DYE SOLAR CELLS

Nanotechnology for Energy Conversion

Can we harvest the sun's vast energy using nanoparticles to fabricate inexpensive, next generation solar cell devices?

Students use nanotechnology and plant pigments to fabricate an artificial photosynthetic device for capturing the sun's energy and convert it to electricity. They are then challenged to design the most efficient dye sensitized solar cell using vegetable or fruit dyes.

By incorporating everyday materials into science lessons, the Materials World Modules (MWM) program at Northwestern University has found the solution to getting students excited about learning science while helping teachers meet national and state education standards.

The modules are easy to organize and inexpensive to use. They can be incorporated into any science class because of the breadth of subjects covered in the Activity and Design Project sections. Each module is a supplemental science unit that takes 1-3 weeks of class time (ideally, approximately 10 hours) to complete.

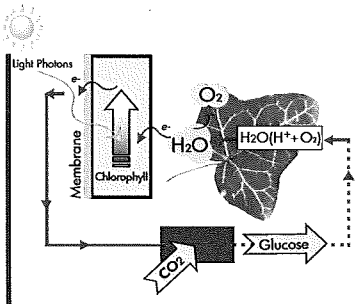
Module At-a-Glance:

Activities

- Investigating the Photosynthesis of Spinach Leaf Discs
- Separating Leaf Pigments Using Paper Chromatography
- Measuring Silicon Solar Cell's Performance
- Making a Spinach Dye Sensitized Solar Cell

Design Project

- Designing a Dye Sensitized Solar Cell with Maximum Power Output



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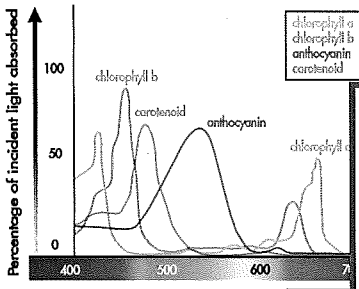

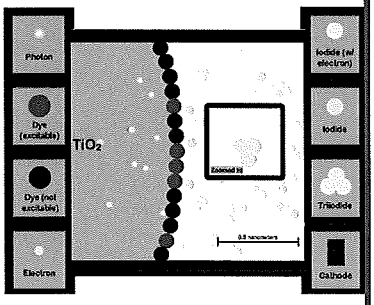

MWM is designed to improve STEM education

Science ▪ Technology ▪ Engineering ▪ Math

Interdisciplinary
Integrates science & non-science subjects

Flexible
Can adapt to your teaching style, students' ability and class time

Hands-on
Contains activities that lead up to inquiry-centered design projects

Cutting-edge
Examines issues on the forefront of technological research

Connects to Your Curriculum

Chemistry
Atomic Structure ■ Bonding ■ Polarity ■ Redox Reactions ■ Rates of Reactions ■ Chromatography ■ Solutions, Colloids, and Suspensions ■ Hydrocarbons ■ Catalyst ■ Electrochemistry

Biology & Life Sciences
Cell Processes ■ Photosynthesis ■ Energy Pathways ■ Ecosystems ■ Carbon Cycle ■ Food Web ■ Decomposition

Mathematics
Orders of Magnitude ■ Size and Scale ■ Surface-to-Volume Ratios ■ Graphing (Making, Reading and Interpreting) ■ Averages ■ Rates

Physics & Physical Sciences
Electromagnetic Waves ■ Colors and Light ■ Capillary Forces ■ Circuits ■ Electron Flow/Current ■ Photoelectric Effect ■ Energy, Work, and Power ■ Energy Source

Geology & Earth Science
Metals ■ Rocks and Minerals ■ Use of Natural Resources ■ Renewable and Nonrenewable Resources ■ Solar Energy

Technology/Engineering Education
Iterative Design ■ Building Prototypes ■ Optimization ■ Communications

Society
Ethics and Impact of Uses of Nanotechnology

Language Arts
Public Speaking ■ Writing a Scientific Paper

Materials World Modules

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847-467-2489 ■ mwm@northwestern.edu

NSF

ENVIRONMENTAL CATALYSIS

Catalysts are part of the solution to protecting the environment – developing new catalytic technologies with nanoscale materials provides for a promising tomorrow.

