ENV H 593 A Sp 17: Current Topics In Risk Assessment

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ENV H 593 A: Current Topics in Risk Assessment

SYLLABUS: Alternatives Assessments: Choosing the right substitute chemicals

Current Concepts in Human Health Risk Assessment Journal Club

Spring Quarter 2017

ENVH 593 (Journal Club)

Credits: 1

Current Quarter Topic:

Instructor:

Elaine M. Faustman, PhD, DABT

Professor, Department of Environmental and Occupational Health Sciences and Director, Institute for Risk Analysis and Risk Communication (IRARC)

Office: 4225 Roosevelt Way NE, Suite 100

Phone: 206-685-2269
E-mail: faustman@u.washington.edu (mailto:faustman@u.washington.edu)

Office hours: By appointment

Course Times and Locations:

Tuesdays from 2:30-4:30pm

Five Sessions: April 4th, April 18th, May 2nd, May 9th, May 16th

Class will be held in 4225 Roosevelt Way NE, Suite 100 in Roosevelt 2228/212

Course Website: https://canvas.uw.edu/courses/1139056

- The Syllabus is posted on the website
- Within the files tab you will find folders containing the readings for each session.
- Please post your selection in the discussion section of canvas by 12pm the Monday before class.
- Please bring 2 completed “Literature Review Forms” with you to class to help guide the discussion.

Course Description:

In this course, we will delve deeper into the concept of chemical sustainability and policy reform by asking what success in this field looks like. How do we evaluate substitute chemicals and what are the measures of success? What short term and alternative approaches can we use to make these decisions? How can risk assessment inform the approaches used for alternatives analysis? We will explore specific timely examples including bisphenol A and phthalate assessments. We will use the recent National Academy of Sciences report, entitled “A Framework to Guide the Selection of Chemical Alternatives” to frame our discussions.

Course Learning Objectives:

Upon completion of this journal club, students shall be able to:

- Demonstrate familiarity with alternatives assessments approaches from the National Academy of Sciences and discuss their relevance to risk assessment and risk management. How can principles of risk assessment inform substitution of alternative assessment?
- Compare and contrast multiple recommendations for alternatives assessments from European bodies, the National Academy of Sciences, Environmental Protection Agency and others. What is missing? What is common?
- Articulate scientific and policy considerations arising from alternatives assessments.

In general:

1. Think critically about risk assessment by completing reading assignments and participating in class discussions.
2. Communicate the concept of integrated risk assessment and risk communication.
3. Explain the risk assessment framework as it relates specifically to the current quarter topic.
4. Analyze assigned readings and interpret their relevance to not only the quarter topic but also their applicability and generalizability to risk assessment topics at large.
5. Summarize key points from assigned journal articles or other required readings.
6. Prepare and deliver an oral presentation(s) discussing the required reading.
7. Critique risk assessment applications as they relate to the current quarter topic.
8. Identify risk assessment strengths and challenges, as well as the role of uncertainty.
9. Develop skills to think critically about the methods and tools used for assessment, management, and communication of risk.

Academic Integrity Statement:

Students at the University of Washington (UW) are expected to maintain the highest standards of academic conduct, professional honesty, and personal integrity.
The UW School of Public Health (SPH) is committed to upholding standards of academic integrity consistent with the academic and professional communities of which it is a part. Plagiarism, cheating, and other misconduct are serious violations of the University of Washington Student Conduct Code (WAC 478-120). We expect you to know and follow the university's policies on cheating and plagiarism, and the SPH Academic Integrity Policy. Any suspected cases of academic misconduct will be handled according to University of Washington regulations. For more information, see the University of Washington Community Standards and Student Conduct website.

UW Disability Statement (Links to an external site.) **(http://depts.washington.edu/uwdrs/faculty-resources/syllabus-statement/)**
Access and Accommodations: Your experience in this class is important to me. If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at206-543-8924 or **uwdrs@uw.edu** **(mailto:uwdrs@uw.edu)** or **disability.uw.edu** **(http://disability.uw.edu/)** . DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between you, your instructor(s) and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

Multi-cultural Inclusion Commitment from Environmental Health

The UW School of Public Health seeks to ensure all students are fully included in each course. We strive to create an environment that reflects community and mutual caring. We encourage students with concerns about classroom climate to talk to your instructor, your advisor, a member of the departmental or SPH Diversity Committee and/or the program director. DCinfo@uw.edu is a resource for students with classroom climate concerns.

