

# Identification of specific plastics which do not release estrogenic activity causing chemicals

Thousand Oaks High School

AP Research STEM



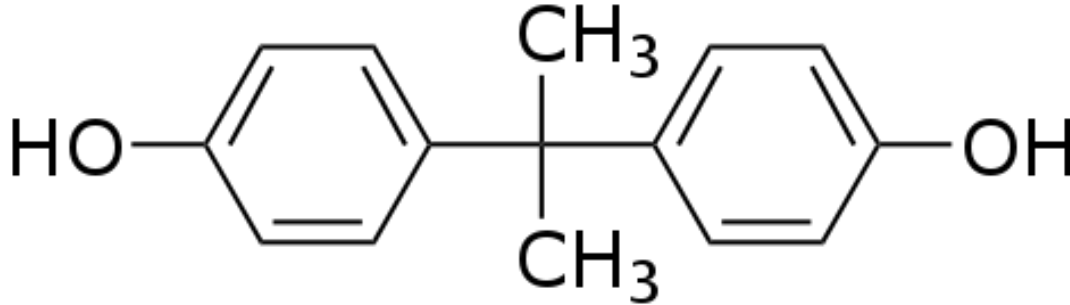
# Introduction

# History of Estrogenicity and Plastics

- » Chemicals which cause Estrogenic Activity (EA) were identified to leach from plastic bottles
- » Various adverse health effects
- » Increased rates of some breast, ovarian, testicular, and prostate cancers



# Bisphenol A



- » Bisphenol A (BPA) is identified as an estrogenic chemical
- » Due to attention from the public is largely eradicated from plastic bottles
- » Present in 93% of the US population in 2005



## Tests for BPA do not show actual estrogenicity

- » Assay's were used to detect BPA
- » Water bottles with potential estrogenicity are marked as safe
- » Leads to an inaccurate information regarding safety of water bottles






# Researchers Begin to identify BPA Free Water Bottles as releasing EA

- » Studies begin to compare overall EA if water bottles marked BPA free and with BPA
  - » Data shows many plastics still released EA causing chemicals
- 




# Research Focuses on BPA, fails to identify plastics without EA

- » Leaves a gap in knowledge of whether plastics are safe or not
  - » Studies focused on proving BPA was not the only chemical which caused EA in water bottles
- 



# Purpose

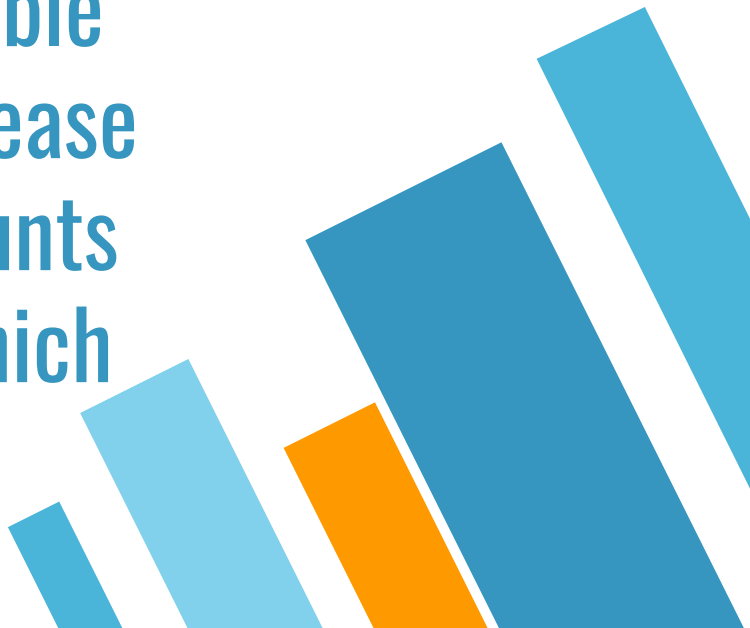
- Determine there are plastics currently available which are safe for use in water bottles
  - Identify individual plastic from different studies level of EA
- 





# Research Question

Are there plastics currently available which do not release dangerous amounts of chemicals which cause EA?






# Hypothesis


**Alternate:** There are individual plastics currently available which do not release dangerous amounts of EA causing chemicals.

**Null:** Current plastics do not exhibit safe amounts of EA causing chemicals and alternatives must be implemented in order to ensure safety.






