MEETING MINUTES

Sustainable Lab Practices Working Group
NIH Environmental Management System (NEMS)
Wednesday, September 17, 2008
1:30 – 2:30 pm

Meeting Objective(s):

- Provide update on the status of the NEMS
- Representatives from Sigma-Aldrich will present information on greener alternatives to the chemicals used in NIH labs

Attendees:

Karen Baxley (OD)
Zhong Chen (NIDCD)
Tom Coate (NIDCD)
Swati Damle (ORF)
Stephen Field (ORF)
Claudia Gerwin (NINDS)
Deborah Gomke (OD)
Julie Hong (NCI)
Charlyn Lee (ORF)
Terry Leland (ORF)
Nicole Levin (Medimmune)
Dominique Lorang-Leins (NCI)
David Mohammadi (ORF)
Kristen Peters (Booz Allen)
Barbara Ploplis (NIDCD)
John Prom (ORF)
Ed Rau (ORF)
Wendy Rubin (ORS)
Ronda Sapp (NIDDK)
Linda Thompson (Booz Allen)
W.C. Trenkle (NIDDK)
Jasmine Wang (Medimmune)
Don Wilson (ORF)
Xinping Yang (NIDCD)
Ning Yeh (NIDCD)
Cheng-rong Yu (NEI)

John Boussios, Sigma-Aldrich, Account Manager
Kevin Corcoran, Sigma-Aldrich, Regional Manager
Ettigounder (Samy) Ponnusamy, Sigma-Aldrich, Principal Scientist
Timothy Venverloh, Sigma-Aldrich, Director, Sustainability

Minutes:

NEMS Update

Terry Leland provided an update on the current activities of the NIH Environmental Management System (NEMS). She informed the group that the NEMS website has been redesigned to be more helpful (http://www.nems.nih.gov/). There will soon be a bimonthly newsletter about the Green Teams, which include teams at various ICs (NIDCD, NIDDK, NEI) as well as other groups (Sustainable Office Practices Working Group and Energy Stewardship Advisory Group).

She also said to expect an email in the next couple of weeks describing the upcoming mandatory NEMS Awareness training.

Sigma-Aldrich Presentation

Timothy Venverloh, Director, Sustainability, and Ettigounder (Samy) Ponnusamy, Principal Scientist, presented to the group "Science is Our World: How Environmental Sustainability Guides Sigma-Aldrich." (Attachment 1)

Mr. Venverloh described sustainability initiatives at Sigma-Aldrich that are providing incremental improvements for employees, the environment, and business. He explained that they are trying to green their services internally through energy tracking and recycling and green process technology, but that they are also trying to green their services for customers through green science product development and green partnerships.

Sigma-Aldrich is currently collecting worldwide data and evaluating global operations on energy use and recycling practices and will post this information on their website to encourage idea sharing with customers and suppliers. Mr. Venverloh hopes the green chemistry and recycling lists will be posted by the end of the year, with ten examples for each. Sigma-Aldrich is also developing their first ever sustainability report, which should be available at the end of this year.

Mr. Venverloh discussed various green services available to NIH including custom packaged reagents (CPR), and returnable/reusable containers (spent solvent containers and Styrofoam coolers). Sigma-Aldrich packaging groups will custom pack reagents to your specifications. Mr. Venverloh believes that some groups at NIH have already set up small quantity ordering though this service. The Stainless Steel Pure-Pac service is a very popular program which ensures solvents maintain their high level of purity and dryness through a positive pressure, closed transfer design. They are available in 20 L to 400 L returnable containers.

Dr. Ponnusamy described various green process technologies that Sigma-Aldrich has developed for internal use. Sigma-Aldrich welcomed the opportunity to partner with NIH for beta partnerships in green chemistry, recycling, and waste reduction.

During the question and answer session, a member of the group asked about the Styrofoam recycling program, and John Boussios offered to get them in touch with Steve Cooper in St. Louis who runs the program.

Another member of the group asked about recycling of the blue ice packs that are sometimes used in shipping. Mr. Venverloh explained that Sigma-Aldrich partners with a local workhouse for the disadvantaged where they refresh the materials and reuse the ice packs.

A member of the group asked if the mercury-free thermometers were certified by National Institute of Standards and Technology or if samples were available. Mr. Venverloh said they are certified for accuracy, but he did not have any samples. Dominique Lorang-Leins then explained that NCI uses them and they work very well.

Kevin Corcoran of Sigma-Aldrich asked about NIH's chemical ranking and reduction efforts. Don Wilson explained that we have developed a list of common priority chemicals that we would like to reduce. The goal is to let people know about chemical alternatives or to ask them to minimize their use when an alternative is not available. It is an ongoing process in the beginning stages, and we still need to develop outreach communications. Lastly, Terry Leland asked for comments from the group on the NIH Target Chemicals Ranking List. (Attachment 2)

Action Items:

Action Item	Responsible Person(s)	Due Date
1. Submit chemical uses and alternatives for NIH Target Chemicals Ranking List	Working Group	October 10, 2008

Next Meeting:

The next meeting is scheduled for Wednesday, October 15, from 1:30 to 2:30 PM in Building 50, Room 1328/1334. During this meeting, the group will identify an outreach strategy for selected target chemicals.