We have the privilege of learning together and we have a responsibility to engage in dialogue in a way that supports learning for all of us. Many of the issues we will discuss in this course may concern issues of disproportionate risks, sensitivities, and impacts due to age, gender, race, and/or social inequalities. This is what public health hopes to address, however we know that these can be difficult topics to address, hence we thus feel it is even more important to be sensitive to our colleagues' experiences and ideas. Here are some practices we as learning community members can strive to use in our learning process:

- My own viewpoint is important—share it. It will enrich others.
- My students' and colleagues' viewpoints are important—listen to them. Do not judge them.
- Extend the same listening respect to others I would wish them to extend to me. We all have room to grow to become better listeners in non-judgmental ways.
- Recognize that I might miss things others see and see things others might miss.
- Raise my views in such a way that I encourage others to raise theirs.
- Inquire into others' views while inviting them to inquire into mine.
- Ask questions when I don't understand something.
- Surface my feelings in such a way that we make it easier for others to surface theirs.
- Test my assumptions about how and why people say or do things.
- Challenge what was said or done, rather than make assumptions about the individual.
- Beware of either-or thinking.
- Be willing to take risks in moving outside my comfort zones.
- Affirm others

Course Session Schedule and Readings:

Session 1, April 4: Introduction to the National Academy of Sciences "A Framework to Guide Selection of Chemical Alternatives"

- Introductions- All

- Overall goals of the course and introduction to the topic- Elaine Faustman

-Coverage of Chapters 1-3

Session 2, April 18: Problem Formulation, Physiochemical Properties and Comparative Exposure Assessment

- Introduction- Elaine Faustman

-Presentation of Key Points from Readings- Students

Please read the selected chapters from the NRC document "A Framework to Guide Selection of Chemical Alternatives" and one other article. Please be prepared to share five key points with the class and discuss your impressions from the readings.

Session 2 Readings:

1. Bare, J.C. and Gloria, T.P., 2008. Environmental impact assessment taxonomy providing comprehensive coverage of midpoints, endpoints, damages, and areas of protection. Journal of Cleaner Production, 16(10), pp.1021-1035.
2. **Chapters 4-6 from the National Research Council. 2014. A Framework to Guide Selection of Chemical Alternatives. Washington, DC: The National Academies Press. doi:https://doi.org/10.17226/18872."**
3. Costanza, J.D., D.G. Lynch, R.S. Boethling, and J.A. Arnot. Use of the bioaccumulation factor to screen chemicals for bioaccumulation potential. Environ Toxicol Chem. 31(10): 2261-8. DOI: 10.1002/etc.1944
4. Edwards S., J. Tickner, Y. Torrie, M. Coffin, and L. Kernan. 2011. A Compendium of Methods and Tools for Chemical Hazard Assessment. **http://www.sustainableproduction.org/downloads/Methods-ToolsforChemHazardAss5-2011.pdf (http://www.sustainableproduction.org/downloads/Methods-ToolsforChemHazardAss5-2011.pdf)**
5. EPA (US Environmental Protection Agency). Safer Choice online. US Environmental Protection Agency Washington DC. https://www.epa.gov/saferchoice
6. Hewitt, M., S.J. Enoch, J.C. Madden, K.R. Przybylak, and M.T. Cronin. 2013. Hepatotoxicity: A scheme for generating chemical categories for read-across, structural alerts and insights into mechanism(s) of action. Crit Rev Toxicol. 43(7):537-58. DOI: 10.3109/10408444.2013.811215
7. Identifying New Persistent and Bioaccumulative Organics Among Chemicals in Commerce. Philip H. Howard and Derek C. G. Muir. Environmental Science & Technology 2010 44 (7), 2277-2285. DOI: 10.1021/es903383a
8. Identifying New Persistent and Bioaccumulative Organics Among Chemicals in Commerce II: Pharmaceuticals. Philip H. Howard and Derek C. G. Muir. Environmental Science & Technology 2011 45 (16), 6938-6946. DOI: 10.1021/es201196x
9. Identifying New Persistent and Bioaccumulative Organics Among Chemicals in Commerce. III: Byproducts, Impurities, and Transformation Products. Philip H. Howard and Derek C. G. Muir. Environmental Science & Technology 2013 47 (10), 5259-5266. DOI: 10.1021/es4004075

