
# Weightless

**Learning Objectives:**

- To consider the difficulties of carrying out science experiments in space;
- To understand the effect of weightlessness on the human body;
- To describe the differences in the life cycles of a mammal and an amphibian.

**Science Skills:**

- Using experimental data to spot a pattern.

**Maths skills:**

- Plot a scatter graph and describe trends in the data;
- Use a variety of scales including negative numbers.

**Resources:**

- PowerPoint
- Class worksheets – Class Table and Class Scatter Graph – 1 per child or group or class – as you prefer.
- Astronaut Bone Density Loss Graph Blank – 2 per child

## WHAT YOU SHOULD KNOW BEFORE YOU START

Mae Jamieson was the first African American to go into space. As a young woman she aspired to be a professional dancer but later went to university and studied to be a doctor. Before she applied to the astronaut program at NASA she also took courses in engineering. She had lots of useful skills for studying science whilst aboard the Endeavour Space Shuttle Orbiter in 1992.

This space shuttle was designed to take off vertically, orbit the Earth and then return to Earth as a glider. NASA built 6 shuttles in total. Many of their missions were to take experimental equipment into space to study what happens in weightless conditions. Mae Jamieson was taken as a mission specialist on one of these missions, but she had to qualify as an astronaut first. Once qualified, she was chosen for this particular mission for her many relevant skills.

One of Mae's many tasks was to investigate the effect of weightlessness on the development of tadpoles. Earth bound scientists had noticed that the cells inside frog embryos could only organise themselves to develop into a tadpole if they were oriented with a particular part of them facing up. They were therefore curious to see if this process was affected by weightlessness. As the Endeavour had room for a small laboratory, the mission was able to bring a centrifuge which could mimic gravity on Earth and thus compare embryos developing in zero gravity to those developing at 1g.

Mae collected eggs from female frogs, fertilised them and then took measurements and made observations. Approximately 50 live tadpoles were delivered to the lab, once the shuttle had landed where the tadpoles then developed into frogs. There were some differences between the tadpoles that had spent the mission in weightless conditions in comparison to the ones that had been in the centrifuge but nothing that stopped them developing into adult frogs.

She also took part in research into the effect of weightlessness on the bones of astronauts. Our bones are constantly breaking down and repairing. It is this process which allows your bones to join back together after a break. Astronauts have their bones scanned before and after their missions. They can also keep track of whether their bones are breaking down or building up by tracking chemicals in their urine.

**WARM UP – generating questions**
Use the first slide of the PowerPoint to explain Mae Jamieson's task on the shuttle mission.

Watch Chris Hadfield (who was on ISS) in the following videos:

https://www.youtube.com/watch?v=KaOC9danxNo
https://www.youtube.com/watch?v=3bCoGC532p8
https://www.youtube.com/watch?v=IKVjUCN0YPw

Tell the children:
Eating and drinking in space are difficult because your food and drink wouldn't stay on a plate or in a cup. It would float about as the astronauts do. Going to the toilet or having a wash are also tricky. Sleeping would feel different too without being able to lie down and feel the bed below you. Imagine trying to carry out an experiment in space. Mae Jemison carried out experiments with tadpoles in space.

We could rear tadpoles in the classroom.
Ask

- What would we need to rear tadpoles in the classroom?
- What would we need to do this in space?
- What equipment might you need?
- What question would you ask Mae about her experiment?

**INTRODUCTION**
Tell the children:
When astronauts return from space, they bring back their data – the measurements and observations they made. Then, the scientists that requested the data have to analyse it. Changes in their own bodies are also tracked to find out if it is possible to put a person into space long enough to reach Mars for example, without too many changes occurring in their bodies.

This kind of data, from many people, is likely to vary, just because everyone is different.

In pairs, measure your height and your hand span. Collect all this data for your class onto a class table using the printable resource *Class Table*:

| person | Height in cm | Hand span in cm |
|---|---|---|
| 1 | | |
| 2 | | |
| | | |

Using the printable resource *Class Scatter Graph* ask each child to mark a cross where their measurements sit on the graph. You may prefer to print one per child.

You may find that the crosses show a trend – the taller the child, the larger the hands.

Explain that a scatter graph is looking for trends in the data. As we are working with different people and everyone is different, we are unlikely to be able to join all the crosses into one straight line. But we can see if there is a trend.

**MAIN TASK**
Display *PowerPoint Slides 1, 2 and 3*.

Tell the children:
Imagine that you are a NASA scientist, and this is the data you have collected on bone density. If you have a normal bone density, then your bones are strong enough to withstand a fall without breaking. If you lose calcium from your bones, they weaken and break more easily: the density is reduced. Normal bone density is counted as 0. Anything over zero is extra strong. Anything under zero is weaker than usual.

Make scatter graphs of the two sets of data on the 'Astronaut Bone Density Graph'. (*Slides 4 and 5* show what the scatter graphs should look like.)

Ask:
- Is there a trend in the data?
- Is it the same for both sets of measurements?
- Can you explain why they are different?

In fact, the weight bearing bones of the legs undergo tiny breaks when you run or jump, impacting them. This stimulates the bone cells to repair and strengthen the bones. So, exercises which involve impact keep our leg bones strong. In space, our legs don't carry the weight of our bodies anymore, so the bones are not stimulated to get stronger.

The upper body doesn't carry so much weight as the legs so it is less affected by weightlessness.

## EXTENSION
Ask the children to decide which other astronaut bones a scientist might like to scan for bone density – giving their reasoning. (The heel bone is usually scanned as it is weight bearing.)

In fact, the heel bone is scanned as it is also affected by weightlessness as it doesn't encounter the stresses and strains from walking when an astronaut is weightless.

## REVIEW
**ALL**: Can plot a scatter graph.
Can identify a trend in the data and offer ideas about how weightlessness affects the human body.
**MOST:** Can independently plot a scatter graph including a scale with negative numbers.
Can explain the trends in the data and link it to the effect of weightlessness on human bones.
**SOME**: Can also suggest which bones might suffer density loss in weightless conditions and those are unlikely to.