Teacher Notes

Activity Guide

This activity guide for the **Phospholipid & Membrane Transport Field Test Kit©** will help you consider different ways you may use these materials. We encourage you to modify these lessons and activities to meet the learning objectives and needs of your specific students.

Objectives

Use the model pieces in the kit to:

- **Compare** and **contrast** the structure of a saturated fatty acid with an unsaturated fatty acid.
- **Model** a dehydration synthesis reaction in the formation of a triglyceride or phospholipid.
- **Examine** the general amphipathic structure of a phospholipid.
- **Compare** and **contrast** various models of phospholipids.
- **Explore** the interaction between phospholipids and water.
- **Construct** a phospholipid monolayer, micelle and bilayer and relate it to plasma membrane structure.
- **Identify** and **simulate** the function of the various types of channel proteins involved in membrane transport.

Big Idea

In the biological sciences, a dehydration synthesis (condensation reaction) is typically defined as a chemical reaction that involves the loss of water from the reacting molecules. This reaction is used in the formation of carbohydrates, proteins, triglycerides and phospholipids.

- **Student Handout 1** introduces students to the composition and structure of triglycerides and phospholipids. Students use foam representations of glycerol and three fatty acids to model a dehydration synthesis of a triglyceride. Additionally, students may model phospholipid synthesis using foam representations of glycerol, two fatty acids and various hydrophilic heads.

- **Student Handout 2** guides students through a series of activities using simplified representations of phospholipids to model a phospholipid monolayer, micelle and liposome.

- **Student Handout 3** familiarizes students with various forms of membrane transport. Students learn about passive transport by using foam representations of aquaporin to move water molecules across the cell membrane, a carrier protein to move glucose molecules and a gated sodium channel to move sodium ions into the cell. Finally, a foam representation of the sodium-potassium pump is used to learn about active transport. Students also become acquainted with the channel protein selectivity filters of a few select channel proteins.

Teacher Notes Continued

Teacher Notes for Student Handout 1

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A supplemental video on fatty acids produced by the Szostak Lab at Massachusetts General Hospital may be accessed at *exploringorigins.org/fattyacids.html*.

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The concept of trans fat may be introduced here.

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In 1901, German chemist Wilhelm Normann showed that liquid oils could be hydrogenated and patented the process. Procter & Gamble acquired the U.S. rights to the Normann patent and began marketing the first hydrogenated shortening, Crisco, in 1911.

Teacher Notes for Student Handout 2

Page 1

Eric Kessler is Director of the Bioscience Program at the Blue Valley School District's Center for Advanced Professional Studies (CAPS) in Overland Park, Kansas, where he facilitates molecular, microbial, organismal, and ecological research with his students. He holds three undergraduate degrees and a master's degree in biology, and recently renewed his National Board Certification. Eric was named a Milken Educator in 2007 and was presented with the Ron Mardigian Memorial Biotechnology Explorer Award in 2013. He attended Genes, Schemes and Molecular Machines at the MSOE Center for BioMolecular Modeling (CBM) in 2003 and became a lead teacher the following year for the workshop, when he introduced this activity to the CBM and 3D Molecular Designs.

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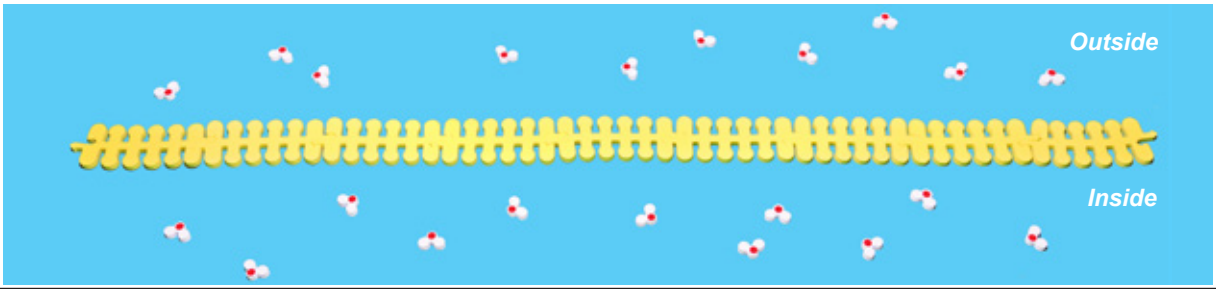
Flippases, Floppases and Scrambleases

There are enzymes that assist in moving phospholipids from one layer to the other. Flippases move phospholipids in the outer leaflet to the inner leaflet. Floppases move phospholipids in the inner leaflet to the outer leaflet. Scrambleases may move the phospholipids in either direction.