10. IC2 (Interstate Chemical Clearinghouse). 2017. Alternatives Assessment Guide Version 1.1. http://theic2.org/article/download-pdf/file_name/IC2_AA_Guide_Version_1.1.pdf (http://theic2.org/article/download-pdf/file_name/IC2_AA_Guide_Version_1.1.pdf)
11. Jacobs MM, Malloy TF, Tickner JA, Edwards S. Alternatives Assessment Frameworks: Research Needs for the Informed Substitution of Hazardous Chemicals. 2016 EHP. Vol: 124 (3). doi: 10.1289/ehp.1409581
12. Kreyling, W. G., Semmler-Behnke, M., Takenaka, S., & Möller, W. (2013). Differences in the biokinetics of inhaled nano- versus micron-sized particles. Accounts of Chemical Research, 46(3), 714–722. http://doi.org/10.1021/ar300043r (http://doi.org/10.1021/ar300043r)
13. MaKay, C., M. Davies, V. Summerfield, and G. Maxwell. 2013. From pathways to people: applying the adverse outcome pathway (AOP) for skin sensitization to risk assessment. ALTEX 30(4):473-86
14. OECD (Organization for Economic Co-operation and Development. 2012. Descriptions of existing models and tools used for exposure assessment: Results of OECD Survey.
15. OECD (Organization for Economic Co-operation and Development. 2013. Current Landscape of Alternatives Assessment Practice: A meta review.
16. OECD (Organization for Economic Co-operation and Development. 2013. Guidance document on developing and assessing adverse outcome pathways.
17. Rossi, M., Tickner, J., & Geiser, K. (2006). Alternatives Assessment Framework of the Lowell Center for Sustainable Production, Version 1.0. Lowell Center for Sustainable Production.[2016-06-29]: www. chemicalspolicy. org/downloads/FinalAltsAssess06. pdf.
18. Rossi, M., Peele, C., & Thorpe, B. (2012). BizNGO Chemicals Alternatives Assessment Protocol: How to Select Safer Alternatives to Chemicals of Concern to Human Health or the Environment.
19. Schulte PA, McKernan LT, Heidel DS, et al. Occupational safety and health, green chemistry, and sustainability: a review of areas of convergence. Environmental Health. 2013;12:31. doi:10.1186/1476-069X-12-31.
20. TURI (Toxics Use Reduction Institute). Five Chemicals Study: Alternatives Assessment

Session 3, May 2: Human Health in Alternative Assessments

- Introduction- Elaine Faustman

- Presentation of Key Points from Readings- Students

Please read the selected chapters from the NRC document "A Framework to Guide Selection of Chemical Alternatives" and one other article. Please be prepared to share five key points with the class and discuss your impressions from the readings.

Session 3 Readings:

1. Chapter 8 from National Research Council. 2014. A Framework to Guide Selection of Chemical Alternatives. Washington, DC: The National Academies Press. doi:https://doi.org/10.17226/18872.
2. Bus, J.S. and R.A. Becker. 2009. Toxicity testing in the 21st century: A view from the chemical industry. Toxicol Sci. 112(2):297-302
3. Minjun Chen, Huixiao Hong, Hong Fang, Reagan Kelly, Guangxu Zhou, Jürgen Borlak, Weida Tong; Quantitative Structure-Activity Relationship Models for Predicting Drug-Induced Liver Injury Based on FDA-Approved Drug Labeling Annotation and Using a Large Collection of Drugs. Toxicol Sci 2013; 136 (1): 242-249. doi: 10.1093/toxsci/kft189
4. Collins, F.S., G.M. Gray, and J.R. Bucher. 2008. Science. 319(5856): 906-7. DOI: 10.1126/science.1154619
5. Crump, K.S., C. Chen, and T.A. Louis. 2010. The Future Use of in Vitro Data in Risk Assessment to Set Human Exposure Standards: Challenging Problems and Familiar Solutions. Environ Health Perspect. 118910): 1350-1354. doi: 10.1289/ehp.1001931.
6. Davies, C., M. Adams, E. Connor, E. Sommer, C. Baier-Anderson, E. Lavoie, L. Romano, and D. Dilfore. 2013. US Environmental Protection Agency's Design for the Environment (DfE) Alternatives Assessment Program. Issues in Environmental Science and Technology, 36 Chemical Alternatives Assessments. 198-229. Doi:10.1039/9781849737234-00198
7. EPA 2013. Next generation risk assessment: incorporation of recent advances in molecular, computational, and systems biology. zhttps://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=286690
8. European Chemical Agency (ECHA). 2016. Guidance on Information Requirements and Chemical Safety Assessment, Chapter R.7a: Endpoint specific guidance. European Chemical Agency, Helsinki, Finland. https://echa.europa.eu/documents/10162/13632/information_requirements_r7a_en.pdf (https://echa.europa.eu/documents/10162/13632/information_requirements_r7a_en.pdf)
9. EPA (US Environmental Protection Agency). 2014. SAB advice on advancing the application of CompTox research for EPA chemical assessments. Science Advisory Board, US Environmental Protection Agency Washington DC.
10. Gauthier AM, Fung M, Panko J, Kingsbury T, Perez AL, Hitchcock K, Ferracini T, Sahmel J, Banducci A, Jacobsen M, Abelmann A. Chemical assessment state of the science: Evaluation of 32 decision-support tools used to screen and prioritize chemicals. Integrated environmental assessment and management. 2015 Apr 1;11(2):242-55. doi: 10.1002/ieam.1605. Epub 2015 Jan 8.

