FIELD OF STREAMS

teacher guide

FIELD OF STREAMS

Goals:

TCI Goals:

1. Raise awareness of career pathways and opportunities in public health.
2. Increase exposure to real-world public health via hands-on experience.
3. Develop an understanding of the critical relationship between current middle school (6-8) curriculum and students' future careers in laboratories.

Students will be able to understand the effects pH, dissolved oxygen, turbidity and temperature has on four specific species of benthic macroinvertebrates, one fish species and one mollusk species. Students will also be able to understand how water quality affects their lives.

Understandings:

- Water quality is oneof the pillars of overall human health.
- Water quality is one of the pillars of study and testing at the State Hygienic Laboratory (SHL) at the University of Iowa.
- Benthic macroinvertebrates are essential for determining water quality of an aquatic environment.
- There are species of macroinvertebrates that may indicate good water quality of an aquatic environment, and there are species that may indicate bad water quality.
- The State Hygienic Laboratory has many community partners to help test Iowa's aquatic environments such as the DNR or IOWATER (volunteer water testing database).
- There are specific parameters measured when checking the water quality of an aquatic environment.
- When the specific parameters are measured, those parameters must meet the standards of aquatic life and must be maintained.

Essential Questions:

- Why is water quality important?
- Who is involved in water quality monitoring?
- How does water quality affect me?
- What is a benthic macroinvertebrate?
- What is good water quality versus bad water quality?
- How do you change the water quality of an environment?
- What is the State Hygienic Lab?
- What is the State Hygienic Lab's role in Iowa?

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Students will know…

- The optimal levels of pH, dissolved oxygen, temperature and turbidity for four specific benthic macroinvertebrates, one fish species and one mollusk species found in Iowa, as well as optimal levels for those parameters for all aquatic life.
- How the SHL tests these parameters and what the parameters mean to the students' health.

Students will be able to…

- Interact with each other to solve the scenario on whether their invertebrate or fish survives in its environment or not.
- Share their findings with other students and discuss water quality topics that relate to them.
- Understand how the SHL is involved in water quality.
- Understand how water quality affects their health and community.

Performance Tasks:

- Scientific inquiry
- Scientific negotiation
- Reflection

Learning Activities and Planned Lesson Instruction:

- We are targeting the following Iowa Core science standards:
  - MS-LS-1
    - Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
  - MS-LS-4D
    - Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- Interactive activity with four specific benthic macroinvertebrate species, one fish species and one mollusk species which have their tolerances of pH, dissolved oxygen concentration, temperature and sediment sensitivity indicated along with optimal levels for all aquatic life indicated on a graphic. There is a lab notebook sheet to help record the student's findings and measurements throughout the activity. For early finishers, there are four wild card scenarios that can be added to the activity for supplemental learning as well as discussion.

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Dissolved oxygen (DO):

- 0-2 mg/L: not enough oxygen to support life.
- 2-4 mg/L: only a few fish and aquatic insects can survive.
- 4-7 mg/L: good for many aquatic animals, low for cold water fish.
- 7-11 mg/L: very good for most stream fish/insects.

pH (acidity):

Temperature:

- Maximum temperature for warm water life is 27 C° (80.6 F˚).
- Maximum temperature for cold water life is 20 C° (68 F˚).

Turbidity/clarity (sediment concentration):

Turbidity:

- Amount of cloudiness/haziness of a fluid caused by particles (like smoke or fog in the air) which is referred to as sediment

Dissolved Oxygen (DO):

- Amount of oxygen present in water (measured in milligrams per liter)

http://extension.usu.edu/waterquality/whats-in-your-water/aquatic_macroinvertebrates (water quality standards)

https://programs.iowadnr.gov/bionet/ (aquatic macroinvertebrate specifics)

http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Water-Monitoring/IOWATER/Library (water quality in Iowa)