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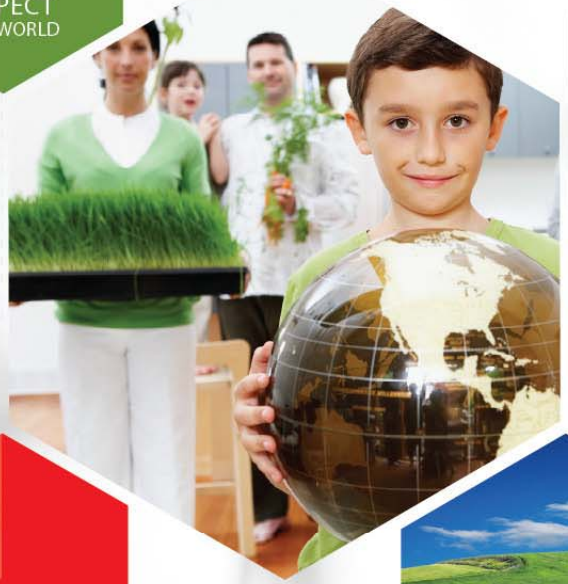
ATTACHMENT 1

Presentation for the National Institutes of Health

September 17, 2008



Science is Our World

How Environmental Sustainability Guides Sigma-Aldrich

Timothy Venverloh, *Director, Sustainability*

Ettigounder (Samy) Ponnusamy, *Principal Scientist*

Green Science & Environmental Stewardship

- Energy tracking and recycling
- Green process technology
- Green science product development
- Green services and partnerships

Energy Tracking and Recycling

Early in 2007, the Worldwide Sustainable Development Committee was formed to collect data, evaluate global operations, and direct sustainable development activities. Our 2008 launch included the following notable activities:

WW Energy Tracking –

- Monitor energy use and natural resource consumption
- Monitor CO_2e emissions to aide in the development of an accurate carbon footprint
- Evaluate engineering opportunities to implement energy conservation projects and reduce CO_2e emissions

WW Recycling –

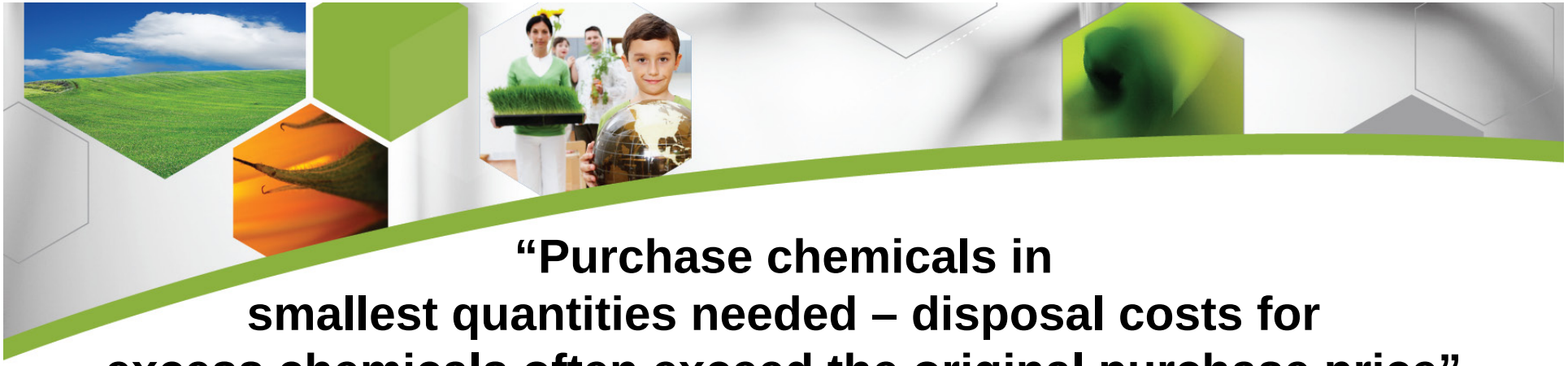
- Recycling activity survey
- Develop website to post worldwide recycling activities for operations and customers
- Continued exploration of recycling partnerships with customers and suppliers

NIH Environmental Management System

NEMS GOALS

“ Minimizing / Substituting Chemicals

- Purchase chemicals in smallest quantities needed – disposal costs for excess chemicals often exceed the original purchase price
- Order chemicals in reusable/returnable containers
- Use less toxic alternative chemicals, such as less toxic lab stains or solvent substitutes
- Replace your mercury-containing equipment with non-mercury substitutes”



“Purchase chemicals in smallest quantities needed – disposal costs for excess chemicals often exceed the original purchase price”

Sigma-Aldrich Discovery^{CPR} –

Our custom packaging groups will custom pack reagents to your specifications:

Convenient

Eliminate on-site stocking and inventory management

One-stop sourcing

Determine price and availability from your desktop

Flexible

No minimum order required

Widest selection of available reagents

Reagent sets include products sourced from over 100 vendors

Specify the amount of material per vial, including mmol-based weights

Specify vial type, labeling/barcode, packaging, and fill data file format

Efficient

24-48 hour turnaround

Reagents are ready-to-use, saving time, reducing storage

Maximize productivity

Minimize disposal

sigma-aldrich.com/discoverycpr • ***discoverycpr@sial.com***

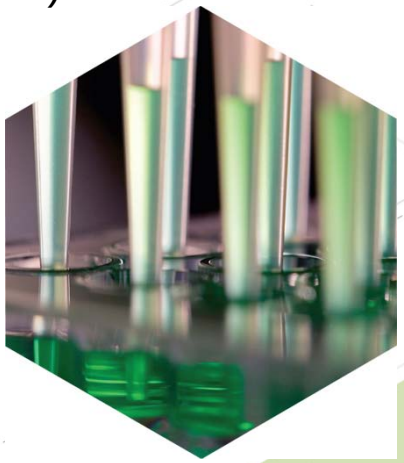
NEMS

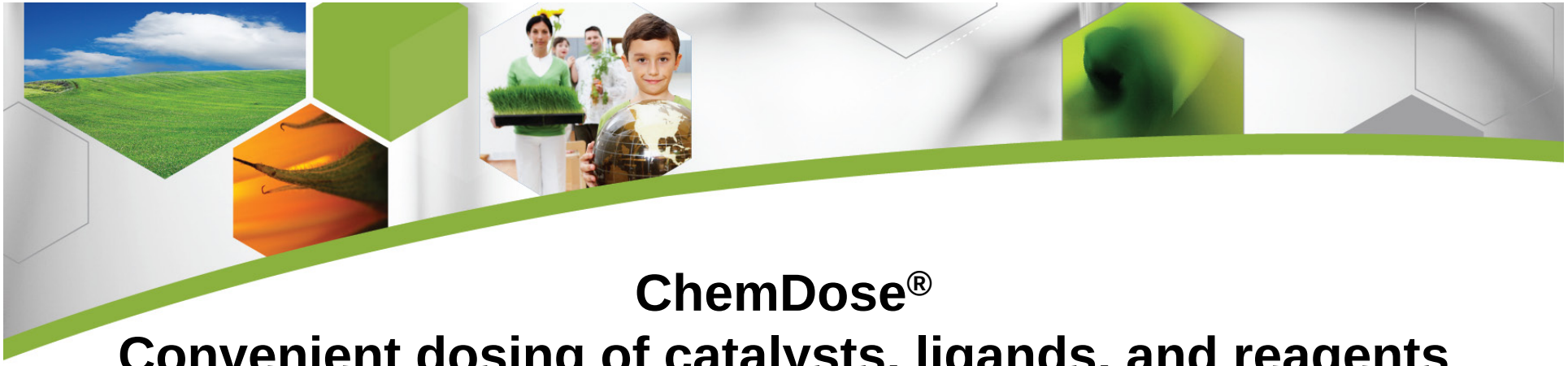
Green Process Technology

- Eliminated HF gas usage for peptide synthesis
- Eliminated HBr, Acetone, and Benzyl-bromide

  in the production of Poly-L-glutamic Acid Polymers, US Patent Granted (#7,317,070 dated 01-08-2008)
- Eliminated Pyridine in the production of NAD (Nicotinamide Adenine Dinucleotides)
- Eliminated Chloroform in the production of SOD (Superoxide Dismutase)
- Eliminated Acetone in the production of Catalase from Bovine liver
- Eliminated Acetone in the production of Tyrosinase from Bovine liver
- Significantly reduced Acetic Acid and Ethanol

  in the production of α-Solanine and α-Chaconine





ChemDose®
Convenient dosing of catalysts, ligands, and reagents

- **Characteristics**
  - -5 mm inert tablets, loaded with milli- and micromolar catalyst / reagents quantities → ideal for high-throughput screening (HTS)
  - -Reagents / catalysts dissolve out upon exposure to solvents, leaving behind an inert matrix (remove by filtration)
  - -Commonly used Pd catalysts, Buchwald-type ligands, and peptide coupling reagents

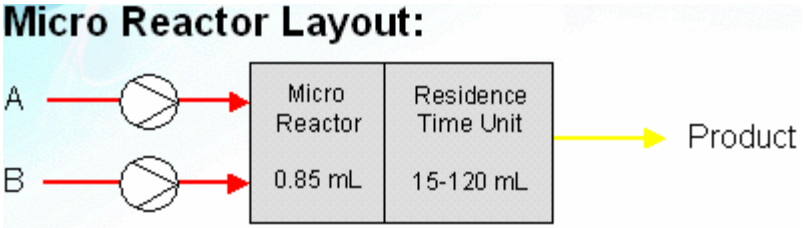
- **Advantages**
  - -Convenient handling
  - -Eliminates the tedious weighing process for small chemical quantities (waste reduction)
  - -Compatible with parallel automation
  - -Simple reaction work-up
  - -Consistent chemical loadings of tablets, controlled release rates
  - -Reaction kinetics closely parallel conventional reagent

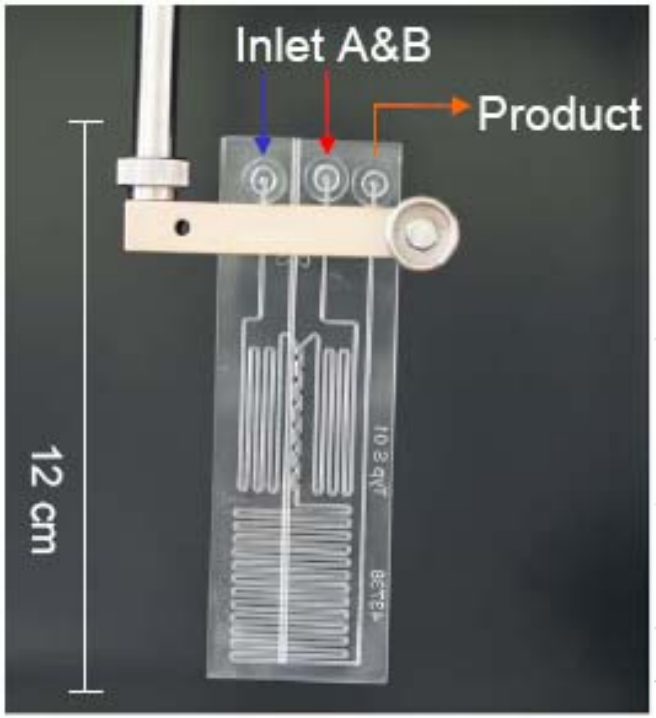
sigma-aldrich.com/chemdose

Ruhland, T. et. al. *J. Comb. Chem*. **2007**, *9*, 301

NEMS

Microreactor Technology





Prominent Fields of Application:

Continuous Flow Synthesis

Process Development

Education

Production (several 100 g per day)

Handling of Instable Products & Intermediates

Product Profile Improvement (Side Product Suppression)

Safe Performance of Highly Exothermic or Hazardous Reactions

sigma-aldrich.com/microreactor

NEMS

Aluminum Nucleophiles: DABAL-Me_3

- **DABAL-Me_3: Adduct of DABCO and $AlMe_3$**

  -Non-pyrophoric alternative to trimethylaluminum; powerful methyl anion equivalent

  -Excellent handling characteristics (solid)

  -Stability similar to $LiBH_4$; will not ignite or significantly decompose on brief exposures to dry air

