

Introduction

Course-Based Undergraduate Research Experience (CURE) core components

Components	Traditional	Inquiry Based	Discovery Based	CURE
Results are unknown to students, instructor, and science community	X	X	✓	✓
Uses science practices	✓	✓	✓	✓
Iteration	?	✓	✓	✓
Collaboration	?	✓	✓	✓
Broadly Relevant	X	X	X	✓

Biochar

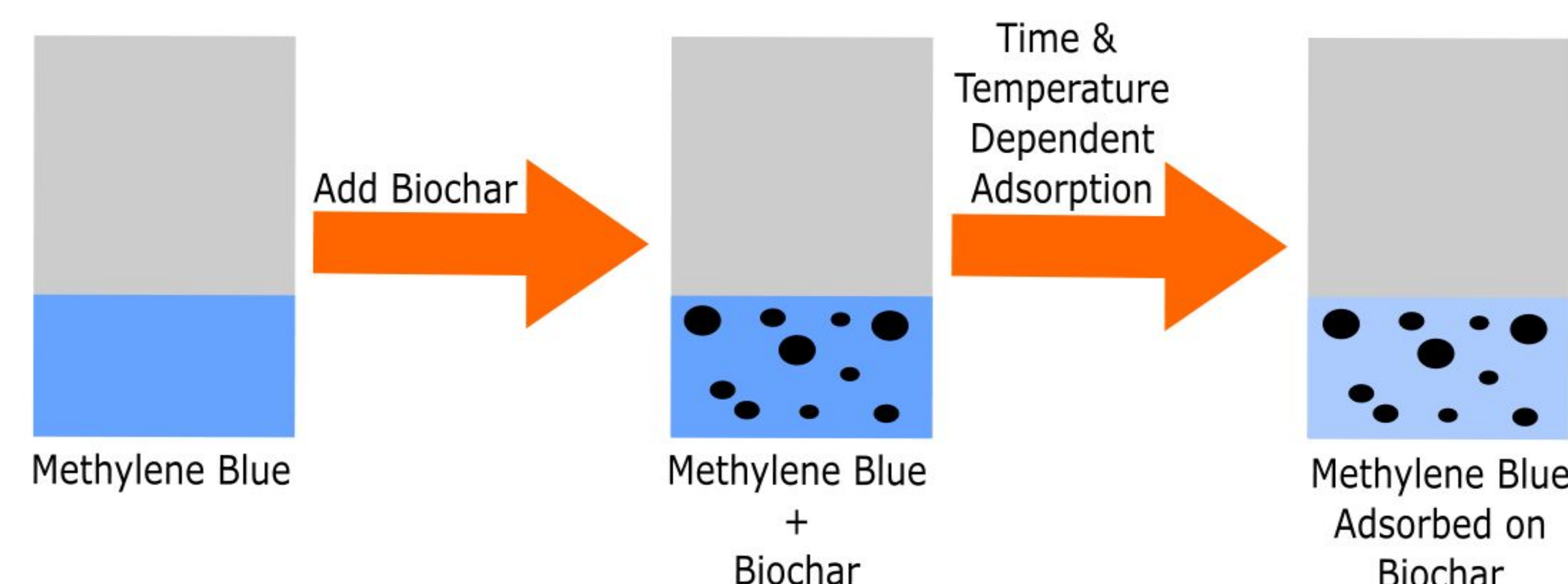


<https://www.denverpost.com/2017/06/24/biochar-now-berthoud-waste-carbon-product/>

- Pyrolysis of biomass
 - Low O₂ environment
- Properties and sizes widely vary
- Interest in using biochar to adsorb pollutants in water
- Collaboration with the biochar division of the Natural Resources Research Institute (NRRI)