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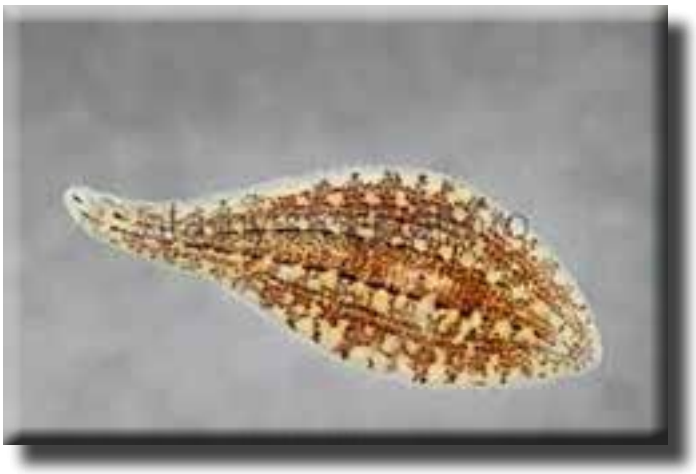

Glossiphonia complanata

(leech)

- pH sensitivity
  - 5.0
- Dissolved oxygen sensitivity
  - 0.0 mg/L
  - 0.0 (% saturation)
- Temperature sensitivity
  - Leeches are not temperature dependent, but prefer to survive in colder temperature waters (no effect on hatching).
- Sediment sensitivity
  - Leeches are poor swimmers so amount of sediment affects how they move in the water. They are pollutant tolerant.

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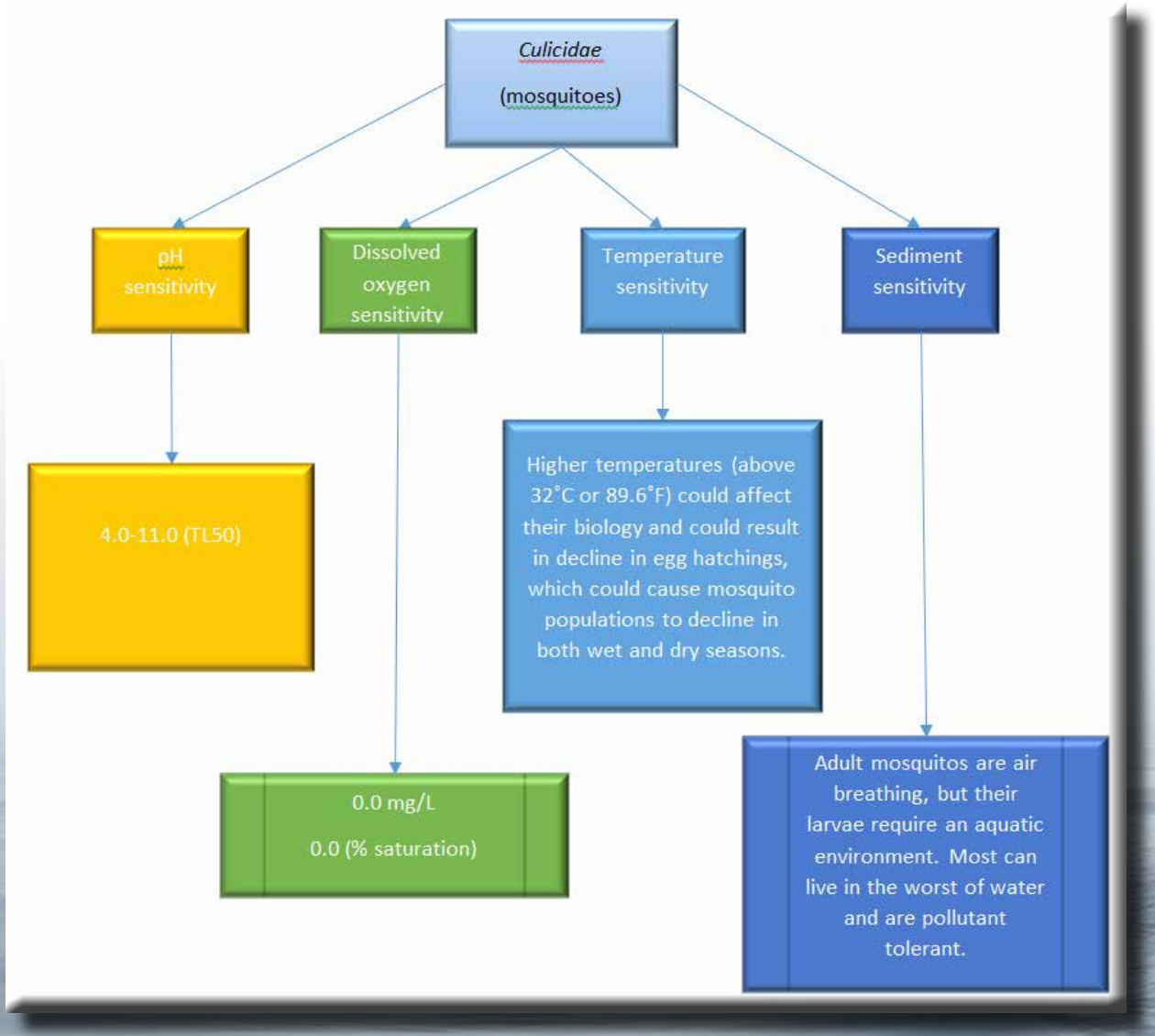