# Methods

- MCF-7 and BG1Luc bioassays
  - Cells proliferate when estrogen is detected
  - Tested and reliable sources of measuring EA
- 



# Data Collection

- » Systematic Literature Review was used in order to accumulate data.
  - » Data was compared and passable plastics were identified.
- 

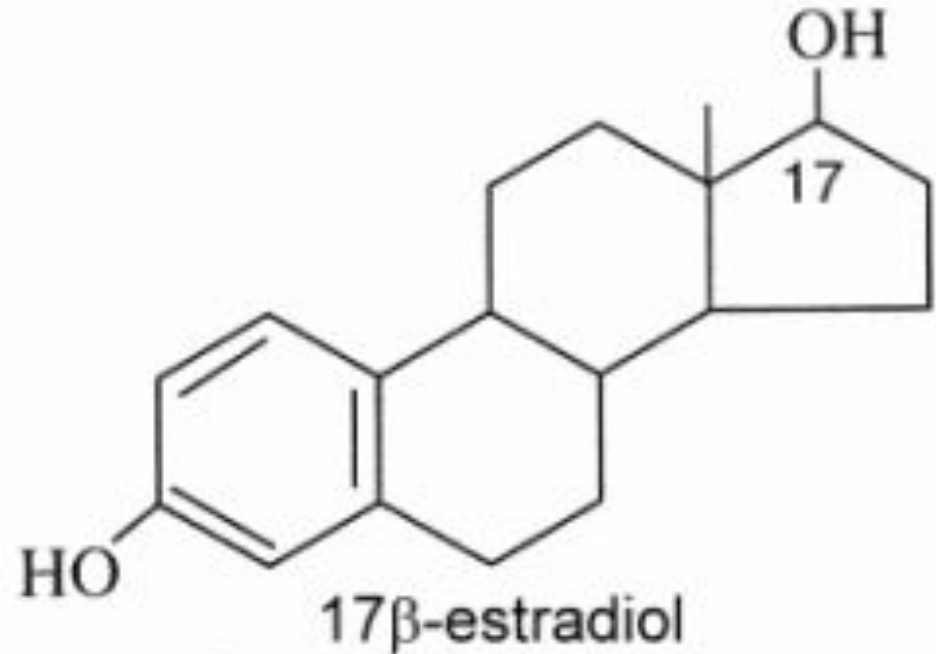
# Necessity of Different Solutions and Stresses

- » Plastic bottles are used to contain a variety of liquids
- » Properties of different liquids affect leaching
- » Bottles are often heated, exposed to UV light, etc.
- » Must be accounted for to achieve reliable data



# Comparison of Data between Studies

- » %Rme2 based on 17B Estradiol
- » Plastics with higher EA will have higher %Rme2





# Results



# %Rme2 of Plastics 1 through 5

Plastic #	Type of Resin	Saline Microwave	EtOH Microwave	Saline UV	EtOH UV	Saline Autoclave	EtOH Autoclave
1	LDPE	5	7	0	4	4	30
2	LDPE	3	7	26	3	-1	27
3	PET	100	3	31	2	47	1
4	LDPE	2	3	0	0	4	5
5	HDPE	6	-4	2	-2	-1	-3



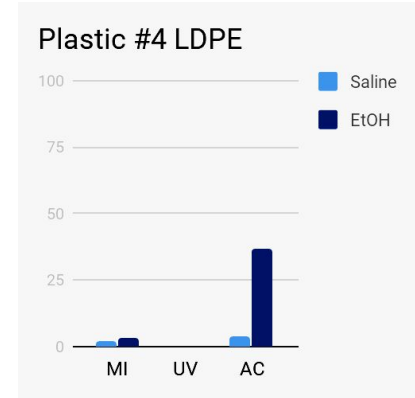
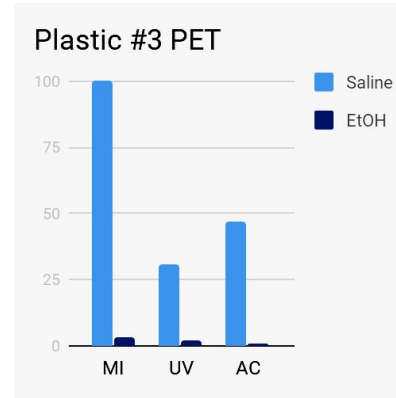
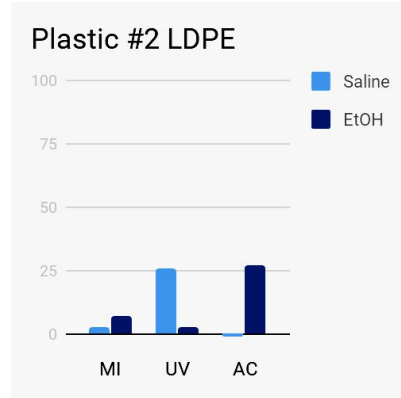
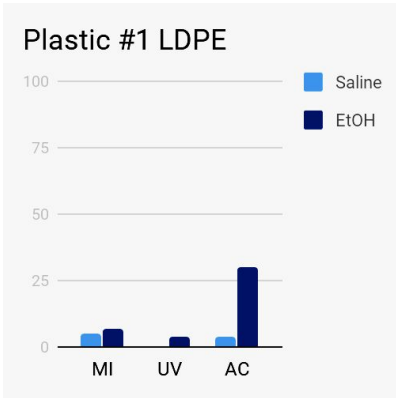
# %Rme2 of Plastics 6 through 11