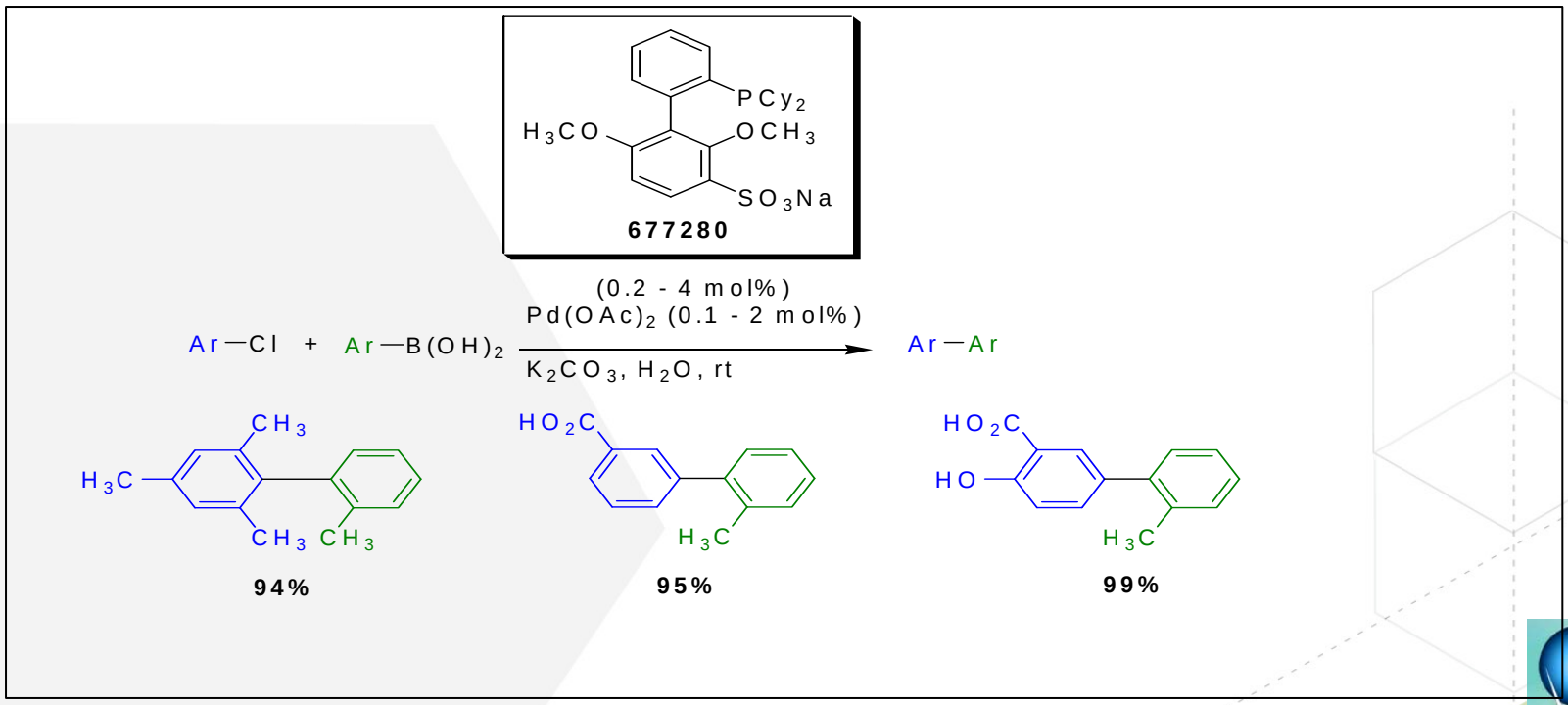
sigma-aldrich.com/dabalme3

Woodward, S. *Synlett* **2007**, 1490.

Water-Soluble SPhos

Suzuki Coupling

-Reaction in water at room temperature

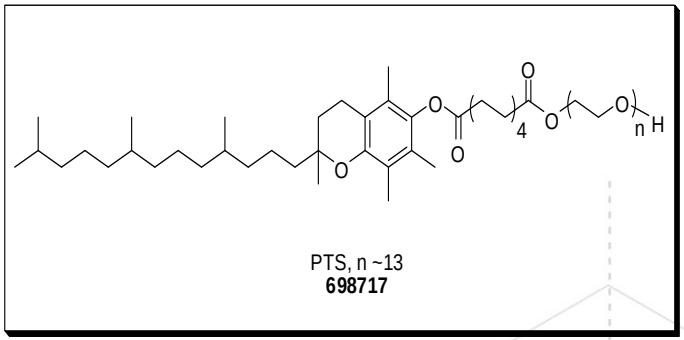


sigma-aldrich.com/sphos

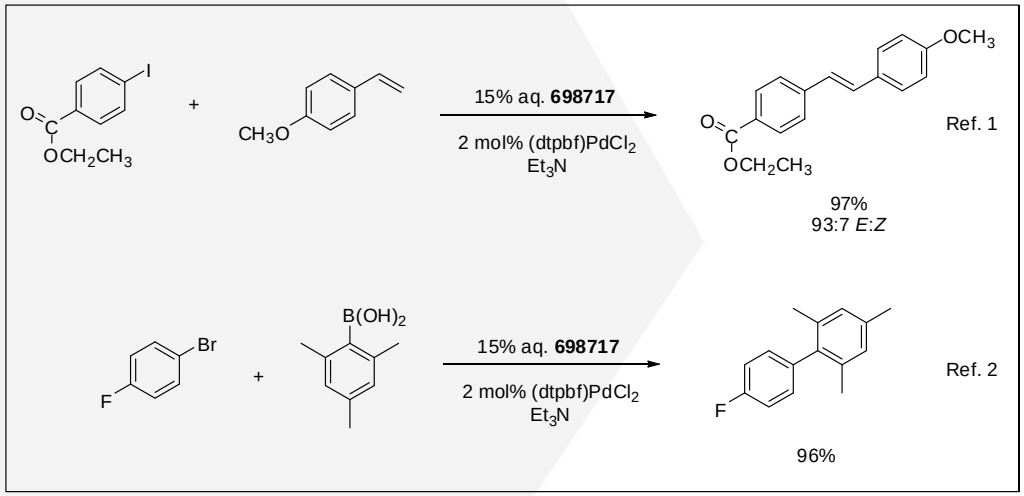
Anderson, K. W. and Buchwald, S. L. *Angew. Chem, Int. Ed.* **2005**, *44*, 6173

Polyoxyethanyl α-tocopheryl sebacate (PTS)

A general-purpose nonionic amphiphile --
Permits a large variety of carbon-carbon bond-forming reactions to take place in water.



