Frogs

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Field(s) of Interest: Physics and Biology

Brief Overview (1-3 sentences):
In this lesson, mentees will have the opportunity to explore the various stages of a frog's life, allowing them to observe its development. Mentees will also focus on unique frog features, such as their tongue and leg anatomy, which play a central role in frog survival. Through interactive activities, mentees will gain hands-on experience, leading to a deeper understanding of how frog features function, and how they differ from those of humans.

Agenda:

- Introduction (5 min)
- Module 1: Hop Into Life: (20 min)
- Module 2: Bye Bye Fly Guy: (10 min)
- Module 3: Catch Me if You Can: (20 min)
- Conclusion (5 min)

Main Teaching Goals/Key Terms:

- ➔ Frogspawn
- ➔ Fertilization
- ➔ Embryo
- ➔ Tadpole
- ➔ Gills
- ➔ Froglet
- ➔ Lungs
- ➔ Non-Newtonian saliva
- ➔ Viscosity
  - ◆ Low viscosity
  - ◆ High viscosity
- ➔ Eye retraction
- ➔ Hindlimb
  - ◆ ilio-sacral joint
- ➔ Tendon
- ➔ Muscle contraction
  - ◆ Potential energy
  - ◆ Kinetic energy
- ➔ Ilo- sacral joint

Background for Mentors

Module 1

- Frogspawn
- Fertilization
- Embryo
- Tadpole
- Gills
- Froglet
- Lungs

The first stage of a frog's life typically begins in the spring when most female frogs lay their eggs. This is the ideal season due to the perfect temperature, abundance of food, and favorable living conditions. These eggs are laid in large clusters known as **frogspawns.** Frogspawns are unique as each egg is surrounded by a jelly-like layer, serving as a layer of protection from predators or harsh conditions. When male frogs come in contact with these eggs and share their cells, the eggs become **fertilized**. This result is an **embryo** which will begin to develop skin, muscles, bones, and a nervous system. Once these essential body parts form, the frog embryo is ready to hatch, allowing it to enter its second stage of life as a tadpole.

Figure 1: *Frogspawn*

After leaving the egg, **tadpoles** develop tails and **gills**, which are slits on the sides of their necks that allow them to breathe underwater. Despite these major developments, tadpoles still rely on the yolk from their egg for nutrition. For the first two weeks, they remain still until the yolk is fully consumed, indicating they are ready to feed from their environment.

Figure 2: Tadpole

As the frog continues to grow over a 14-week period, it will reach the **froglet** stage where it will lose its tail and begin to grow its front and back legs. Additionally, the froglet will lose its gills and develop **lungs**, which means it will no longer be able to breathe underwater, but will gain the ability to breathe air and move on land.

Figure 3: Froglet

Over time, the froglet will grow bigger and stronger, entering the adult stage where it gains the ability to reproduce, allowing us to see the frogs we all know and love!

Figure 4: *Adult Frog*

Module 2

- Non-Newtonian saliva
- Viscosity
    - Low viscosity
    - High viscosity
- Eye retraction

One of the most unique and recognizable features of a frog is its long tongue. A frog's tongue is relatively long compared to its body, measuring about one third of its body length. That's as if our tongue reached all the way to our belly button! Additionally, a frog's tongue is located at the very front of its mouth, further enhancing its ability to capture prey.

Figure 5: *Frog's Tongue*

After watching a frog catch a fly, it's natural to think its tongue is sticky. However, this isn't the case, as a sticky tongue would make it impossible for a frog to even stick out its tongue. So how does a frog's tongue catch its prey? Frogs have a unique mucus-like saliva with **Non-Newtonian properties**, meaning their saliva can change its thickness depending on how much pressure it is under.

Figure 6: Frog Eating

When a frog extends its tongue toward its prey, the saliva has a **low viscosity**, making it thin and runny. This is ideal because it allows the saliva to sink into any gaps or cracks in the prey, ensuring a secure capture.

As the frog retracts its tongue, the high speed causes the saliva to change from low to **high viscosity,** becoming thick and stiff (similar to honey).

Once the tongue is back in the frog's mouth, the frog uses **eye retraction**, which allows them to press their eyes down into their mouth, helping them swallow their food. With the help of a slower movement, the saliva returns to

	a low viscosity.