Students learn what a catalyst is, gain an idea of the scope of catalysis research today, and become aware of the effect of catalysis on environmental protection. Advances in nanotechnology are also discussed as a solution to eliminate environmental pollutants. Students are challenged to design an original solution to an environmental problem of their choice.

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Module At-a-Glance:

Activities
- Catalyzing with Platinum Black
- Searching for Catalysts
- Using a Heterogeneous Acid Catalysis
- Using a Metal Catalyst to Degrade an Air Pollutant
- Using Photocatalysis to Degrade a Water Pollutant

Design Project
- Designing a Catalytic System to Degrade a Pollutant
- Conceptual Design for Environmental Catalysis

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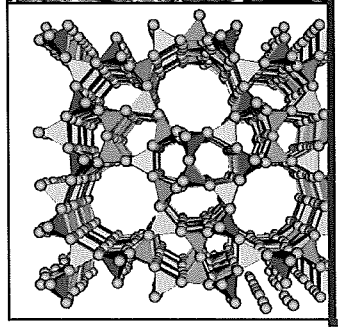

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Connects to Your Curriculum

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Structure and Properties of Matter ■ Conservation of Matter ■ Oxidation-Reduction Reactions ■ Catalysts ■ Activation Energy ■ Reaction Kinetics ■ Biochemical Reactions ■ Combustion ■ Thermodynamics

Biology & Life Sciences
Photosynthesis ■ Enzymes ■ Biochemistry

Mathematics
Measuring ■ Graphing (Making, Reading, and Interpreting) ■ Computing ■ Averages ■ Rates

Physics & Physical Sciences
Properties of Matter ■ Physical and Chemical Changes ■ Heat Energy ■ Light Energy ■ Energy Transformations

Geology & Earth Science
Metals ■ Use of Natural Resources ■ Environmental Pollution Issues

Technical Education
Designing ■ Building Prototypes ■ Communications

Language Arts
■ Writing a Report ■ Public Speaking

NANOSCALE DRUG DELIVERY

Nanotechnology is applied to create targeted delivery of nanomedicine for localized treatment.

Students learn how nanotechnology is revolutionizing the approach to drug delivery and diagnostics. They are engaged in a simulated, as well as hands-on experience, in designing nanomedicine for targeted delivery. Students are challenged to design a nanodrug with an optimum time-release profile.

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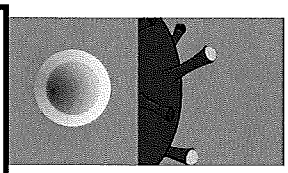
Module At-a-Glance:

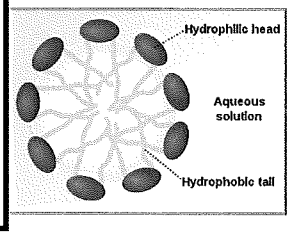
Activities

- Game: Designing a Search and Destroy Nanomedicine
- Hunting for Drug Delivery Systems that Use Nanoparticles
- Making Biodegradable Alginate "Drug" Capsules
- Determining the Rate of "Drug" Release

Design Project

- Designing a Fast Acting, Time-Release Nanomedicine





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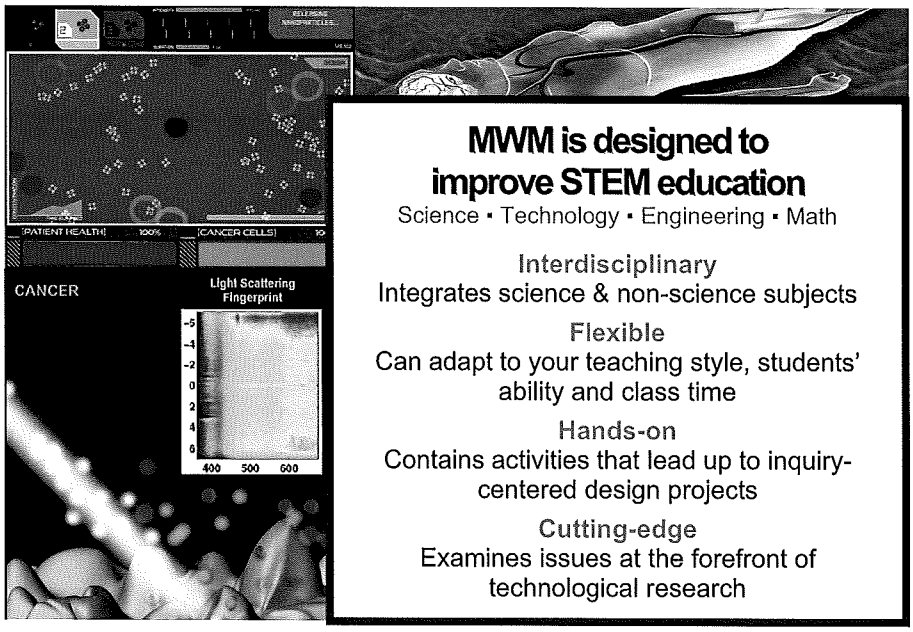