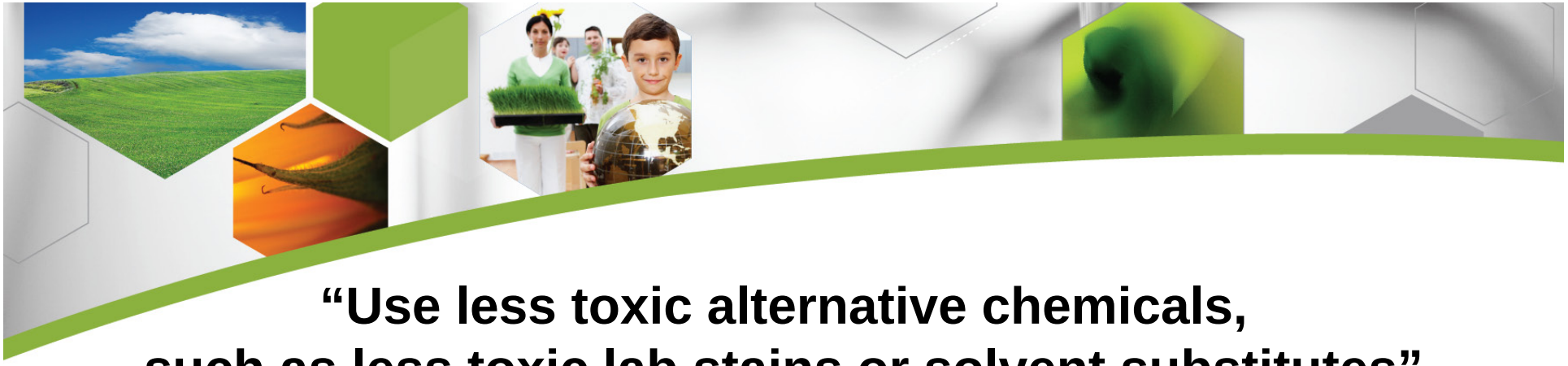
Heck and Suzuki–Miyaura Couplings in Water:



Lipshutz et al. *Org. Lett.* **2008**, *10*, 1329.

Lipshutz et al. *Org. Lett.* **2008**, *10*, 1333.

sigma-aldrich.com/pts



“Use less toxic alternative chemicals, such as less toxic lab stains or solvent substitutes”

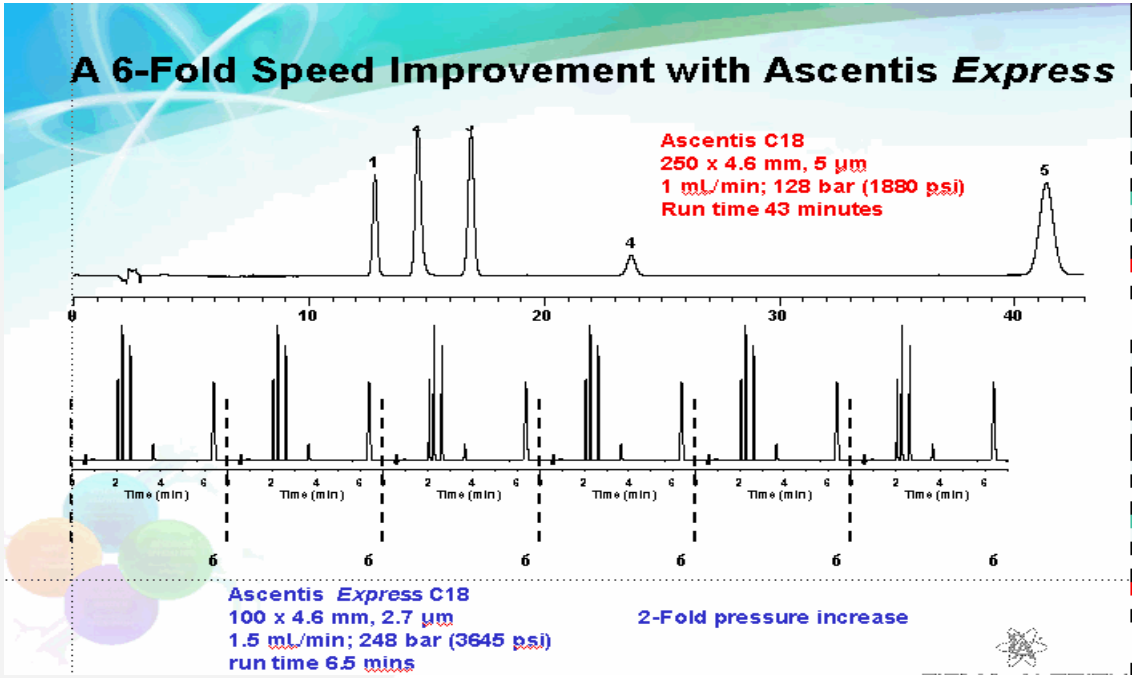
Bioscience

Novozymes:	Recipient of the Presidential Green Chemistry Challenge Award for eco-friendly products.
GenElute DNA:	Green alternative to guanidine thiocyanate and guanidine hydrochloride for DNA purifications.
GenElute RNA:	Green alternative to TRI reagent BD and Tri reagent LS for molecular biology applications.
Extract-N-Amp:	Green alternative to phenol, to phenol chloroform 5:1, and to phenol chloroform isoamyl alcohol 25:24:1 for molecular biology applications.
EZBlue:	Does not require organic solvents for destaining as is common for most electrophoresis gel stains.