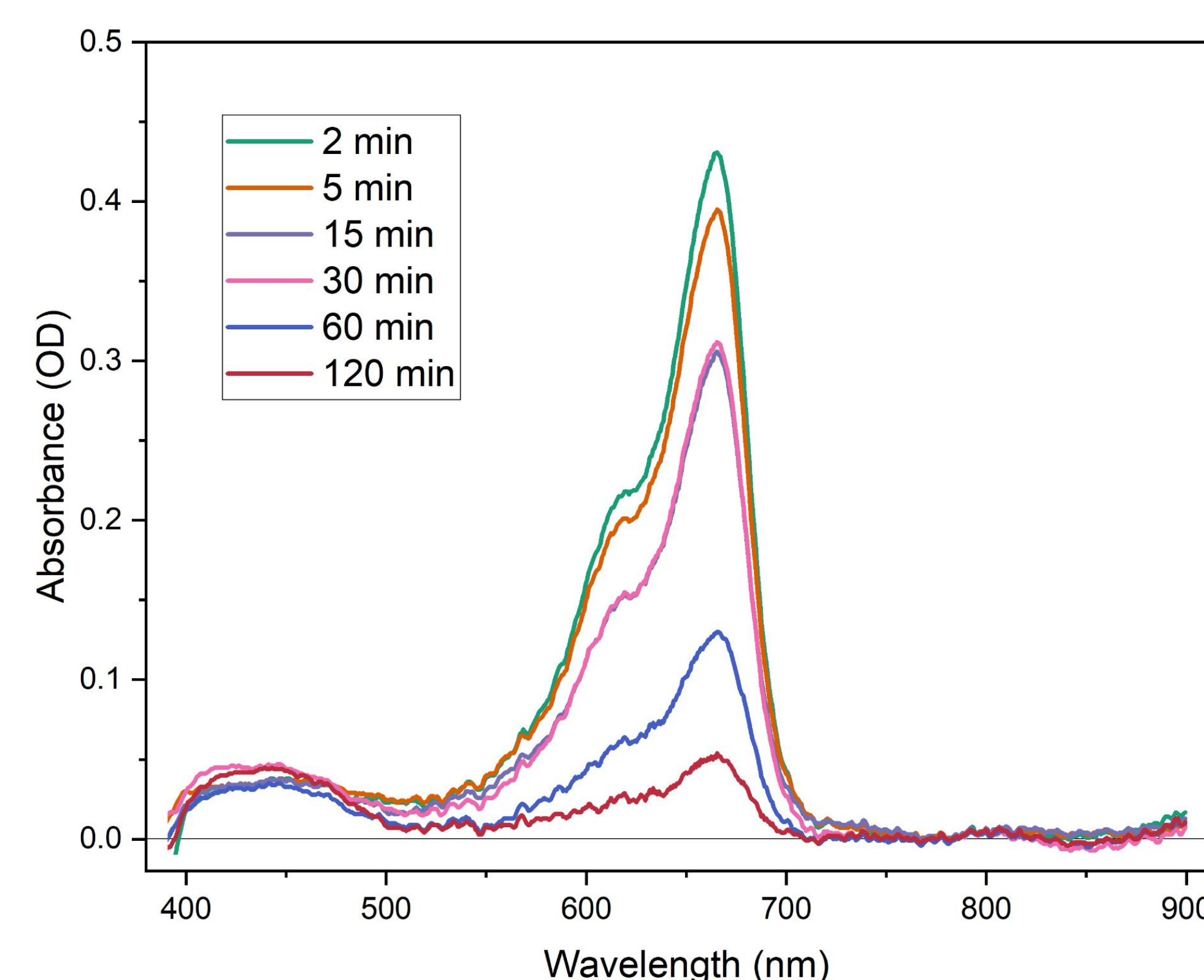
Introduction Adsorption Experiment

- Prior knowledge: absorbance spectroscopy & dilutions
- General Chemistry II Concepts: Thermodynamics & Kinetics



- Each group of 3 or 4 is assigned a [MB]
- As a lab section, they complete all the runs
- 10 mL MB solution with 35 mg biochar for each run time

MB Concentration (mg/L)	Time (min)	Temperature (°C)
4	2	0 - 5
6	5	19 - 25
8	15	38 - 41
	30	
	60	
	120	