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Structure and Properties of Matter ■ Atomic Theory ■ Bonding ■ Solutions, Colloids, and Suspensions ■ Organic Chemistry ■ Reaction Kinetics ■ Biochemical Reactions ■

Biology & Life Sciences
Cell Biology ■ Biochemistry ■ Diseases ■ Immune System ■ Drugs ■ Molecular Biology ■ Biotechnology

Mathematics
Measuring ■ Graphing (Making, Reading and Interpreting) ■ Computing ■ Averages ■ Rates ■ Orders of Magnitude ■ Size and Scale ■ Surface-to-Volume Ratios ■ Mathematical Modeling

Physics & Physical Sciences
Properties of Matter ■ Physical and Chemical Changes ■ Colors and Light ■ Spectrophotometry

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MANIPULATION OF LIGHT IN THE NANOWORLD

What makes opals so colorful? What can optical engineers learn from a peacock feather?

Students learn about how light interacts with matter at the nanoscale. They will fabricate, test, and evaluate their own photonic crystals.

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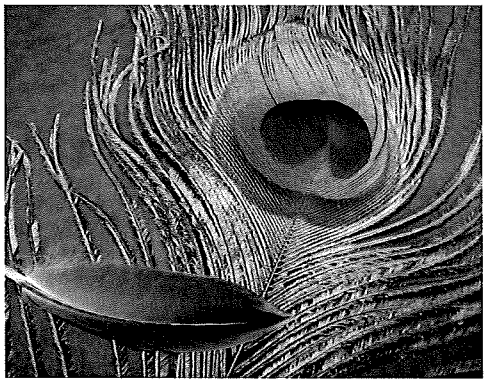
Module At-a-Glance:

Activities
- Lights and Their Spectra
- Observing Diffraction
- Observing Interference
- Observing Iridescence

Design Project
- Fabricating Photonic Crystals



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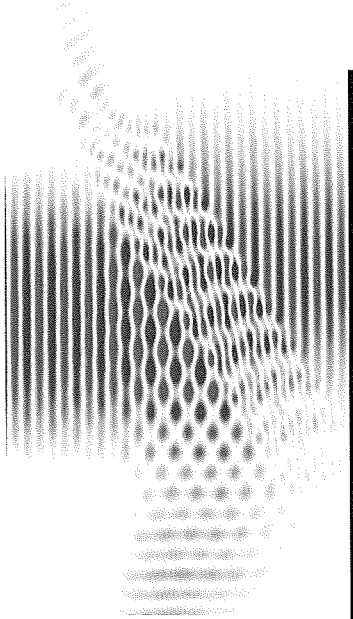

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Connects to Your Curriculum

Chemistry
Spectroscopy ■ Structure of Atoms ■ Pigments

Biology & Life Sciences
Function of the Eye ■ Organisms' Response to Light ■ Resolution in Microscopes ■ Color and Iridescence in Nature, Adaptation

Mathematics
Angles and Arcs ■ Measuring ■ Sine and Cosine ■ Dimension ■ Wave Functions

Physics & Physical Sciences
Electromagnetic Spectrum ■ Energy Transfer ■ Color ■ Interaction of Energy and Matter ■ Waves Diffraction and Interference ■ Thin Films

Earth & Space Science
Energy of the Sun ■ Extraterrestrial Spectroscopy ■ Solar Spectrum ■ Resolution in Telescopes ■ Crystalline Solids (Opals)

Language Arts
■ Writing a Report ■ Public Speaking

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