search on sigma-aldrich.com

NEMS

Ultra-High Pressure Liquid Chromatography



sigma-aldrich.com/ascentisexpress

“Replace your mercury-containing equipment with non-mercury substitutes”

Enviro-Safe® pocket thermometer (8)

Z257761	**−10–110 °C temperature, Without armor** (Aldrich)
Z257826	**−10–110 °C temperature, With armor** (Aldrich)
Z257788	**−5–50 °C temperature, Without armor** (Aldrich)
Z257834	**−5–50 °C temperature, With armor** (Aldrich)
Z257753	**0–220 °F temperature, Without armor** (Aldrich)
Z257818	**0–220 °F temperature, With armor** (Aldrich)
Z257796	**20–120 °F temperature, Without armor** (Aldrich)
Z257842	**20–120 °F temperature, With armor** (Aldrich)

Enviro-Safe® thermometer (16)

Z273929	**L 200 mm, -10–110 °C temperature, immersion level, 50 mm** (Aldrich)
Z273945	**-10–150 °C temperature, immersion level, 50 mm** (Aldrich)
Z252964	**-20–110 °C temperature, immersion level, 76 mm** (Aldrich)
Z252972	**-20–150 °C temperature, immersion level, 76 mm** (Aldrich)
Z252980	**-10–260 °C temperature, immersion level, 76 mm** (Aldrich)
Z253022	**0–230 °F temperature, immersion level, 76 mm** (Aldrich)
Z253030	**0–300 °F temperature, immersion level, 76 mm** (Aldrich)
Z253049	**20–500 °F temperature, immersion level, 76 mm** (Aldrich)
Z252999	**-20–110 °C temperature, immersion level, total** (Aldrich)
Z253006	**-20–150 °C temperature, immersion level, total** (Aldrich)
Z273937	**-10–110 °C temperature, immersion level, total** (Aldrich)
Z273953	**-10–150 °C temperature, immersion level, total** (Aldrich)
Z253014	**-10–225 °C temperature, immersion level, total** (Aldrich)
Z253057	**0–230 °F temperature, immersion level, total** (Aldrich)
Z253065	**0–300 °F temperature, immersion level, total** (Aldrich)
Z253073	**20–440 °F temperature, immersion level, total** (Aldrich)

Enviro Kleen™ Formulated for the Environment

Enviro-Safe® and Easy-Read® Thermometers are the market leaders in environmentally friendly thermometers. They are the first thermometers to achieve certification stating that they are 100% non-toxic, non-hazardous, biodegradable, and “green”.

sigma-aldrich.com/envirosafe

sigma-aldrich.com/ebrovacuumgauges

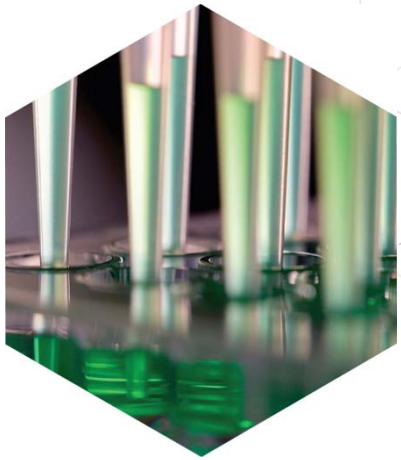
NEMS

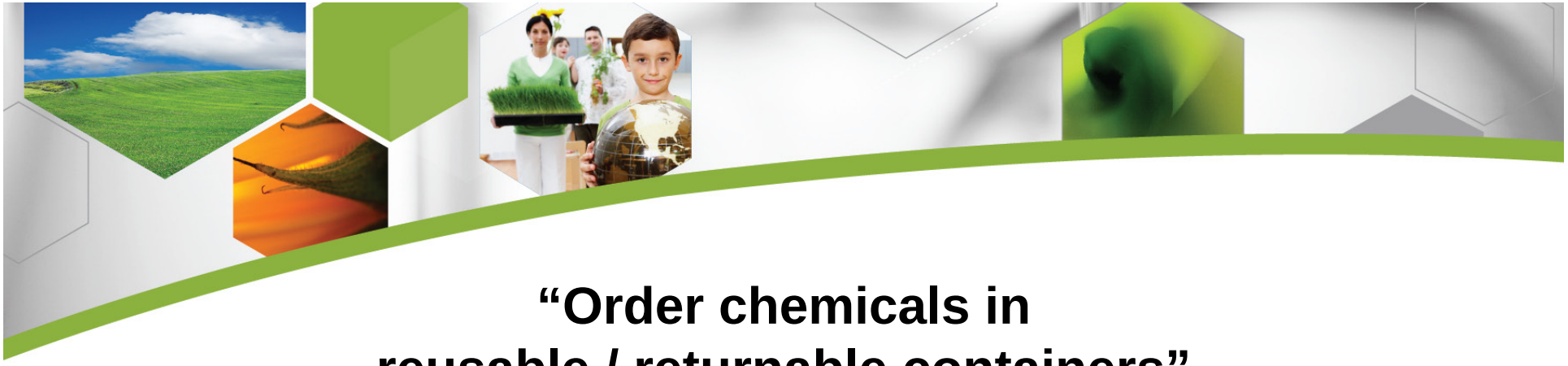
Green Services and Partnerships

Examples:

Spent solvent containers – brown glass / clear glass

Styrofoam coolers – container return/reuse program





“Order chemicals in reusable / returnable containers”

