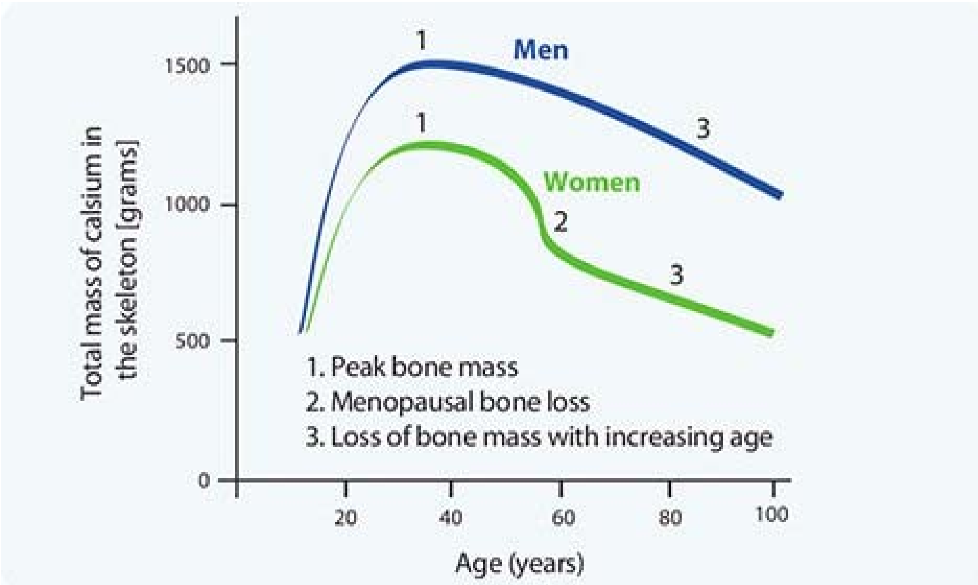
Astronaut Bone Loss in Space



Under low-gravity conditions, human bones respond by losing mass. The longer an astronaut remains in space, the more bone loss occurs. This is considered one of the greatest challenges to humans operating in space for extended periods of time, such as journeys to Mars and living in 'space stations'. The above graph shows normal bone loss with age for humans living on Earth. The average bone loss for some astronauts is 1.9 percent per month.

Problem 1 – From the graph above, what is the average rate of bone loss between age 40 and age 70 for A) Men and B)Women?

Problem 2 – Suppose a 40 year old male astronaut spent 6 months aboard the International Space Station. If he started out with 1500 grams of bone calcium, how much calcium would remain in his bones when he returned to Earth?

Problem 3 - Suppose a 40 year old female astronaut spent 6 months aboard the International Space Station. If she started out with 1200 grams of bone calcium, how much calcium would remain in her bones when she returned to Earth?

Problem 4 – From the graph, how old would both astronauts be in order to have the same amount of calcium as they did after returning to Earth?

Problem 1 – From the graph above, what is the average rate of bone loss between age 40 and age 70 for A) Men and B)Women? Answer: A) rate = (change in mass) / (change in time) = (1100 – 1500) / (100 – 40) = - 6.7 grams/year. B) rate = (500 – 1200)/(100 – 40) = - 11.7 grams/year.

Note: Because the signs are negative, the rate is a mass loss. As a percentage, for men the rate is 100% x (6.7/1500) = 0.4% per year. For women it is 100% x (11.7/1200) = 1.0% per year…more than twice as fast as for men.

Problem 2 – Suppose a 40 year old male astronaut spent 6 months aboard the International Space Station. If he started out with 1500 grams of bone calcium, how much calcium would remain in his bones when he returned to Earth? Answer: The astronaut will lose 0.019 x 6 months x 1500 grams = 171 grams lost

Problem 3 - Suppose a 40 year old female astronaut spent 6 months aboard the International Space Station. If she started out with 1200 grams of bone calcium, how much calcium would remain in her bones when she returned to Earth? Answer: The astronaut will lose 0.019 x 6 months x 1200 grams = 137 grams lost

Problem 4 – From the graph, how old would both astronauts be in order to have the same amount of calcium as they did after returning to Earth? Answer: For the male astronaut, his final bone mass is 1500 grams – 171 grams = 1329 grams. From the graph below, this bone mass is reached when a typical male reaches the age of about 67 years. For the female astronaut, her final bone mass is 1200 grams – 137 grams = 1063 grams. From the graph below, this bone mass is reached when a typical male reaches the age of about 55 years.