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IOWATER BENTHIC MACROINVERTEBRATE FLOW CHART

Shells

1 Shell

Snail (not pouch): When opening is facing you, shell opens on right, operculum (flap over opening) present.

Orbsnail: One shell, coiled and flattened, a.k.a. rams-horn, 3-30 mm.

Limpet: One shell, not coiled, shaped like a flat cone 3-7 mm.

Pouch Snail: When opening is facing you, shell opens on the left, no operculum (flap over opening).

2 Shells

Mussels/Clams: Fleshy body enclosed between 2 clamped shells (bivalve), 2-250 mm.

No Shells

Legs

4 Pairs of Legs

Water Mite: 8 legs, round body, may be brightly colored, 2-3 mm.

5 or more pairs of legs

Sowbug: Grey body wider than it is high, 7 pairs of legs, 5-20 mm.

Crawdad: 5 pairs of legs 1st pair have claws, up to 6 in. long.

Scud: White to grey, 7 pairs of legs, swims sideways, body higher than wide, 5-20 mm.

3 Pairs of Legs

Rat-tailed Maggot: Worm-like, soft-bodied with long breathing tube, semi-transparent skin, 4-70 mm.

No Legs (might have prolegs)

Crane Fly: Milky, green, or light brown color, caterpillar-like segmented body, 4 finger-like lobes at back end, no visible head, 10-100 mm.

Midge Fly: Small, dark head, 2 tiny legs on each end, 2-20 mm.

Bloodworm is one type of midge fly, has a red body due to hemoglobin.

1 Tail

Crawling Water Beetle: Larva has one long tail and legs with one hook-like claw, 2-10 mm in length.

Alderfly: Looks like a small Dobsonfly but has one long tail and no gill tufts, 10-25 mm.

Damselfly: 6 thin hooked legs; large eyes; 3 broad oar-shaped "tails" (gills), 10-50 mm in length.

Mayfly: 6 legs, feathery or oval-shaped gills on lower body, 2 to 3 long tails, 3-30 mm in length.

3 Tails

No Wings (might have wing pads)

Wings

Aquatic Worm: Thin, worm-like, 0.5-700 mm.

Flatworm (Planarian): Flat, soft-bodied worm with arrowhead-shaped head, 1-30 mm in length.

Mosquito: Head has small mouth brushes and short antennae; abdomen has breathing siphon, surfaces for air, 4-12 mm.

Black Fly: One end of body wider, black head and suction pad on other end, 3-12 mm.

Leech: Brown, slimy body, suction pads on body, 5-400 mm.

2 Tails

Hard Wings meet evenly on back

Predaceous Diving Beetle: Adults have an oval streamlined body, longer antennae than Whirligig Beetle, 1-80 mm in length.

Whirligig Beetle: Flattened oval body, short, clubbed antennae, erratic swimmer, 3-15 mm.