11. Hewitt, M., S.J. Enoch, J.C. Madden, K.R. Przybylak, and M.T. Cronin. 2013. Hepatotoxicity: A scheme for generating chemical categories for read-across, structural alerts and insights into mechanism(s) of action. Crit Rev Toxicol. 43(7):537-58. DOI: 10.3109/10408444.2013.811215
12. Richard S. Judson, Robert J. Kavlock, R. Woodrow Setzer, Elaine A. Cohen Hubal, Matthew T. Martin, Thomas B. Knudsen, Keith A. Houck, Russell S. Thomas, Barbara A. Wetmore, and David J. Dix. Estimating Toxicity-Related Biological Pathway Altering Doses for High-Throughput Chemical Risk Assessment. Chemical Research in Toxicology 2011 24 (4), 451-462. DOI: 10.1021/tx100428e
13. Kar, S., O. Deeb, and K. Roy. 2012. Development of classification and regression based QSAR models to predict rodent carcinogenic potency using oral slope factor. Ecotoxicol Environ Saf. 82: 85-92.
14. Robert Kavlock, Kelly Chandler, Keith Houck, Sid Hunter, Richard Judson, Nicole Kleinstreuer, Thomas Knudsen, Matt Martin, Stephanie Padilla, David Reif, Ann Richard, Daniel Rotroff, Nisha Sipes, and David Dix. Update on EPA's ToxCast Program: Providing High Throughput Decision Support Tools for Chemical Risk Management. Chemical Research in Toxicology 2012 25 (7), 1287-1302. DOI: 10.1021/tx3000939
15. Knapen D, Vergauwen L, Villeneuve DL, Ankley GT. The potential of AOP networks for reproductive and developmental toxicity assay development. Reproductive Toxicology. 2015 Aug 15;56:52-5. doi: 10.1016/j.reprotox.2015.04.003. Epub 2015 Apr 15.
16. Knudsen, T., M. Martin, K. Chandler, N. Kleinstreuer, R. Judson, and N. Sipes. 2013. Predictive Models and Computational Toxicology. Methods in Molecular Biology 947:343-47. doi: 10.1007/978-1-62703-131-8_26.
17. Krewski, D., M. Westphal, M. Al Zoughool, M.C. Croteau, and M.E. Andersen. 2011. New directions in toxicity testing. Annu Rev Public Health 32:161-78
18. Maxwell, Gavin, et al. "Applying the skin sensitisation adverse outcome pathway (AOP) to quantitative risk assessment." Toxicology In Vitro 28.1 (2014): 8-12.
19. Meek B, Doull J. Pragmatic Challenges for the Vision of Toxicity Testing in the 21st Century in a Regulatory Context: Another Ames Test? … or a New Edition of "the Red Book"? Toxicological Sciences. 2009;108(1):19-21. doi:10.1093/toxsci/kfp008.
20. National Research Council. Toxicity testing in the 21st century: a vision and a strategy. National Academies Press, 2007.
21. Rusyn, I., Sedykh, A., Low, Y., Guyton, K. Z., & Tropsha, A. (2012). Predictive Modeling of Chemical Hazard by Integrating Numerical Descriptors of Chemical Structures and Short-term Toxicity Assay Data. Toxicological Sciences, 127(1), 1–9. **http://doi.org/10.1093/toxsci/kfs095** **(http://doi.org/10.1093/toxsci/kfs095)**
22. Sand, S., Portier, C. J., & Krewski, D. (2011). A Signal-to-Noise Crossover Dose as the Point of Departure for Health Risk Assessment. Environmental Health Perspectives, 119(12), 1766–1774. **http://doi.org/10.1289/ehp.1003327** **(http://doi.org/10.1289/ehp.1003327)**