Module 3

- Tendon
- Muscle contraction
    - Potential energy
    - Kinetic energy
- ilio-sacral joint

The South African Sharp Nosed frog holds the record for the highest jumping frog, reaching an impressive 14 feet! That is the equivalent of two Lebron James lying head to toe! This is especially remarkable considering that the average human is only able to jump about 1.7 feet.

Figure 7: *South African Sharp Nosed Frog*

A frog's ability to jump such lengths comes from its powerful hindlimbs, stretchy tendons, and unique skeletal structure. A **tendon** is a strong, stretchy band that connects muscles to bones. Before a frog jumps, its leg **muscles contract**, shortening to generate force and stretch the tendons. This process stores **potential energy** within the tendons. When this energy is released, the tendons recoil like a spring, converting potential energy into **kinetic energy**, thus producing the powerful push needed for a frog to leap.

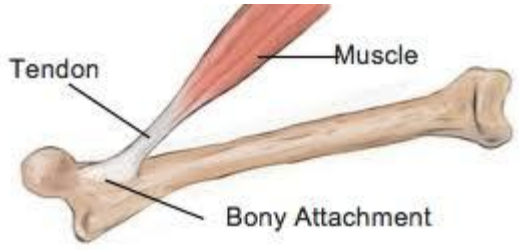

Figure 8: Human Tendon

One key part of this process is the **ilo-sacral joint** located at the pelvis. This specialized hinge-like joint allows the frog to fully extend its body during takeoff, maximizing the length and power of each jump.

	

Figure 9: *Frog Jumping!*

Introduction

This lesson is important because it explores not only the amphibian life cycle, but also touches on topics such as evolutionary adaptations and biological functions. Understanding these concepts gives students a broader understanding of frogs, evolution, and anatomy that they can apply to other animals and even humans!

Concepts to Introduce ● **Amphibians**: Amphibians are animals that live in both water and on land. They need a moist environment to survive. Some examples of amphibians are frogs, salamanders, and newts. ● **Life cycle**: Every living thing goes through a life cycle. It is the series of stages that every living thing goes through. Some stages of a life cycle are birth, growth, reproduction, and death. Some life cycles, like a human's life cycle, are longer than other organisms (That's why people use the term "dog years" when talking about the age of their dog!).	**Questions to Pique Interest** ● What are some features that frogs have that help them in their everyday lives? ○ Long tongue ○ Ability to jump high ● How are we (humans) different from frogs?
Scientists, Current and Past Events ● Frogs were actually the first animals to ever be cloned! ● The life cycle of frogs has helped us learn about developmental stages ○ We can use frogs to study muscle function, create pregnancy tests, and experiment with cloning	**Careers and Applications** ● Zoologist ○ Herpetologist (studies amphibians and reptiles specifically) ● Aquatic veterinarian ● Wildlife biologist

Module 1: Hop Into Life

Through this activity, students will get the opportunity to work independently and build the four different stages of a frog's life cycle. By doing so, students will gain a concrete understanding as to what features are present at each stage.

Teaching Goals	**Materials**
1. **Frogspawn**: Mass of frog eggs laid in water 2. **Fertilization**: Male frog cells combine with egg 3. **Embryo:** Fertilized egg in development 4. **Tadpole**: Second life stage 5. **Gills:** Slits on side of neck for underwater breathing 6. **Froglet:** Third Life Stage 7. **Lungs:** Organs for breathing air on land	Per student - 1 Premade life cycle template - 1 playdough container

Different Methods for Teaching *in collaboration with MD [Valeria]

1. **Foster Engagement Through Storytelling:** Invite students to craft a unique narrative that follows their frog through every stage of its life. Encourage them to give their frog a name and even assign an age—whether it's 4, 18, or 30 years old. This narrative-driven approach not only sparks creativity but also makes the learning experience more engaging and relatable.

2. **Highlighting the Difference Between Lungs and Gills:** Provide students with small labels or stickers that they can place next to each structure. Encourage them to write "gills" or "lungs" on these labels, making it clear which respiratory feature is present at each stage.