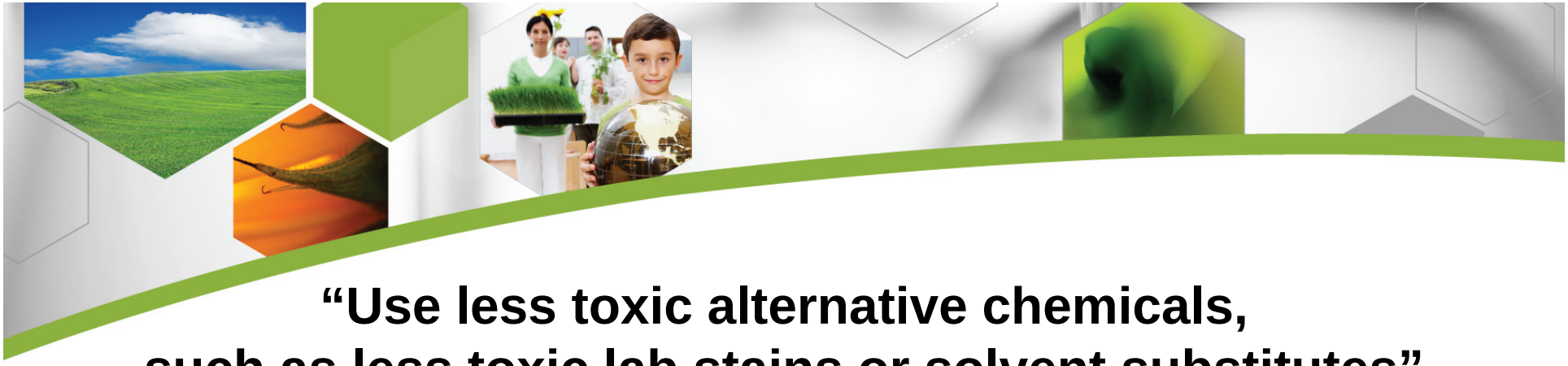
Sigma-Aldrich offers solvents and high hazard materials in returnable containers. Customizable dispensing options are also available.

LAUNCH
Cylinder Return Program

- **Improve Safety**
- **Maintain Quality**
- **Eliminate Disposal of Bottle and Packaging Waste**

sigma-aldrich.com/rc

NEMS



“Use less toxic alternative chemicals, such as less toxic lab stains or solvent substitutes”

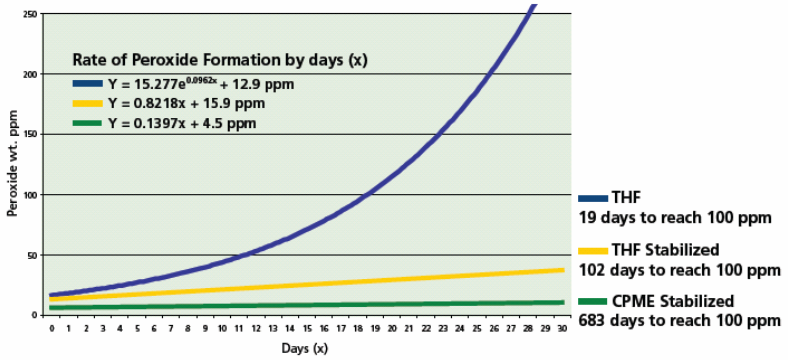
Alternative Solvents

Increased safety, low peroxides formation, reduced environmental footprint.

e.g., 2-Methyltetrahydrofuran (2-MeTHF); Cyclopentyl methyl ether (CPME)

Properties	CPME	2-MeTHF	THF	Ether	DCM	1,4-Dioxane	MTBE
Density (20 °C) [g/cm3]	0.86	0.86	0.89	0.71	1.32	1.03	0.74
Dielectric constant (25 °C)	4.76	6.97	7.58	4.197	8.93	2.227	—
Boiling point [°C]	106	80	65	34.6	39.8	101	55
Heat of Vaporization (bp) [Kcal/kg]	69.2	87.1	98.1	86.1	80.5	98.6	81.7
Solubility of Solvent in Water (23 °C)	1.1	14	Infinite	6.5	1.3	Infinite	4.8
Solubility of Water in Solvent (23 °C)	0.3	4.4	Infinite	1.2	0.2	Infinite	1.5
Azeotropic temperature with Water [°C]	83	89	64	34	39	88	52
Flash point [°C]	–1	–11.1	–14.2	–45	—	12	–28
Explosion range [vol%] Lower / Upper limit	1.1% / 9.9%	—	1.84% / 11.8%	1.85% / 48%	14% / 22%	2% / 22%	1.6% / 15.1%

Peroxide Formation of Ether Solvent



Conditions

- 20 mL of each sample in a brown bottle (capacity of 65 mL)
- Stored at room temperature, in a dark place and in the presence of air

sigma-aldrich.com/greensolvents

NEMS

Sigma-Aldrich
Products for Green Science

Sigma-Aldrich® Green Science
CERTIFIED

We welcome the opportunity for beta partnerships

Green chemistry

Recycling

Waste Reduction

NEMS

SIGMA-ALDRICH GLOBAL CITIZENSHIP

Breakthrough Worldview

Scientific discovery bridges the divide of social equity with knowledge. By facilitating scientific breakthroughs, sharing knowledge, and building mutually beneficial relationships with the people touched by our business, we promote science on a global scale.