23. Sand, S., Ringblom, J., Håkansson, H. and Öberg, M. (2012), The point of transition on the dose-effect curve as a reference point in the evaluation of in vitro toxicity data. J. Appl. Toxicol., 32: 843–849.
24. Sirenko, Oksana, et al. "Multiparameter in vitro assessment of compound effects on cardiomyocyte physiology using iPSC cells." Journal of biomolecular screening 18.1 (2013): 39-53.
25. Sutter, Andreas, et al. "Use of in silico systems and expert knowledge for structure-based assessment of potentially mutagenic impurities." Regulatory Toxicology and Pharmacology 67.1 (2013): 39-52.
26. Teubner, Wera, et al. "Computer models versus reality: how well do in silico models currently predict the sensitization potential of a substance." Regulatory Toxicology and Pharmacology 67.3 (2013): 468-485.
27. Thomas RS, Philbert MA, Auerbach SS, et al. Incorporating New Technologies Into Toxicity Testing and Risk Assessment: Moving From 21st Century Vision to a Data-Driven Framework. Toxicological Sciences. 2013;136(1):4-18. doi:10.1093/toxsci/kft178.
28. Tice RR, Austin CP, Kavlock RJ, Bucher JR. Improving the Human Hazard Characterization of Chemicals: A Tox21 Update. Environmental Health Perspectives. 2013;121(7):756-765. doi:10.1289/ehp.1205784.
29. van der Burg B, Wedebye EB, Dietrich DR, Jaworska J, Mangelsdorf I, Paune E, Schwarz M, Piersma AH, Kroese ED. The ChemScreen project to design a pragmatic alternative approach to predict reproductive toxicity of chemicals. Reproductive Toxicology. 2015 Aug 1;55:114-23. doi: 10.1016/j.reprotox.2015.01.008. Epub 2015 Feb 2.
30. John F. Wambaugh, R. Woodrow Setzer, David M. Reif, Sumit Gangwal, Jade Mitchell-Blackwood, Jon A. Arnot, Olivier Joliet, Alicia Frame, James Rabinowitz, Thomas B. Knudsen, Richard S. Judson, Peter Egeghy, Daniel Vallero, and Elaine A. Cohen Hubal. High-Throughput Models for Exposure-Based Chemical Prioritization in the ExpoCast Project.Environmental Science & Technology 2013 47 (15), 8479-8488
31. Wetmore, Barbara A., et al. "Integration of dosimetry, exposure and high-throughput screening data in chemical toxicity assessment." Toxicological Sciences (2011): kfr254.
32. Wetmore, Barbara A., et al. "Relative impact of incorporating pharmacokinetics on predicting in vivo hazard and mode of action from high-throughput in vitro toxicity assays." toxicological sciences (2013): kft012.
33. Wu, Shengde, et al. "Framework for identifying chemicals with structural features associated with the potential to act as developmental or reproductive toxicants." Chemical research in toxicology 26.12 (2013): 1840-1861.
34. Yoon, Miyoung, et al. "Evaluation of simple in vitro to in vivo extrapolation approaches for environmental compounds." Toxicology in Vitro 28.2 (2014): 164-170.

