surface location allows for easy detection of hair cell death
  • Permeable to several vital dyes – allow for fluorescent in vivo imaging
Behavioral analysis system to detect cisplatin-induced hair cell death.

**Zebrafish Model for Hair Cell Research**

- Detect the water current **direction**
- Detect the water current **speed**

**Stimuli**

**Sensory system**

**Locomotor apparatus**

**Response**

**Correlation**

**Water current**

**Lateral line (Hair cells)**

**Rheotaxis**

- Face to the water current direction
- Swim with the same speed of the current
Zebrafish Model for Hair Cell Research
Acknoledgement

Space Bio-Medical Education

J-SBRO, JAXA

Human Research Program Education & Outreach Project, NASA
International Mission X teams

ASI, CCE, CDTI, CNES, DLR, ESA, FFG, Netherkands Space Office (ESA), UK Space Agency

STS-107 Mission

JUSTSAP S*T*A*R*S Program
JSUP
PROSAP
SPACEHAB
Paragon SDC
BioServe
Ochanomizu University
Tokyo Institute of Technology

Department of Otolaryngology,
The University of Arizona

Toward a cancer-free generation...