PowerPoint Presentation

Mechatronics Rendering of Cellular Active Transport (Sodium-Potassium Pump)

SUMMIT PROGRAM
July 16 - August 10, 2007

By:
HAROLD MEISELMEN
Clara Barton High School

ANALIE NARCA
Philippa Schuyler Middle School for the Gifted and Talented (I.S.383)
BIOLOGY (cell membrane) & MECHATRONICS

BIOLOGY (cell membrane)
Mechatronics Rendering of Cellular Active Transport (Sodium-Potassium Pump)
To provide a visual model and demonstration of the sodium-potassium active transport pump.

To show the conformational change in the membrane protein during cellular active transport.
CELL MEMBRANE
STRUCTURE & FUNCTION

extracellular fluid (outside)

binding site

phospholipid bilayer

glycoprotein

phospholipid

carbohydrate

cholesterol

protein filaments

cytoplasm (inside)

RECEPTOR PROTEIN

MARKER PROTEIN

TRANSPORT PROTEIN
SEQUENCE OF EVENTS

1. Three sodium ions ($\text{Na}^+$) enter the enzyme from within the cell.

2. ATP phosphorylates the enzyme, causing it to pump 3 $\text{Na}^+$ out of the cell.

3. Two potassium ions ($\text{K}^+$) enter the enzyme from outside the cell.

4. The now-unphosphorylated enzyme pumps the 2 $\text{K}^+$ into the cell.
PARTS AND COMPONENTS

- BOE Basic Stamp
- Microprocessor
- USB Cable
- Jumper Wires
- Resistors
- Capacitors
- Push Button
- LED
- Servo Motor
Servo motor controls the closing - opening of cell membrane Protein, ATP and sequence of events.
PIN 1.
- Pin 13 servo 2 - ATP binding site on protein
- Pin 14 servo 1 - Protein channel
- Pin 15 servo 3 - Caption- steps of the process
- **Na⁺** (Red LED) ions attracted to the binding site of protein
- 3 **Na⁺** (Red LED) bind to protein
- Protein changes shape exposing **ATP** binding site
- High-energy **phosphate** (Yellow LED) attaches to the protein
- Protein changes shape exposing **Na⁺** (Red LED) to the outside of cell and the 3 sodium ions are released
- 2 **K⁺** ions (Green LED) attach to the protein
- High-energy **phosphate** (Yellow LED) is released from the Protein Binding site
- Protein channel returns to its original shape bringing the **K⁺** ions (Green LED) in to the cell
By using Mechatronics we would be able to:

- explain biological processes in an engaging way for students
- make complex concepts in biology tangible and easier to understand
- allow student’s participation through manipulation and control of Mechatronics rendering of certain biological concepts (future development)
- show the use and potential of Mechatronics in the teaching and learning process not only for Science and Math but also for other subject areas.
Expansion of the use of the model by increasing interactivity, including manipulation of ion and ATP concentrations, showing the effect of chemicals on the process.

Use of this model to further explain the role of this process in muscular contraction and nerve impulses conduction.
ACKNOWLEDGEMENT

- New York State Department of Education
- Polytechnic University
- Professor Vikram Kapila
- Anshuman Panda
- Special Thank you to PADMI NI VIJ AYKUMAR
- Elbert Narca
- Keith
- Nathan
- Daniel
- Billy
- Shing
- Jared