Water Scavenger Beetle: Adult may or may not be streamlined, most have no hairs on legs, short clubbed antennae, 1-40 mm.

Leathery Wings form an X on back

Water Strider: Slender body, long legs "walk" on water surface, 3-21 mm.

Water Boatman: Forelegs spoon-shaped and shorter compared to Backswimmer, 3-11 mm in length.

Backswimmer: Forelegs not as spoon-shaped as Water Boatman's, swims upside-down, body is V-shaped, 5-17 mm in length.

Giant Water Bug: Raptor-like forelegs for catching prey, leathery textured, oval body, 15-65 mm in length.

Water Scorpion: Raptor-like forelegs for catching prey, long breathing tube, stick-like long body, 15-45 mm.

No Tails

Water Scavenger Beetle: Larva have short antenna, 8 soft body segments, 4 -60 mm.

Riffle Beetle: Larva has hard plates on each segment, 2-60 mm in length.

Whirligig Beetle: Larva has many hairs on body, short tail or no tail, up to 30 mm in length.

Water Penny Beetle: Flat saucer-shaped body, 6 tiny legs and gills on underside, 4-6 mm.

Dragonfly: Wide oval abdomen, 6 hooked legs, large eyes, 10-60 mm in length.

Dobsonfly: 6 legs, 8 pairs of feelers and gill tufts on lower half of body, short antennae, 25-90 mm in length.

Predaceous Diving Beetle: Larva has many hairs on body, two feathery tails, large head, 5-70 mm in length.

Caddisfly: 6 hooked legs on upper body, 2 hooks on end, may have stick, rock, or leaf case, 2-40 mm in length.

Stonefly: 6 legs with hooked tips, antennae, 2 tails, gill tuffs under legs or no visible gills, 5-60 mm in length.

Riffle Beetle: Adult has 6 legs, body covered with tiny hairs, walks slowly underwater, 1-8 mm in length.

Crawling Water Beetle: Adult is often patterned or spotted, 2-6 mm.

0 mm 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

Pollution Intolerant (High Quality Group)
Somewhat Pollution Tolerant (Middle Quality Group)
Pollution Tolerant (Low Quality Group)

Pollution Intolerant (High Quality Group)

Common Name	Common Habitats	Breathing Method	Feeding Group	Unique characteristics or behaviors
Caddisfly	Riffles	Absorb dissolved oxygen with gills on abdomen & through the skin.	Predators, Shredders, Grazers, & Collectors	Some types can build a portable case out of natural materials by making silk thread.
Dobsonfly	Fast flowing water, under rocks, logs and leaf packs	Absorb dissolved oxygen with gills on abdomen & through the skin.	Predators	Hunt for prey at night. They live as larvae in the water 1-3 years and shed their skin throughout this period.
Mayfly	Found in all habitats	Absorb dissolved oxygen with gills.	Collectors & Grazers	Can hatch in large numbers all at once. Very large hatches on the Mississippi River can be seen on satellite images.
Riffle Beetle	Riffles	Larvae absorb dissolved oxygen through the skin. Adults trap atmospheric oxygen in patches of water resistant hairs.	Collectors & Grazers	Adults trap enough atmospheric oxygen in one trip to the surface that they live their entire lives underwater. Their wings waste away once they begin their adult lives underwater.
Snail (not pouch)	On aquatic vegetation, sand, gravel, & other solid surfaces	Absorb dissolved oxygen with gills.	Mostly Grazers	
Water Penny Beetle	Riffles	Absorb dissolved oxygen with gills.	Grazers	Nocturnal.
Stonefly	Riffles with course substrates (gravel, cobbles and boulders)	Absorb dissolved oxygen with gills.	Collectors & Predators, while a few are Grazers	They do pushups or wag their abdomens from side to side to move water across their gills to increase their dissolved oxygen absorption.