35. Zeise, Lauren, et al. "Addressing human variability in next-generation human health risk assessments of environmental chemicals." *Environmental Health Perspectives (Online)*1 (2013): 23.

Session 4, May 9: Lifecycle, Ecotoxicology and Identifying Alternatives

- Introduction- Elaine Faustman

- Presentation of Key Points from Readings- Students

Please read the selected chapters from the NRC document "A Framework to Guide Selection of Chemical Alternatives" and one other article. Please be prepared to share five key points with the class and discuss your impressions from the readings.

Session 4 Readings:

1. Arnold, S.M., Greggs, B., Goyak, K.O., Landenberger, B.D., Mason, A.M., Howard, B., Zaleski, R. and Zaleski, R.T., 2017. A quantitative screening-level approach to incorporate chemical exposure and risk/safety into alternative assessment evaluations. Integrated Environmental Assessment and Management. doi: 10.1002/ieam.1926. [Epub ahead of print]
2. Belanger, S.E., Sanderson, H., Embry, M.R., Coady, K., DeZwart, D., Farr, B.A., Gutsell, S., Halder, M., Sternberg, R. and Wilson, P., 2015. It is time to develop ecological thresholds of toxicological concern to assist environmental hazard assessment. Environmental toxicology and chemistry, 34(12), pp.2864-2869. doi: 10.1002/etc.3132. Epub 2015 Oct 30.
3. Chapters 7, 10, 11 and Appendix B from National Research Council. 2014. A Framework to Guide Selection of Chemical Alternatives. Washington, DC: The National Academies Press. doi:https://doi.org/10.17226/18872.
4. Corvaro, M., Gehen, S., Andrews, K., Chatfield, R., Arasti, C. and Mehta, J., 2016. GHS additivity formula: A true replacement method for acute systemic toxicity testing of agrochemical formulations. Regulatory Toxicology and Pharmacology, 82, pp.99-110. doi: 10.1016/j.yrtph.2016.10.007. Epub 2016 Oct 17.
5. European Chemical Agency (ECHA). 2011. Guidance on the Preparation of an Application for Authorization. European Chemical Agency, Helsinki, Finland. **https://echa.europa.eu/documents/10162/13643/authorisation_application_en.pdf (https://echa.europa.eu/documents/10162/13643/authorisation_application_en.pdf)**
6. EPA (US Environmental Protection Agency). 2014. Significant New Alternatives Policy (SNAP) Program. Online. **https://www.epa.gov/snap (https://www.epa.gov/snap)**
7. EPA (US Environmental Protection Agency). Technical Overview of Ecological Risk Assessment - Analysis Phase: Ecological Effects Characterization. **https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/technical-overview-ecological-risk-assessment-0 (https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/technical-overview-ecological-risk-assessment-0)**
8. EPA (US Environmental Protection Agency). Ecological Structure Activity Relationships (ECOSAR) Predictive Model. **https://www.epa.gov/tsca-screening-tools/ecological-structure-activity-relationships-ecosar-predictive-model (https://www.epa.gov/tsca-screening-tools/ecological-structure-activity-relationships-ecosar-predictive-model)**
9. Fraysse, B., R. Mons, and J. Garric. 2006. Development of a zebrafish 4-day embryo-larval bioassay to assess toxicity of chemicals. Ecotoxicol Envrion Saf. 63(2):253-67. DOI: 10.1016/j.ecoenv.2004.10.015
10. Jørgensen, A., Le Bocq, A., Nazarkina, L. et al. Methodologies for social life cycle assessment. Int J Life Cycle Assess (2008) 13: 96. doi:10.1065/lca2007.11.367
11. Malloy, T. F., Sinsheimer, P. J., Blake, A. and Linkov, I. (2013), Use of multi-criteria decision analysis in regulatory alternatives analysis: A case study of lead free solder. Integr Environ Assess Manag, 9: 652–664. doi:10.1002/ieam.1449
12. OSHA (Occupational Safety and Health Administration). Transitioning to Safer Chemicals: Explore the Steps. **https://www.osha.gov/dsg/safer_chemicals/step1_engage.html (https://www.osha.gov/dsg/safer_chemicals/step1_engage.html)**
13. Reif DM, Martin MT, Tan SW, et al. Endocrine Profiling and Prioritization of Environmental Chemicals Using ToxCast Data. Environmental Health Perspectives. 2010;118(12):1714-1720. doi:10.1289/ehp.1002180.
14. Reif DM, Sypa M, Lock EF, et al. ToxPi GUI: an interactive visualization tool for transparent integration of data from diverse sources of evidence. Bioinformatics. 2013;29(3):402-403. doi:10.1093/bioinformatics/bts686.
15. CA DTSC (California Department of Toxic Substances Control). 2012. Alternative Analysis Workshop Tools, Methodologies and Frameworks. **https://www.dtsc.ca.gov/PollutionPrevention/upload/WorkshopTables.pdf (https://www.dtsc.ca.gov/PollutionPrevention/upload/WorkshopTables.pdf)**
16. Malloy, Timothy F., et al. "Developing Regulatory Alternatives Analysis Methodologies for the California Green Chemistry Initiative." UCLA Sustainable Technology & Policy Program (2011).
17. Reihlen, Antonia. Guide on Sustainable Chemicals: A Decision Tool for Substance Manufacturers, Formulators and End Users of Chemicals. Umweltbundesamt, 2011.
18. Stone, Alex. "Quick Chemical Assessment Tool Version 1.3." (2015)