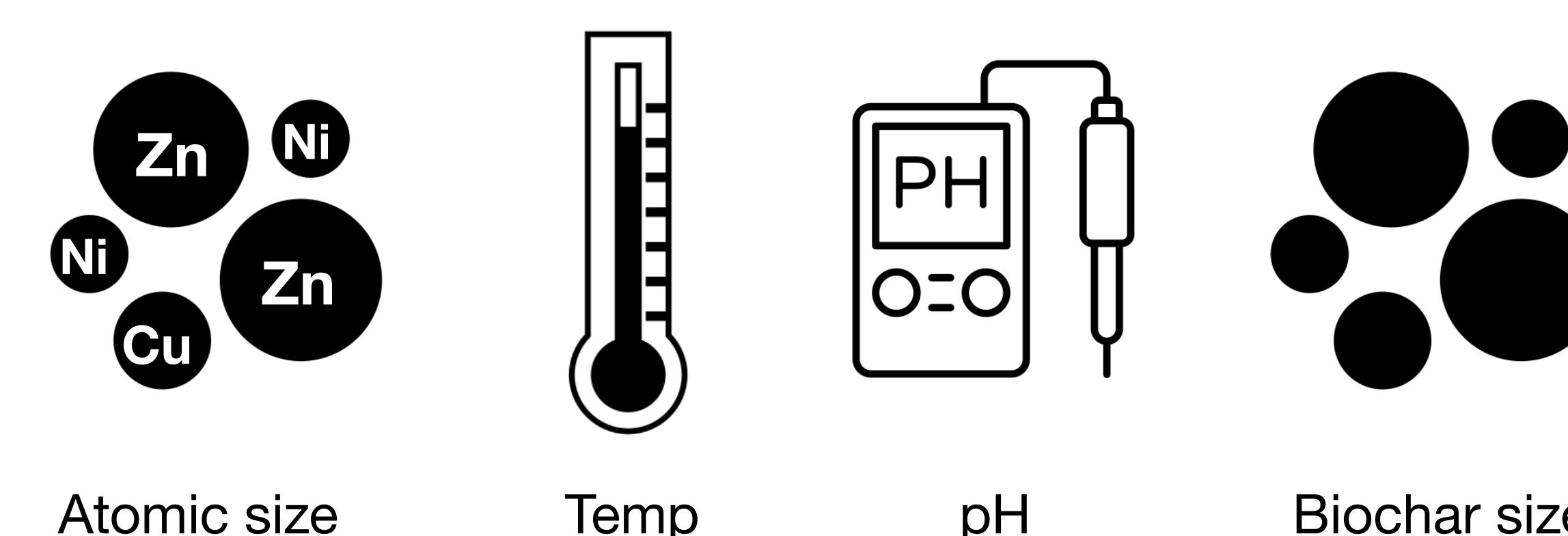


MB absorbance decreases over time as it adsorbs to biochar

- This lab is designed to introduce the variability of biochar and its adsorption capacity
- Also shows students there are a variety of parameters that affect adsorption

Biochar Adsorption CURE

- Student prompt: Interested in metal removal by biochar
 - 3 commercial & 2 local biochar samples
 - 15 metal cation options
- Students create open-ended questions exploring the adsorption capacity of metals on biochar
 - Exploring adsorption parameters examples:



Week	CURE Progression
1	Syllabus
2	Local biochar introduction talk, Literature search
3	CREATE Activity, Introduction to prompt
4	Introduction to research questions EDTA titration lab for determining [Ca ²⁺]
5	Introduction to experimental proposals Submit individual research questions MB adsorption on biochar lab week 1
6	Pick their group's research question MB adsorption on biochar lab week 2
7	Individual experimental proposal MB adsorption on biochar lab week 3
8	Group experimental proposal
9	Spring break, Gather CURE materials
10 - 15	CURE experiments
16	Finalize posters from rough draft feedback
17	Poster presentation final

Key References

- Dolan, E. L.; Weaver, G. C. *Guide to Course-Based Undergraduate Research*; Macmillan Learning: New York, 2021.
- Fan, S.; Wang, Y.; Wang, Z.; Tang, J.; Tang, J.; Li, X. Removal of Methylene Blue from Aqueous Solution by Sewage Sludge-Derived Biochar: Adsorption Kinetics, Equilibrium, Thermodynamics and Mechanism. *J. Environ. Chem. Eng.* **2017**, 5 (1), 601-611. <https://doi.org/10.1016/j.jece.2016.12.019>