Somewhat Pollution Tolerant (Middle Quality Group)

Common Name	Common Habitats	Breathing Method	Feeding Group	Unique characteristics or behaviors
Crawling Water Beetle	Slow moving waters, among aquatic vegetation or algae	Trap atmospheric oxygen under their front wings and under a flattened section of their hind legs.	Shredders, some are Predators	
Backswimmer	Slow moving water, at the water surface or in the water	Trap atmospheric oxygen in hairs on the abdomen, under their wings and between their head and thorax.	Predators	Swim upside down. They are strong fliers.
Water Boatman	Calm waters	Trap atmospheric oxygen in hairs on the abdomen, under their wings and between their head and thorax.	Collectors	Can remain under water for an extended period by moving hind legs over their trapped air bubble to increase the diffusion of dissolved oxygen into the bubble.
Predaceous Diving Beetle	Slow moving waters mostly	Trap atmospheric oxygen under their wings.	Predators	The larvae are often called Water Tigers. They inject their prey with a liquid that dissolves its insides then the larva sucks up the liquid leaving behind the outer skin of the prey.
Damselfly	Waters with moderate to no flow	Absorb dissolved oxygen with three paddle-like gills at the end of their abdomen.	Predators	When dissolved oxygen levels get low they rise to the water surface to absorb atmospheric oxygen through their skin.
Whirligig Beetle	Adults at water surface	Larvae absorb dissolved oxygen with gills; Adults breathe atmospheric oxygen when at the water surface and trap it under their wings when diving.	Predators	Have divided eyes & can see both above the water and below the water. Their erratic swimming creates waves that echolocate food. They produce defensive excretions that smell like apples.
Dragonfly	Waters with moderate to no flow	Absorb dissolved oxygen with gills lining a chamber in the abdomen. Can rise to the surface and absorb atmospheric oxygen through the skin.	Predators	Their lower lip is an elbowed extendable grasping mouth piece used to catch prey that they ambush or stalk. They can eat larval fish and tadpoles.
Crane Fly	Found in all habitats	Breathe atmospheric oxygen with spiracles at the end of their abdomen.	Shredders	They break down leaves and detritus making energy & nutrients available. They can digest cellulose with the aid of bacteria in their gut. Adults look like large mosquitoes but do not bite.
Water Scorpion	Slow moving waters	Breathe atmospheric oxygen with a breathing tube at the end of their abdomen.	Predators	They cannot swim and move so slowly that algae, protozoa, and mites will grow on their skin.
Crawdad	Found in all habitats	Absorb dissolved oxygen with gills.	Shredders, Grazers, & Predators	When attacked they can break off their clawed first legs by contracting muscles. The leg will re-grow over time but will be smaller than the original leg.
Giant Water Bug	Slow moving waters	Breathe atmospheric oxygen with two flat structures at the end of the abdomen. Trap atmospheric oxygen under their wings to dive.	Predators	Catch large prey such as fish and frogs. Have venomous salivary enzymes that paralyze their prey. Some males carry the eggs providing dissolved oxygen and cleaning them with their legs.
Alderfly	All habitats, prefer areas with soft bottoms	Absorb dissolved oxygen with gills on abdomen & through the skin.	Predators	They are burrowers and can be found as deep as 35 cm.
Mussels/Clams	Moderate flow, sand, and/or gravel substrate that is stable	Absorb dissolved oxygen with gills and mantle.	Filter Feeders	Often the largest invertebrates in terms of body mass in freshwaters. Freshwater mussels have a parasitic larval stage.
Sowbug	All habitats, prefer areas with abundant hiding places	Absorb dissolved oxygen with gills.	Collectors, Shredders, & Predators	Females hold the eggs and young in a pouch on the underside of her body for up to 30 days after hatching.
Orbsnail	Soft, silty substrates	Obtain atmospheric oxygen through a lung-like structure.	Collectors & Grazers	
Water Mite	Found in all habitats	Absorb dissolved oxygen through the skin.	Predators & External Parasites	Have a very complex life cycle with many stages of development including a 6-legged parasitic stage. Their hosts are most often aquatic insect larvae.
Scud	Found in all habitats	Absorb dissolved oxygen with gills.	Collectors, Shredders, Grazers, & Predators	Express the behavior called negative phototaxis, meaning they avoid bright light.
Water Strider	Found in all habitats	Breathe atmospheric oxygen with spiracles like terrestrial insects.	Predators	They walk on water with surface tension, claws on their legs, and an excreted wax.
Limpet	Riffles	Absorb dissolved oxygen through the skin and with a projection from their foot.	Grazers	