Session 5, May 16: Case Studies in Alternatives Assessment

- Introduction- Elaine Faustman

- Presentation of Key Points from Readings- Students

Please read the selected chapters from the NRC document "A Framework to Guide Selection of Chemical Alternatives" and one other article. Please be prepared to share five key points with the class and discuss your impressions from the readings.

Session 5 Readings:

1. Aschberger, K., Campia, I., Pesudo, L.Q., Radovnikovic, A. and Reina, V., 2017. Chemical alternatives assessment of different flame retardants–A case study including multi-walled carbon nanotubes as synergist. Environment International. doi: 10.1016/j.envint.2016.12.017. Epub 2017 Feb 1.
2. Bui, T.T., Giovanoulis, G., Cousins, A.P., Magnér, J., Cousins, I.T. and de Wit, C.A., 2016. Human exposure, hazard and risk of alternative plasticizers to phthalate esters. Science of the Total Environment, 541, pp.451-467. doi: 10.1016/j.scitotenv.2015.09.036. Epub 2015 Sep 26.
3. Chapter 12 from National Research Council. 2014. A Framework to Guide Selection of Chemical Alternatives. Washington, DC: The National Academies Press. doi:https://doi.org/10.17226/18872.
4. Eladak, S., Grisin, T., Moison, D., Guerquin, M.J., N'Tumba-Byn, T., Pozzi-Gaudin, S., Benachi, A., Livera, G., Rouiller-Fabre, V. and Habert, R., 2015. A new chapter in the bisphenol A story: bisphenol S and bisphenol F are not safe alternatives to this compound. Fertility and sterility, 103(1), pp.11-21. doi: 10.1016/j.fertnstert.2014.11.005. Epub 2014 Dec 2.
5. EPA (US Environmental Protection Agency). 2012. DecaBDE Phase-Out Initiative. **https://hero.epa.gov/hero/index.cfm/reference/download/reference_id/1003362 (https://hero.epa.gov/hero/index.cfm/reference/download/reference_id/1003362)**
6. EPA (US Environmental Protection Agency). 2014. AN ALTERNATIVES ASSESSMENT FOR THE FLAME RETARDANT DECABROMODIPHENYL ETHER (DecaBDE). **https://www.epa.gov/sites/production/files/2014-05/documents/decabde_final.pdf (https://www.epa.gov/sites/production/files/2014-05/documents/decabde_final.pdf)**
7. Howard, G.J., 2014. Chemical alternatives assessment: the case of flame retardants. Chemosphere, 116, pp.112-117. doi: 10.1016/j.chemosphere.2014.02.034. Epub 2014 Apr 2.
8. Pham, N., Iyer, S., Hackett, E., Lock, B.H., Sandy, M., Zeise, L., Solomon, G. and Marty, M., 2016. Using ToxCast to Explore Chemical Activities and Hazard Traits: A Case Study With Ortho-Phthalates. Toxicological Sciences, p.kfw049. doi: 10.1093/toxsci/kfw049. Epub 2016 Mar 11.
9. Shatkin, J.A. and Ong, K.J., 2016. Alternative testing strategies for nanomaterials: State of the science and considerations for risk analysis. Risk Analysis, 36(8), pp.1564-1580. doi: 10.1111/risa.12642. Epub 2016 Jun 7.

Wang, Z., Cousins, I.T., Berger, U., Hungerbühler, K. and Scheringer, M., 2016. Comparative assessment of the environmental hazards of and exposure to perfluoroalkyl phosphonic and phosphinic acids (PFPAs and PFPiAs): Current knowledge, gaps, challenges and research needs. Environment international, 89, pp.235-247. doi: 10.1016/j.envint.2016.01.023. Epub 2016 Feb 26.

Course Summary:

Date	Details