CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
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Project Number
S1416

Project Title
Glucose as a Teratogen Affecting Cranial Neural Crest Migration in the Developing Chick Embryo

Abstract

Objectives/Goals
Since infants of diabetic mothers are five times as likely as the normal population to be born with a birth defect, this project aims to determine if glucose itself plays a role in these malformations. If glucose does play a role, the goal is to examine how glucose is able to bring about these defects.

Methods/Materials
Fertilized chick eggs were incubated until proper stages were reached (stages 4, 7, or 8; Hamburger and Hamilton, 1955). Over 350 embryos were used in each control/experimental stage. Embryos were cultured either in vitro (stage 4) or in vivo (stages 7 and 8) and then subjected to varying amounts of glucose or sucrose (the control) through use of a Picospritzer. For studies involving uPA inhibition, a 1mM solution of Amiloride was added. Cultures were incubated for a further 24 hours to 7 days and then fixed in 4% Paraformaldehyde. Immunohistochemistry was performed on stage 4 embryos to label for the gene Hnk-1. Older embryos were examined visually using a dissection microscope.

Results
Embryos subjected to a 1.08M solution of glucose showed cardiovascular and craniofacial defects. 57% of embryos developing in 0.36M glucose showed some sort of craniofacial defects in contrast to the 8% in the control. A dominant craniofacial defect shown was open neural tubes. Inhibition of uPA showed dark labeling down the midline of the embryo suggesting that neural crest cells stayed premigratory. For stage 4 embryos, only 4% showed neural tube closure in contrast to the 100% closure rate of control embryos.

Conclusions/Discussion
Cardiovascular defects are significant in that these defects are seen in other teratogens. Also, results show that as glucose concentrations increase, so does the likelihood that an embryo will develop some sort of a defect. I had hypothesized that glucose is able to inhibit the migratory abilities of neural crest which brings about the defects and the results indicate that this hypothesis is valid. Inhibiting uPA allowed me to examine effects of neural crest inhibition and results suggest that embryos subjected to glucose do indeed have non-migratory crest. It is widely known that diabetics have a higher chance of giving birth to a defective child, but glucose (at higher than normal concentrations) has never been classified as a teratogen. This study initiates more studies hopefully leading to glucose being added to the list of known teratogens.

Summary Statement
My project shows that glucose at higher than normal concentrations prevents the migratory abilities of neural crest cells which in turn brings about the developmental defects that are so much more common among infants of diabetic mothers.

Help Received
Dr. Mark A.J. Selleck at the USC Keck School of Medicine offered guidence, lab funding, and equipment; Mr. Duane Nichols at Alhambra High School watched over the project as a whole; My parents helped with transportation to and from my lab.