6	PPHO	0	-4	3	2	-6	-3
7	PPCO	3	7	-7	-6	-6	-3
8	Random Bottle	3	23	71	17	-1	19
9	Random Bottle	4	21	98	39	8	23
10	Random Bottle	-7	-5	81	22	0	4
11	Random Bottle	34	-2	80	12	-1	1

# %Rme2 of Plastics 12 through 13

12	PETG Baby Bottle	0	-2	122	44	0	1
13	PETG Baby Bottle	-8	17	61	111	0	15
14	PS	3	3	17	45	76	0
15	COC 3	9	7	20	20	0	6
16	COC p18	4	1	9	11	1	-2
17	COC p19	6	2	6	-2	4	2

# Various Results

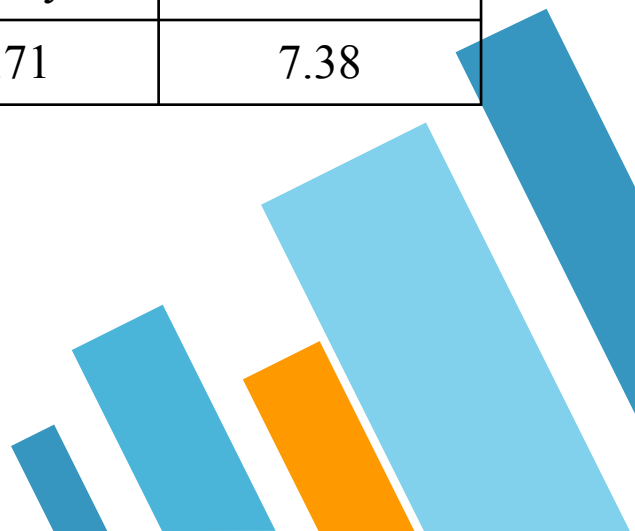


Charts 1-4 Show respective %Rme2 of Saline and EtOH solutions under different stress (Microwave, UV Rays, Autoclave)



## Average %Rme2 of each Stress

	Mean %Rme2 Overall	Mean %Rme2 Microwave	Mean %Rme2 UV Rays	Mean %Rme2 Autoclave
All Plastics	14.16	7.382	27.71	7.38






# Discussion




# Averages across different stresses showed the necessity of varying tests

- » %Rme2 was significantly greater for UV light tests
  - » Some plastics were assessed as safe on all but one test
- 