Procedure

1. Pass out a frog life cycle template to each student
2. Students will build the four stages out of playdough
3. Have students observe changes through stages

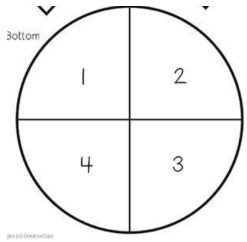

Figure 1: *Frog Template that will be passed out to each group*

Figure 2: *Frog Stages each student will make*

	 **Figure 3:** *Goal Final Product*

Classroom Notes

Module 2: Bye Bye Fly Guy

In this activity, students will get the opportunity to work in teams to mimic a frog catching its prey. This hands-on activity provides students a more secure understanding of the motion frogs use.

Teaching Goals	**Materials**
1. **Non-Newtonian saliva:** Viscosity changes when force is applied to it 2. **Viscosity:** How thick or sticky a liquid is and how easily it flows a. **Low viscosity:** Thin and flows easily b. **High viscosity:** Thick and flows slowly 3. **Eye retraction:** Movement in frogs where they move their eyes downward into their mouth.	**Per student** - 1 sticky hand per student Per class - Handful of beads

Different Methods for Teaching *in collaboration with MD [Valeria]

1. **Exploring Viscosity Through the Sticky Hand Challenge:** Have students record how many flies they can catch under different conditions (for example, a quick grab versus a slow approach) to illustrate the concept of viscosity in action. Lead a conversation where students compare their results and relate their observations to the idea of low versus high viscosity.
    - "What did you notice about the number of flies caught with a quick grab compared to a slow approach?"
    - "How do these differences relate to the concepts of low and high viscosity?"

Procedure

Note: please choose the procedure that you believe is best for your site!

Option 1:

1. Have a designated area for beads
2. Split the class into two groups
3. In teams, each student will take turns using the sticky hand to collect beads from a distance and bring them back to their team "frogmouth"
4. Continue until all beads are collected or the timer ends (about 3 min)
5. Repeat as you see fit

Figure 1: *Sticky hands students will use*

Option 2: 1. Divide the class into small groups 2. Handout sticky hands and place beads on the table 3. Set a 30-second timer and have students compete to see who can catch the most beads 4. Repeat as you see fit	

Module 3: Catch Me if You Can!

In this activity students will work individually to create a frog build that mimics how a frog jumps.

Teaching Goals

1. **Tendon:** A strong, stretchy band that connects muscles to bones
2. **Muscle contraction:** muscle shortens and tightens to produce force
    a. **Potential energy:** Stored energy
    b. **Kinetic energy:** Energy in motion
3. **ilio-sacral joint:** Hinge-like joint allows the frog to fully extend its body during takeoff, maximizing the length and power of each jump.

Materials

Per student

- 2 paper cups
- 1 piece of construction paper
- 1 pair googly eyes
- 1 rubber band

Other supplies

- Glue
- Scissors
- Stapler
- Markers

Different Methods for Teaching *in collaboration with MD [Valeria]

1. **Make External References:** As the model leaps, the mentor explains that the powerful jump is made possible by strong hindlimbs, the ilio-sacral joint, and stretchy tendons working with muscle contraction. The mentor also points out that a frog's hop can be as impressive as two LeBron James lying head-to-toe, linking this amazing feat to the mechanics behind the jump.

Procedure

1. Pass out materials and have students cut paper into a circle for a frog body and 2 frog legs
2. Have students decorate their frogs
3. Take one of the paper cups and cut two slits on each side, making flaps that can fold backwards.
4. Put your elastic around one of the flaps and secure the flap in place with a stapler.
5. Twist the elastic band to make an X, and attach it to the other flap. Secure it in place with a stapler also.
6. Staple your frog to the cup that has the elastic band
7. Place your other paper cup upside

Figure 1: *Frog Body*

Figure 2: *How the frog's should look after students decorate*

down on a flat surface, and put your frog cup on top of it. Holding the sides of the cup with the elastic band, push down onto the upside down cup, then let go

8. Jumping frog!

Figure 3: *Slits on the side of cup*

Figure 4 *Use the rubber band to make X shape*

Figure 5: *Final Product!*

Conclusion

Gather students and ask them to reflect on the different topics they learned. Was there anything surprising? The main idea to end with is that frogs are very unique creatures that have a variety of unique features helping them survive in the world!