

Mimicking Mother Nature

Synthetic Chemist Erik Sorensen:
Building Healing Molecules

Findings

Department of Health and Human Services
National Institutes of Health
National Institute of General Medical Sciences

Sorensen Emulates Nature

Synthetic chemist Erik Sorensen creates molecules to heal disease

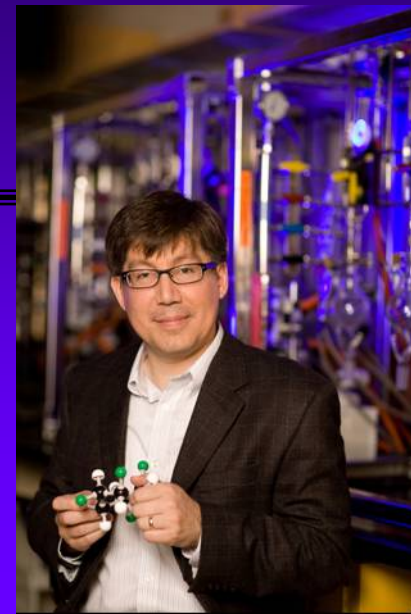


Photo: Brian Wilson

Nature's chemicals

- May hurt or heal
- Are the sources of many medicines
- Can be synthesized by scientists

Question:

Can chemical weapons be helpful?

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Answer: Yes

Chemical weapons can be helpful

- **Snakes, spiders, and sea snails use venom to kill prey**
- **Hemlock trees protect themselves with poison**
- **Bacteria and fungi use toxins to fight enemies**

Nature's Chemical Weapons

Chemicals from plants, animals, fungi, and bacteria

In nature

- Kill prey
- Protect from predators
- Reduce competition for resources

In medicine

- Kill viruses, bacteria, and cancer cells
- Suppress the immune system
- Treat heart disease and depression

From Plant to Medicine



In nature, foxglove is poisonous. In medicine, it is used to make digoxin, a drug used for heart failure and irregular heartbeat

In nature, opium is a beautiful flower. In medicine, it is used to make morphine, a strong painkiller



Photo: Wikipedia Commons

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From Mold to Medicine

- Penicillin is a common antibiotic used to cure infections
- The penicillin molecule started its life as a mold



Credit: Christin L. Case

How to Make a Molecule

Step 1: Know all the atoms in the target molecule, how they connect to each other, and how they fit together in 3-dimensional space

Step 2: Choose a few starting materials (atoms) and pour or scoop them one-by-one into a glass flask

Step 3: Design a series of chemical reactions that will convince the atoms to form the target molecule by attaching at the correct places, releasing unneeded parts, or correctly swapping one atom for another

Adapting to Nature in Short Supply



Credit: National Institutes of Health

Taxol®

- A drug used to treat cancer
- Originally manufactured from the bark of harvested Pacific yew trees, which are scarce
- Now manufactured from
 - Plant cells grown in the lab
 - Needles from farm-raised or wild yew trees

Cyclostreptin: a Self-Made Molecule

- A molecule with potential cancer-killing properties
- Structure is 6 chemical rings with a backbone of 5-6 carbon atoms
- The molecule's name
 - Cyclo: rings are fused together in a complicated arrangement
 - Streptin: substance was isolated from *Streptomyces* bacteria
- A rare, synthesized molecule, in that it can spontaneously fold into its final form

Tools and Techniques

- Chemical reactions
- Bioprospecting
- Magnetic resonance imaging and X-ray crystallography

What tools unavailable in nature can chemists use to help them make nature's molecules?

What are some of the ways scientists do this?

How do these tools help synthetic chemists?

Research Applications

What are some of the concerns of people who are opposed to bioprospecting?