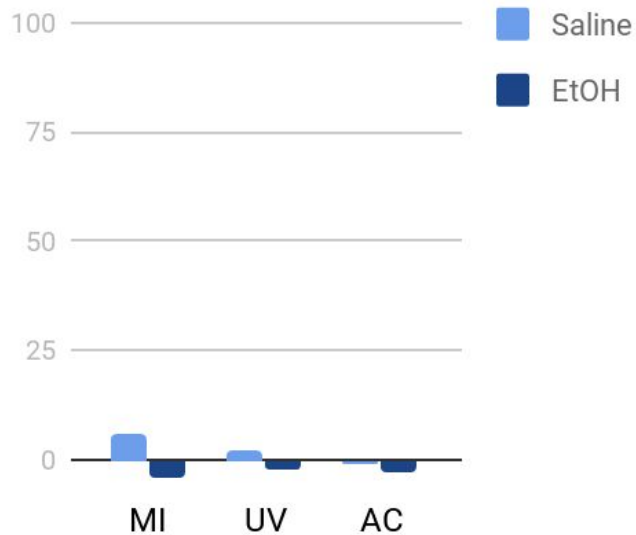


# Some Tested Plastics showed safe amounts of EA released

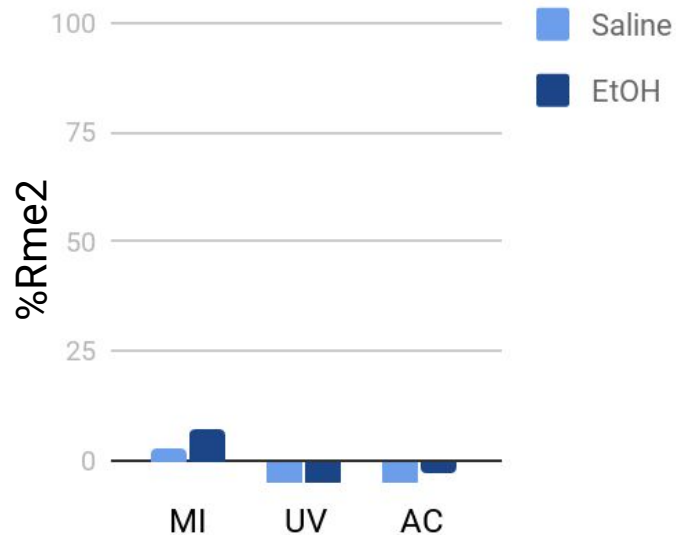
- » 15%Rme2 or less is considered EA free by the EPA
  - » Several plastics had less than 15%Rme2 on all tests
- 

# Examples of Safe Plastics

## Plastic #5 HDPE




## Plastic #7








# Conclusion

- » Most plastics do release EA causing chemicals
  - » There are plastics currently available which do not release EA causing chemicals
- 



## Further Work

- » More plastics tested would allow for a wider scope of research
  - » Studies which do not account for differing solutions and stresses could be redone
- 