Teacher Notes for Student Handout 3

Page 2

You may opt to set up the membrane in a linear fashion (shown below) if more conducive to your teaching environment.



Teacher Notes Continued

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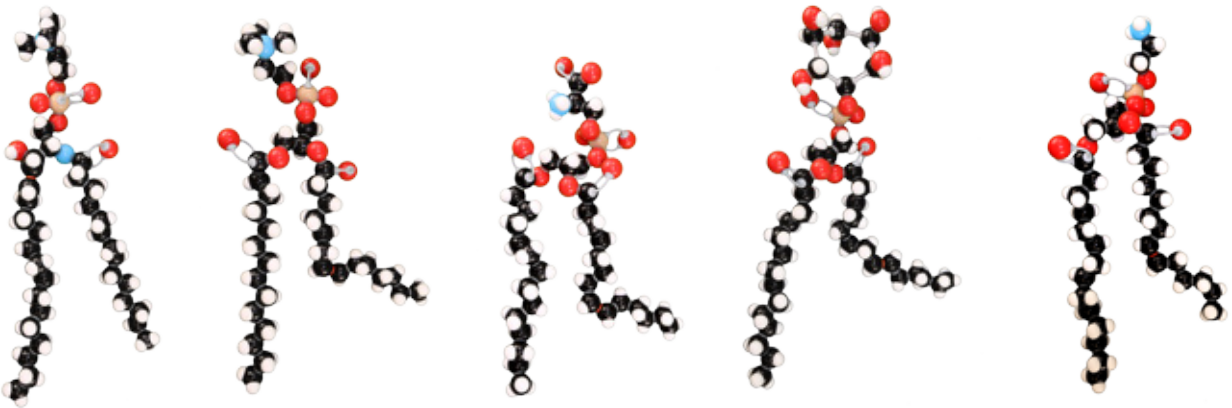
You may choose to use the kit to introduce the students to the terms hypertonic, hypotonic and isotonic.

An excellent supplemental video by the **Theoretical and Computational Biophysics Group** of the **National Institutes of Health** (NIH) Center for Macromolecular Modeling and Bioinformatics at the Beckman Institute, University of Illinois at Urbana-Champaign, may be referenced at the following website:
www.ks.uiuc.edu/Gallery/Movies/aquaporin-movie-explanation.html.

Other Available Physical Models

Additional 3D Molecular Designs' products that may help your students understand phospholipids:

- Molecules of Life Collection© Cell Membrane Polymer and Phospholipid Monomer (right)
- Phospholipid Modeling Set (below)



Sphingomyelin | Phosphatidylcholine | Phosphatidylserine | Phosphatidylinositol | Phosphatidylethanolamine

They are available for purchase at *3dmoleculardesigns.com*. Molecules of Life Collection© Lipid Models are also available through the MSOE Lending Library at *cbm.msoe.edu/MSOELendingLibrary/*.

National Standards

Connections to: A Framework for K-12 Science Education

*Practices, Crosscutting Concepts, and Core Ideas**

Dimension 1. Scientific and Engineering Practices

1. Asking Questions (for science) and Defining Problems (for engineering)
2. Developing and Using Models
6. Constructing Explanations (for science) and Designing Solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Dimension 2. Crosscutting Concepts

1. Patterns
2. Cause and Effect: Mechanism and Explanation
3. Scale, proportion, and quantity
6. Structure and function
7. Stability and change

Dimension 3. Disciplinary Core Ideas

Physical Science

PS1: Matter and its Interactions

PS1: Matter and Its Interactions
PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions
PS1.C: Nuclear Processes

Life Science

LS 1: From Molecules to Organisms: Structures and Processes

LS1.A: Structure and Function
LS1.B: Growth and Development of Organisms
LS1.C: Organization for Matter and Energy Flow in Organisms
LS1.D: Information Processing

Engineering, Technology and Applications of Science

ETS1: Engineering Design

ETS1.A: Defining and Delimiting an Engineering Problem
ETS1.B: Developing Possible Solutions
ETS1.C: Optimizing the Design Solution