Pollution Tolerant (Low Quality Group)

Common Name	Common Habitats	Breathing Method	Feeding Group	Unique characteristics or behaviors
Mosquito	Prefer still waters	Breathe atmospheric oxygen with a siphon at the end of their abdomen.	Collectors	Unofficial Iowa State Insect.
Water Scavenger Beetle	Slow moving waters	Trap atmospheric oxygen under their wings and in hairs on their underside.	Predators & Collectors	They are voracious eaters.
Pouch Snail	Soft, silty substrates	Obtain atmospheric oxygen through a lung-like structure.	Mostly Grazers	
Midge Fly	Found in all habitats	Absorb dissolved oxygen through the skin.	Collectors, Grazers, & Predators	Most diverse and abundant family of aquatic insects.
Leech	Found in all habitats	Absorb dissolved oxygen through the skin.	Predators	Most are not bloodsuckers.
Rat-tailed Maggot	Slow moving waters	Breathe atmospheric oxygen with a long telescoping breathing tube at the end of their abdomen.	Collectors	Often found in areas with a lot of decaying organic matter. Adults are called Flower Flies.
Flatworm	Found in all habitats	Absorb dissolved oxygen through the skin.	Predators & Collectors	Capable of regeneration.
Aquatic Worm	Found in all habitats	Absorb dissolved oxygen through the skin.	Collectors	Can live in areas with very low dissolved oxygen.
Black Fly	Found in flowing waters	Absorb dissolved oxygen through the skin.	Collectors	Can move across the substrate much like an inchworm.

RESOURCE LINKS

State Hygienic Laboratory (SHL): *www.shl.uiowa.edu* Under Education/Training check out "Did You See That?" game and also "Opportunities"

SHL Education and Training Resources: *http://www.shl.uiowa.edu/edtrain/*

Association of Public Health Laboratories (APHL): *www.aphl.org*

APHL Careers: *www.thatssick.org*

IOWATER: *http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Water-Monitoring/IOWATER*

Iowa Department of Natural Resources (Water Quality Monitoring): *http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Water-Monitoring*

National Institute of Health Office of Science Education/SEPA: *http://science.education.nih.gov/*

National Institute of Environmental Health Sciences: *www.niehs.nih.gov/health/scied/index.cfm*

Centers for Disease Control and Prevention: *www.cdc.gov*

CDC Educational Resources: *http://www.cdc.gov/careerpaths/k12teacherroadmap/index.html*

Environmental Protection Agency: *http://www.epa.gov/students/index.html*

National Science Teachers Association: *www.nsta.org*

National Laboratory Day: *www.nationallabday.org/*

U.S. National Library of Medicine (NLM): *toxtown.nlm.nih.gov/* and NLM: *toxmystery.nlm.nih.gov/*

Abbott - Labs Are Vital: *www.labsarevital.com*

Public Health Job Career Finder: *www.publichealthjobs.net*

Pfizer Guide to Careers in Public Health: *www.pfizercareerguides.com*

Centers for Disease Control and Prevention Zombie Apocalypse: *http://blogs.cdc.gov/publichealthmatters/2011/05/preparedness-101-zombie-apocalypse/*

Association of State and Territorial Health Officials: *www.ASTHO.org*

American Society for Microbiology: *www.asm.org*

Environmental Protection Agency: *www.epa.gov*

U.S. Dept. of Agriculture: *www.usda.gov*

U.S. Geological Survey: *www.usgs.gov*

American Water Works Association: *www.awwa.org*

National Ground Water Association: *www.ngwa.org*

Water Environment Federation: *www.wef.org*

Siemens Foundation: *www.siemens-foundation.org*

Project Lead The Way Biomedical Sciences: *https://www.pltw.org/our-programs/pltw-biomedical-science*