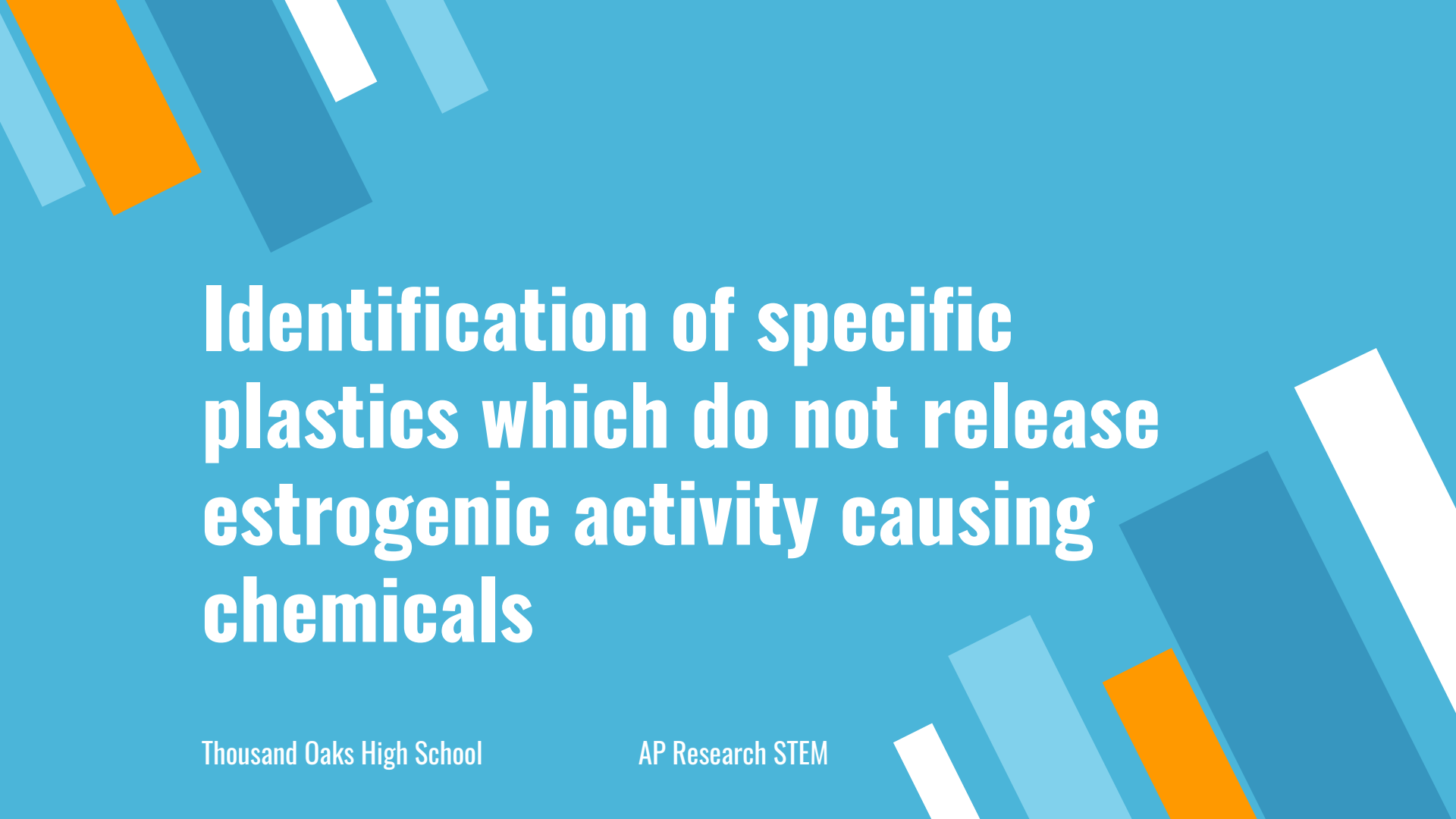


# Acknowledgements

- » Dr. Nikki Malhotra
  - » Michelle Magnusson
- 

# References

- » Bittner et al.: Estrogenic chemicals often leach from BPA-free plastic products that are replacements for BPA-containing polycarbonate products. *Environmental Health* 2014 13:41.
- » Chun Z, Yang, Stuart I, Yaniger, V, Craig Jordan, Daniel J. Klein, and George D. Bittner (2011). Most Plastic Products Release Estrogenic Chemicals: A Potential Health Problem that Can Be Solved. *Environ Health Perspect* 119:989–996 (2011)
- » Cooper JE, Kendig EL, Belcher SM. (2011). Assessment of bisphenol A released from reusable plastic, aluminium and stainless steel water bottles.
- » Kabuto H, Amakawa M, Shishibori T. 2004. Exposure to bisphenol A during embryonic/fetal life and infancy increases oxidative injury and causes underdevelopment of the brain and testis in mice. *Life Sci* 74:2931–2940
- » Kavlock RJ, Daston GP, DeRosa C, Fenner-Crisp P, Gray LE, Kaattari S, et al. 1996. Research needs for the risk assessment of health and environmental effects of endocrine disruptors: a U.S. EPA-sponsored workshop. *Environ Health Perspect* (suppl 104):715–740
- » Leusch FD, de Jager C, Levi Y, Lim R, Puijker L, Sacher F, Tremblay LA, Wilson VS, Chapman HF: Comparison of five in vitro bioassays to measure estrogenic activity in environmental waters. *Environ Sci Technol* 2010, 44(10):3853–3860
- » Meeker JD, Sathyanarayana S, Swan SH. 2009. Phthalates and other additives in plastics: human exposure and associated health outcomes. *Philos Trans R Soc Lond B Biol Sci* 364:2097–2113
- » Natarajan N, Shambaugh GE III, Elseth KM, Haines GK, Radosevich JA. 1994. Adaptation of the diphenylamine (DPA) assay to a 96-well plate tissue culture format and comparison with the MTT assay. *BioTechniques* 17:166–171
- » National Research Council. 1999. *Hormonally Active Agents in the Environment*. Washington, DC:National Academies Press
- » Routledge, E. J., Supter, J. P. 1996. Estrogenic Activity of Surfactants and some of their Degradation Products Assessed Using a Recombinant Yeast Screen.
- » Soto AM, Sonnenschein C, Chung KL, Fernandez MF, Olea N, Serrano FO. 1995. The E-SCREEN assay as a tool to identify estrogens: an update on estrogenic environmental pollutants. *Environ Health Perspect* 103(suppl 7):113–122
- » Vom Saal FS, Nagel SC, Timms BG, Welshons WV: Implications for human health of the extensive bisphenol A literature showing adverse effects at low doses: a response to attempts to mislead the public. *Toxicology* 2005, 212(2–3):244–252. Author reply 253–254.
- » Wagner, M., Oehlmann, J. 2009. Endocrine disruptors in bottled mineral water: total estrogenic burden and migration from plastic bottles



# Identification of specific plastics which do not release estrogenic activity causing chemicals

Thousand Oaks High School

AP Research STEM