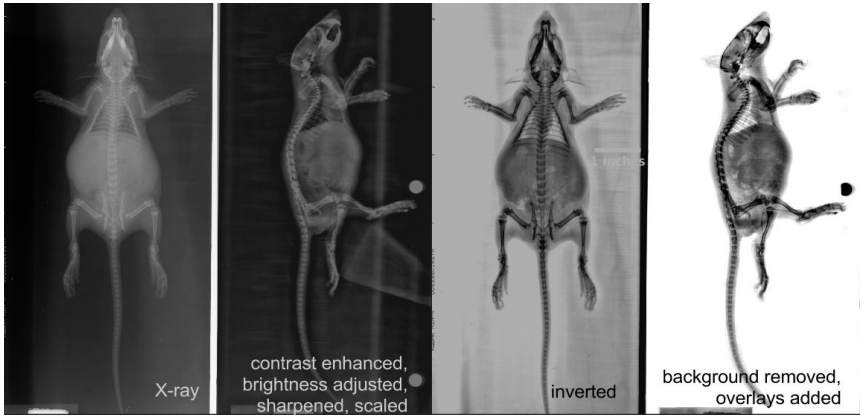
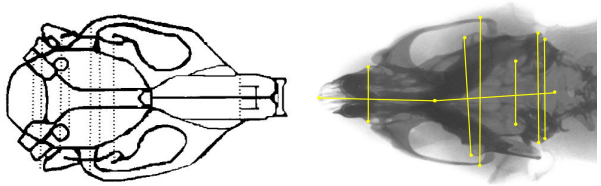
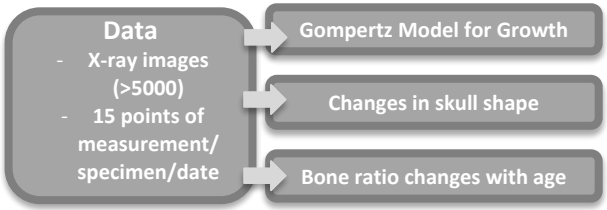
Growth and Allometry

Developing organisms require nutrients, but the amount of resources required to produce body parts is not constant, and structures can be privileged when nutritional intake is limited. As a consequence, states of malnutrition have the potential to affect the overall, and relative growth (allometry) of an organism.





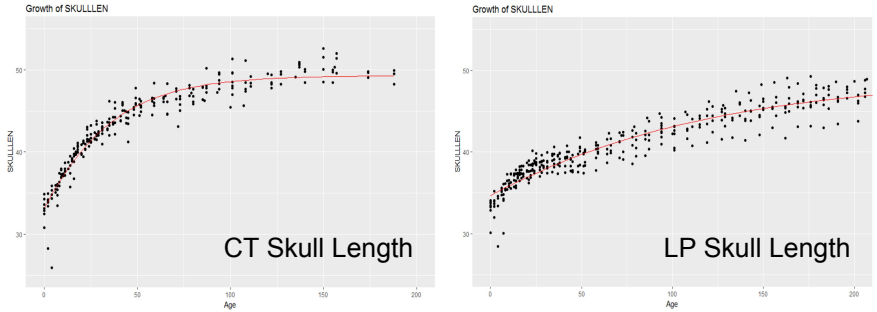


The data consists of rat images taken over the course of development, and spreadsheets containing previously collected measurements of individual growth trajectories.

The rats were in the following two groups for comparison of nutritional effects on growth:

