# Pump it up!

By Jodi Burns

**Introduction-** When an energy source causes an object to move, the thing that moves is called a motor. When the object causes the fluid to move, it's called a pump.

**Time required:** Five 55 minute class periods

**Lesson Overview-** students construct a pump that is powered by an outside source (hand pump, water pump, or electrical pump). Then they learn about pumps that are internally powered and ultimately construct a chemical pump from produce. Before doing this, they also design an assay test to determine the concentration of catalase in various vegetables.

**Part One: pumps that use outside power***

**Motivation: Why are pumps important?**
**Pumps are important for water** https://youtu.be/BCHhwxvQqxg

**what is a pump and how do you make one?**
**Hand pump-**https://youtu.be/ZOGkqlju51g
**water-** https://youtu.be/vXDC48eEt5k
https://youtu.be/1sWnI3WKCxQ
**electric:**https://youtu.be/51J5GWHKNWY

**Explain:** A pump moves fluid from one place to another. Where does a pump get its power? (from kinetic energy like they saw in the film or electricity). What is the basic design of one of these pumps?

**Group discussion.** Students decide which pump they want to construct: water wheel, hand pump, or electric pump. Then gather materials and begin.

**Materials:***
**Hot glue gun for each group (7)**
**Pvc pipe in various lengths and shapes**

**Pipe cutter**
**Plastic spoons**
**Soda cans**
**Big popsicle sticks**
**Bamboo skewers**
**Other items such as cardboard, bottlecaps, straws, etc.**

***A more simplified model for each type of pump still needs to be provided. The videos and list of materials are just suggestions.**

**<u>Part 2</u>:Pumps that use internal power**

Students copy down the following terms in their journals:
**Vocab:**
**Pump -** a device that moves fluid from one place to another.
**Biological-** has to do with life
**Catalyst-** Makes chemical reactions happen faster.
**Enzyme-** Biological catalyst
**Catalase-** A type of enzyme (like a yorkie is a type of dog).
**Substrate-** the stuff enzymes consume (or "eat")
**Assay-** a test given to find out the concentration of a substance.

Explain: Now that you have experienced working with pumps that are externally powered, now let's look at creating pumps that are internally powered.

**Motivation:** show ppt chemically driven pumps
https://drive.google.com/a/bakersfield.k12.mo.us/file/d/1N9s6gkWOFC7p42sPHEcnXJHzu_riZ4Oc/view?usp=drive_web

**Background**
Have students read and reflect on Disarming hydrogen peroxide with the help of yeast. Template for reflections can be found on my Google classroom site.

**Materials:**
Graduated Cylinders (100 mL)
Various vegetables all cut to the same size
3% hydrogen peroxide.
Filter paper
Measuring cups

Different types of produce (apples, carrots, bananas, grapes, etc)

**Design assay and record procedure and results**
Divide students into groups of 3 or 4. Instruct them to design a fair test for determining which piece of produce has the most catalase. Extra points for making providing quantifiable results. Then students copy down procedure in their lab notebooks and create a data table.
Have them also identify the independent and dependent variables in this test.

**Results (Data Table)**
*Possible design for table*

**Result of different vegetables in 25 mL of hydrogen peroxide (Assay test)**

| **Type of Fruit or vegetable (all 15 grams)** | **Height of bubbles in cylinder** |
|---|---|
| | |
| | |
| | |

**Ask students to quantify the results of their assay test.** Which vegetables made the most bubbles? Number your vegetables according to their concentrations. The highest number goes to the vegetable that produced the most bubbles.

**Part 3** Design an internally Powered (Chemically Driven) pump

**Explain:**Chemically driven pumps could be handy at detecting toxins in water. choose a catalase enzyme to design a pump to detect hydrogen peroxide in water. See how sensitive you can make it.

**Procedure**
Students will work together to create a pump (find a way to make the slice of vegetable stationary in the petri dish) and then design a fair way to test them using dye to trace the fluid flow.** Record pump design and procedure for testing in their lab notebooks. Create a data table.

**challenge: create tracer particles that are the same density as water to show the movement of the fluid instead of dye. (water has a density of 1 g/cm3).

Possible design:

**Number of seconds that pumps move the solution**.

| pump design | All H2o2 | 50% H2o2 | 25% H2o2 | 5% H2o2 |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

After comparing their results with other classmates, Students record results in notebooks.

**<u>Part 4</u> Design a moving sensor (motor)**

**Explain: when a pump is allowed to move, it becomes a motor. Have students then use a vessel (like a straw) to hold a thin sliver of catalase (or apple, carrot or banana) and design a way to test them using the same type of table that they used for the pumps.**

**Number of seconds that motors move the solution**.

| motor design | All H2o2 | 50% H2o2 | 25% H2o2 | 5% H2o2 |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

After comparing their results with other classmates, Students record results in notebooks.

| **Other Ideas for investigating:** |
| --- |
| Movement of carrot motor (does it tend to move in a certain shape or pattern?) |
| Speed of veggie motor ? |
| How does shape affect the movement of the vegetable? |
| Do organic vegetables contain more catalase than grocery store variety? |

**Carry out the test** take down data in notebook.

- Graph your findings. Independent variable (x axis) and dependent variable (y axis)
- Show data table, graph, and conclusion on google classroom site.
- Present to class.
- Compare class data.
- Combine meaningful data to create a comprehensive report of class findings.
- **Challenge**: Is there a way to extract catalase from carrots?