

Evolving for Survival: What Can We Learn from the Urinary Systems of Mammals?

Teacher guide

Below we provide a brief teacher's guide. We include the learning objectives of this module, prerequisites and suggested activities for each of the classroom breaks between video segments.

Learning objectives of module

This lesson uses simple hands-on experiments to demonstrate how the urinary system works. In the process, students will practice the following skills:

- Thinking visually and physically
- Manipulating physical variables such as speed, time, flow rate. Note they all have different units
- Comparing their calculations to a real life biological system

Prerequisites

Students will apply the following concepts they learned in high school physics

- Gravity (Activity 2 --- direction of gravity)
- Fluid mechanics (Activity 1, 3 – flow rate, flow velocity)
- Conversion of units (Activity 4 – real life value calculation)
- Training on proper tools* (drills, hot glue for Activity 1, 2 and 5), use of calculators or Excel spreadsheets

* Materials can also be prepared in advance to facilitate finishing lesson in an hour.

Suggested activities during each classroom break between video segments

We suggest the teacher run through the experiments first. The activities involve draining out of water. The location should be close to the access of water if possible. Participants may get wet.

We suggest the students work in teams of at least two. One partner can help support and manipulate the large containers of water, which can be cumbersome. The other student removes the plug to release water, and counts time by stopwatch.

We recommend the use transparent containers to enable students to see the water level. In nature, the bladder is elastic and it will collapse while emptying.

In our experiments, we use rigid containers, but we drill one extra hole at the top of containers to prevent the formation of a vacuum which decreases flow.

The best place to put a hole in a bottle is on its cap. We then use hot glue to attach the tube to the cap. For the validation of Torricelli's law, use pipes of various length.

If students can be trusted to use drill and hot glue, we suggest students make their own container and pipe system (Activity 5)

In this lesson, we apply Torricelli's law to a closed container. In general, this cannot be done accurately because closed containers build up negative pressures as they are emptied. Animal bladders, however, resemble bellows and so they do not build up such pressure. Thus, we may apply Torricelli's law to animal bladders.