Forming Scientific Questions

What is a scientific question?

- **Good scientific questions:**
  - Have **real answers**. Often the answer is as simple as "yes" or "no".
  - Are **testable**. This means you could design an experiment or take measurements to find the answer.
  - Have a **hypothesis** that is **falsifiable**. This means that your experiment could show that your hypothesis is false (and that's ok!)
  - Are **interesting**! You should want to know the answer!

Broad “Fact” questions

Example: “How many organisms are affected by plastics?”

- What data would you collect?
  - Where would you collect data? In your school? The whole world?
  - Could you test every organism from bacteria to blue whales?
- What would your hypothesis be?
  - It’s hard to make one.
  - There is a real answer, but it’s almost impossible to find.
- Rewrite the question as a class to make it more specific.

Narrow "Fact" questions

Example: "What is the weight of the plastic under the bench outside today?"

- What data would you collect?
  - You would weigh the plastic under the bench. Good! You can do that.
- What would your hypothesis be?
  - It's hard to make one. Guessing the weight of the plastic is like guessing the number of jelly beans in a jar.
- What does the answer tell you?
  - The answer is so specific that it is not comparable to any other area at any other time.
- Rewrite the question as a class to make it broad enough to be comparable to other areas where there might be plastic.

“Comparison” Questions

Example: “Is plastic found on the baseball field worse than plastic on the football field?”

- Comparison questions are great!
  - The answers are informative about patterns in general, not just about your particular study.
- What are the vague words in this sentence?
- What does **worse** mean?
  - What would you measure to determine whether the plastic was “worse” or “better”?
- Which **plastics**?
  - There are many of different types of plastic. Pick a few types to compare.
- Rewrite the question as a class to make the wording more specific.

“Why?” Questions

Example: “Why is there trash on the school campus?”

- What would your hypothesis be?
  - Why questions are often too broad and there is rarely one answer, plus they are usually too difficult to test.
- Rewrite the question as a class to make it more scientific.
  - Think about a more specific question in which something could actually be measured or compared.

Imagine you have:

- transect tape
- marker flags
- debris pick-up data sheets
- clipboards
- trash bags
- plastic gloves
- stop watches
- ‘Types of Plastics’ Table
- plastic data sheets

Types of Plastics

plastic type	full name	recycling code	examples	recyclable?
PETE	polyethylene terephthalate	1	soda bottles	yes
HDPE	high density polyethylene	2	milk jugs, shampoo bottles, yogurt containers	yes
PVC	polyvinyl chloride	3	clear food packaging, candy wrappers, some bottles	sometimes
LDPE	low density polyethylene	4	squeezable bottles, shopping bags	yes
PP	polypropylene	5	caps, straws, some bottles	yes
PS	polystyrene	6	disposable plates & cups, CD cases	not usually
PC, other	polycarbonate	7	water jugs, sunglasses, DVDs	not usually

Summary of Toxic Effects

Toxic compound	Use	Effect(s)	Plastic type(s)
bisphenol A	plasticizer, can liner	mimics estrogen	PVC, PC
phthalates	plasticizer, artificial fragrances	Interferes with testosterone, sperm motility	PS, PVC
persistant organic pollutants (POPs)	pesticides, flame retardants, etc.	possible neurological and reproductive damage	all plastics
dioxins	produced in manufacture of PVC, during waste incineration	carcinogen, interferes with testosterone	all plastics
nonylphenol	anti-static, anti-fog, surfactant (in detergents)	mimics estrogen	PVC
polyaromatic hydrocarbon (PAHs)	produced when fossil fuels are burned	developmental and reproductive toxicity	all plastics
polychlorinated biphenyls (PCBs)	electronics manufacture	interferes with thyroid hormone	all plastics
styrene monomer	breakdown product	carcinogen, can form DNA adducts	polystyrene