CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
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Project Number
S0410

Project Title
A Study on the Molecular Evolution of Voltage-Sensitive Ion Channel Genes

Abstract

Objectives/Goals
The purpose of this experiment is to explore the molecular evolution of ion channel genes. Based upon previous studies, the hypothesis is that potassium channels were the first ion channels to arise during evolution. These channels then gave rise to sodium and calcium channels, by duplication, followed by sequence changes and then another duplication. If the hypothesis is correct, domains 1 and 3 of the sodium and calcium channels should be similar to each other and domains 2 and 4 should be similar to each other

Methods/Materials
The International Union of Pharmacology database was used to get the GenBank accession numbers of K+, Na+, and Ca++ channels. The sequences of a number of voltage-gated channel cDNAs and proteins from the NCBI database were collected. The sequence of each domain was considered a separate sequence. The MAKDAT program was used to read the sets of sequence files and create output files suitable for input to the CLUSTALW program. The sequences of each sodium channel domain and calcium channel domain were aligned with the potassium channel domains using the CLUSTALW program. An evolutionary tree was developed using the sequence alignments and the PARSIMONY program.

Results
Many phylogenetic trees were constructed using the programs throughout the course of the experiment. One tree depicted a comparison of the K+, Na+, and Ca++ channels, which showed the channels divided into two monophyletic groups, one consisting of Na+ and Ca++ channels, and the other consisting of K+ channels. Another tree displays the lineage of each of the four domains of both Na+ and Ca++ channels. It shows the corresponding domains of each type of channel as closely related. It also depicts domains I and III as sharing a common ancestor and domains II and IV as sharing a common ancestor as well.

Conclusions/Discussion
Of the many trees that were produced, one shows the phylogenetic relationships of this entire ion channel gene superfamily. The Na+ and Ca++ channels appear to have arisen as separate from the voltage-gated K+ channels. The sequence similarities of each domain of the Na+ channel to the corresponding domain of the Ca++ channel imply that there existed a common ancestral single-domain channel gene that gave rise to the Ca++ channel by two duplications and then gave rise to the Na+ channel by further divergence following gene duplication.

Summary Statement
This purpose of this project is to explore the history of voltage-sensitive ion channels and specifically to determien the molecular evolution of K+, Na+, and Ca++ channel genes.

Help Received
Dr. G. Chandy and Dr. G. Gutman (Univeristy of California, Irvine) provided computer programs.