MEETING MINUTES

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NIH Environmental Management System (NEMS)
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ATTACHMENT 2

NIH Target Chemicals Ranking Matrix

Chemical	Quantity Waste Gen. CY07	Regulatory Mandate	Alternative Availability & Feasibility	Total Points	Use	Alternatives
TIER 1 – TOP PRIORITY LIST OF NIH TARGET CHEMICALS						
Ethidium Bromide	10 (201.1 Kg)	0	15	66	• DNA stain • Gel electrophoresis	• SYBR Red, SYBR Safe • SYBR Red (Biotium Inc), EnVISION™ (Amresco) • Gel Green (Biotium, Inc) (instead of SYBR Green)
Picric acid	1 (7 Kg)	6	15	74	• Staining agent	• 2% aqueous ferric ammonium sulfate • Fluorescent based cells?
					• Boudin fixative	• Modified Davidson's Fixative[1] • Davidson fixative (Ethanol, acetic acid, formalin)
					• Tissue fixative	• ?
Acetonitrile	15 (3532.7 Kg)	9		50	• HPLC	• Reduce flow rates • Use capillary columns
					• Solvent	• Polyethylene glycol
					• Organic synthesis • *Routinely used by chemists*	• Water
					• Oligo and peptide synthesis	• Purchase oligonucleotides and peptides from commercial vendors Synthesis also require the use of other organic chemicals

[1] *Latendressee et al. published a detailed report on evaluations of this alternative in Toxicologic Pathology 30(4):524-533 (2002). Also, Ed Rau article in* ***Chemical Health and Safety*** *Volume 10, Issue 2, March-April 2003, Page 27*

Chemical	Quantity Waste Gen. CY07	Regulatory Mandate	Alternative Availability & Feasibility	Total Points	Use	Alternatives
Xylene	15 (2634.5 Kg)	9		50	• Radioactive tracer studies (liquid scintillation cocktails) • *Minimally used by chemists*	• Non-hazardous proprietary liquid scintillation cocktails (National Diagnostics) • Solvent recycling systems
					• Clearing agents in histology • In Situ	• Histo-Clear (National Diagnostics, RA Lamb) • Clear-Rite 3™ • Americlear™ • Histosolv X™/ Shandon Xylene Substitute • Mediclear II™ • Pro-Par Clearant • CitriSolv (Fisher) • SpoT –light tissue pre-treatment kit (invitrogen) • Sodium thiocyanate
Methanol	15 (5656.3 Kg)	9		57	• Washing gels	• Ethanol • Water
Chloroform	15 (986.5 Kg)	9		62	• General, reaction solvent	• Dimethoxyethane • Polyethylene glycol
					• Traditional DNA extraction • *Routinely used by chemists*	• New DNA extraction kits using polycarbonate filters, PEG, and simple salts

Chemical	Quantity Waste Gen. CY07	Regulatory Mandate	Alternative Availability & Feasibility	Total Points	Use	Alternatives
Dichloromethane	15 (1095.5 Kg)	9		55	• Cleaning agent	• D-Limonene
					• General, reaction solvent • Alternative to Dichloromethane for Biphasic Reactions o Alkylation o Amidation o Nucleophilic Substitution Reaction • *Routinely used by chemists*	• Benzotrifluoride (trifluorotoluene) • Diethoxymethane • Ionic liquids • Water • 2-Methyltetrahydrofuran (2-MeTHF)
					• DNA extraction	•Commercial DNA extraction kits using non-organic chemicals (Quiagen, Sigma)
Chromic acid	15 (8.4 Kg)	9	15	58	• Chromic acid baths • *Minimally used by chemists*	• Alconox • Base baths • Disposable labware
Dimethyl formamide	15 (632.5 Kg)	9		45	• Solvent	• Polyethylene glycol • N-methyl pyrrolidone • Water
Formaldehyde	10 (737 Kg)	6		45	• Tissue Fixative	• Streck's Tissue Fixative
Hexane	10 (873.2 Kg)	10		43	• Solvent	• Cetyltrimethylammonium chloride (CTAC) • Dimethyledodecylamine oxide (DDAO) • Sodium dodecyl sulfate (SDS) • Water
Phenol	10 (518.1 Kg)	9		53	• Solvent	• Polyethylene glycol
					• Traditional DNA extraction	•New DNA extraction kits using polycarbonate filters, PEG, and simple salts

Chemical	Quantity Waste Gen. CY07	Regulatory Mandate	Alternative Availability & Feasibility	Total Points	Use	Alternatives
Phosphoric acid	10 (142.9 Kg)	3		34	• Cage cleaning	• Citric acid
Trichloroacetic acid	10 107.4 Kg)	3		35		
Perchloric acid	1 (4.2 Kg)	3		32		
Mercury	10 (216.5 Kg)	12	15	77	• Single vial fixative for concentration, permanent stain, EIA, IFA and PCR procedures	• Alpha-Tec Systems PROTO-Fix Parasitology Fixative
					• B-5 mercury based fixatives and other fixatives	• AZF (Acetic Zinc Formalin) Fixative Newcomer Supply • B-Plus Fixative(TM) BBC Biochemical • B5 Fixative Modified Newcomer Supply • Histo-Fix, Trend Scientific Inc. • Shandon Zinc Formal-Fixx™ Thermo Electron • Z-5 Anatech Ltd. • Zenkers Fixative Modified Newcomer Supply
					• Hematoxylin stain	• Harris Hematoxylin Anatech Ltd.
					• Parasitology - permanent staining, concentration, EIA, and ELISA procedures	• SAF Fixative (Sodium Acetate Acetic Acid Formalin) Medical Chemical Corporation
Mercury Compounds	1 (11 Kg)	12	15	68	• Thimerosal	• Methyl paraben, Propyl paraben, Thymol

Chemical	Quantity Waste Gen. CY07	Regulatory Mandate	Alternative Availability & Feasibility	Total Points	Use	Alternatives
					• Mercuric chloride PVA for permanent staining	• Zinc-PVA parasitology transport vials Medical Chemical Corporation
TIER 2 - NIH TARGET CHEMICALS UNDER CONSIDERATION						
CFC-11 and 12	1 (0.4, 15.9 Kg)	12	15	66	• Refrigerant	• HFC-134a
Carbon tetrachloride	5 (49.2 Kg)	12		58	• Solvent	• Water
1,1,1-Trichloroethane	5 (46.1 Kg)	12		58	• Solvent	• Volatile methyl siloxanes (VMS)
Ethylene oxide	5 (42.9 Kg)	9		48		
Silver nitrate	1 (9.03 Kg)	9		48		