

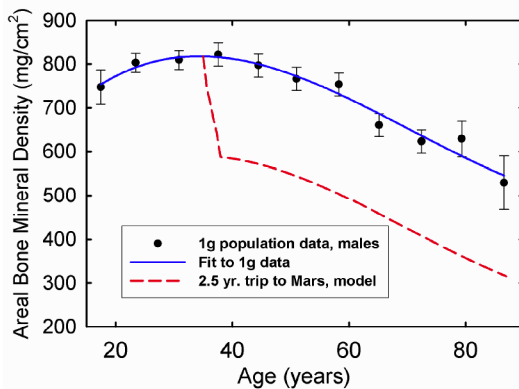
# BIOPHOTONICS AND BONE BIOLOGY

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One of the more-serious side effects of extended space flight is an accelerated bone loss [Bioastronautics Critical Path Roadmap, [http://research.hq.nasa.gov/code\\_u/bcpr/index.cfm](http://research.hq.nasa.gov/code_u/bcpr/index.cfm)]. Rates of bone loss are highest in the weight-bearing bones of the hip and spine regions, and the average rate of bone loss as measured by bone mineral density measurements is around 1.2% per month for persons in a microgravity environment [T. Lang et al., *JBMR* 2004]. Figure 1 shows that an extrapolation of the microgravity-induced bone loss rates to longer time scales, such as a 2.5 year round-trip to Mars (6 months out at 0 g, 1.5 year stay on Mars at 0.38 g, 6 months back at 0 g), could severely compromise the skeletal system of such a person.



**Figure 1.** Age-related bone loss in a 1g population of males (data from Atlas of Clinical Endocrinology: Osteoporosis, 2003) compared to a hypothetical person exposed to microgravity and partial gravity during a 2.5 year Mars trip. The model assumes a linear response of bone loss with g-level, and does not account for the possibility of new bone growth upon returning to 1 g, as no data yet exists for such an effect.

It is well known that bone remodeling responds to mechanical forces. We are developing two-photon microscopy techniques to study bone tissue and bone cell cultures to better understand the fundamental response mechanism in bone remodeling. Osteoblast and osteoclast cell cultures are being studied, and the goal is to use molecular biology techniques in conjunction with Fluorescence Lifetime Imaging Microscopy (FLIM) to study the physiology of in-vitro cell cultures in response to various stimuli, such as fluid flow induced shear stress and mechanical stress. We have constructed a two-photon fluorescence microscope for these studies, and are currently incorporating FLIM detection. Current progress will be reviewed. This work is supported by the NASA John Glenn Biomedical Engineering Consortium.

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