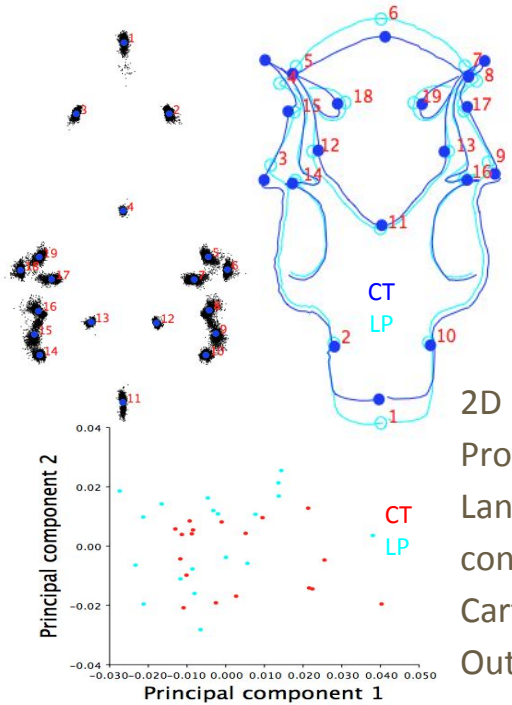
- Low Protein (LP) - fed diet with lowered protein
- Normal Protein (CT) - fed normal diet for lab rats

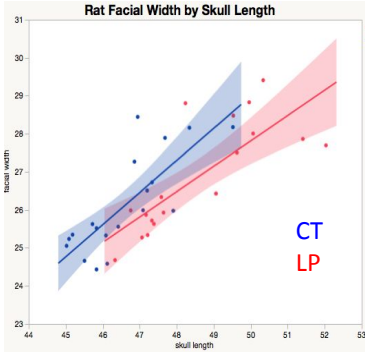
Analysis



The Gompertz function is a model for growth with an element of decay associated with the rate of increase.

We made an R script for the Gompertz equation and graphed the growth of different body parts for CT and LP rats. The graphs above show a side-by-side comparison of skull length growth, with the CT rats having a higher rate of initial growth but also faster decay to a plateau compared to the LP rats.

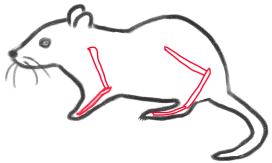


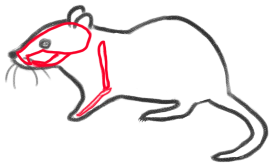


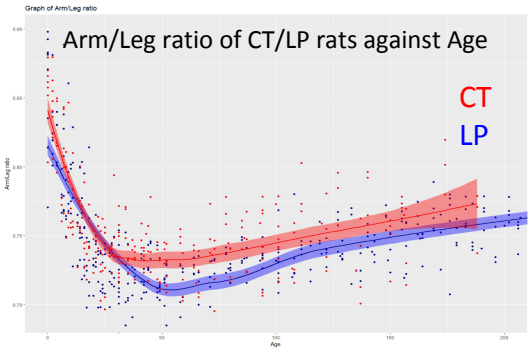
2D Morphometrics Software: Procrustes Superimposition, Landmark Analysis, PCA conducted on MorphoJ. Cartesian Coordinates & Outline files made in JMorph.

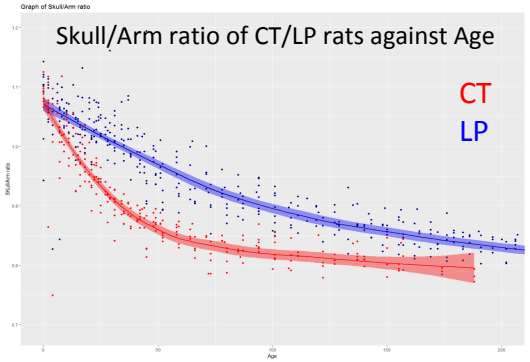
Simply looking at the facial width to skull length ratios, we see an overall change in shape. Cranial shape analysis was conducted to further understand the localized changes in skull morphology.

Summary of Results









From the results, we can see that protein deficiency alters the relative growth of individual bones, resulting in a change in size and shape. The LP rats show slower initial growth, though they do eventually reach the same size as CT rats.

The LP diet also alters the shape of the cranium to be longer and narrower compared to CT rats. Finally, when looking at the ratio of bones, LP rats show ratios with less variation compared to CT rats. This could be attributed to a limiting effect of the lowered protein diet, restricting variation of bone ratios to what can be managed by the current level of nutrition.

Team Members: Xinyu Li: xinyu.li@duke.edu; Ana Galvez: ana.galvez@duke.edu; Jonathan Rub: jonathan.rub@duke.edu