**Lesson Plan: Life’s little complexities**

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**Introduction to Lesson Plan:** Multicellular organisms have more complexity than meets the eye. Sure, there are external features that we can see, but every biological component can be broken down into smaller subunits. Additionally, multicellular bodies are subdivided into functional systems, and each system must be connected to the others in order for the organism to live.

In this lesson, students will learn about the complexity and organization of multicellular animals through the process of regeneration/healing. Planarian flatworms are able to regrow almost every part of their body after injury (a full worm can be formed from tiny pieces), and in order to do this they must re-establish biological organization for their new body parts. The proper cell types need to be produced, those cells must arrange into functional tissues, the tissues then form discrete organs, the organs arrange into organ systems, and finally the organ systems form the proper interconnections. Students will learn these concepts through presentation, activities, and follow up assessment.

**List of Standards Addressed:** From Georgia Standards of Excellence (7th grade level)
“**S7L2** – Obtain, evaluate, and communicate information to describe how cell structures, cells, tissues, organs, and organ systems interact to maintain the basic needs of organisms.”

**b.** Develop and use a conceptual model of how cells are organized into tissues, tissues into organs, organs into systems, and systems into organisms.

**c.** Construct an argument that systems of the body (Cardiovascular, Excretory, Digestive, Respiratory, Muscular, Nervous, and Immune) interact with one another to carry out life processes.

**Learning Objectives:**

* Describe the biological organization of a multicellular organism (cells, tissues, organs, organ systems, then organism).
* Explain how organ systems need to work together in order to carry out basic life processes of multicellular organisms.
* Understand the complexity of tissues that need to be reestablished in a healing/regenerative scenario.

**Appropriate Grade Levels:** 7th

**Suggested Number of Students and Group Size:** 20-40 students divided into 3 groups

**Setting:** Indoors. A science lab would be best, but a classroom would also work.

**Approximate Time for Lesson:** 1 hour for the initial lesson (25 minute introduction, then ~10 minutes for each station), and <25 minutes for the regeneration observation follow-up a week later. The initial lesson could be stand-alone (no follow-up) if we cannot arrange a second visit. We will just need to know this ahead of time so that we can adjust Station 1 accordingly.

**Resources/Materials Needed for Students:**

* *Petri dishes* or similar small, clear containers (1 per 2 students)
* *Regenerative planarian flatworms*. We will bring these during our visit. However, if you want to do the lesson yourself, these can be obtained from Carolina Biologicals or even collected from the outdoors (the ones we work with are aquatic). (4 per 2 students is appropriate)
* *Magnifying devices for Station 1 and 3* so that the students can see the worms more clearly**.** The best option for a real science “feel” would be dissecting microscopes, but an easier option would be magnifying glasses. (1 per 5 students would be appropriate)
* *Cutting devices for Station 1* in order to cut/amputate the worms. They cut fairly easily, so even an object like a plastic spoon will suffice (avoid anything without a smooth edge, such as serrated plastic knives). (1 per 2 students)

**Resources/Materials Needed for Educators:**

* *Lesson plan*
* *PowerPoint presentation (and a way to project it for the class to see)*
* *Station activities* described in the “Lesson Activity” section below.
* *Regeneration/amputation graphic for Station 1*
* *Neighborhood model and laminated labels (neighborhood components and biological hierarchy levels) for Station 2*
* *Planarian anatomy board and worms with dyed intestines for Station 3.*

**Lesson Activity:** (*1 hour*)

1. **Formative Assessment** – When the students walk into the classroom, they must write a short answer to the prompt “What must happen in order for an animal to heal after injury?” on the board. This will show us what their understanding of the healing process is (or if they have never even considered how complex the process would be).
2. **Introduction** – this is a presentation that begins with the concept of healing (1st our ability then the almost unlimited ability of our flatworm model), transitions to what needs to be re-established in order to regenerate large parts of the body, connects to the concept of biological organization through this scenario (standard of excellence), then finishes with how the organ systems must make connections between each other in order to create a viable organism (standard of excellence). It will make the activities at the 3 stations go more smoothly/quickly. (*25 minutes*)
3. **Divide the students into 3 groups**
4. **Station Activities (active learning):** In order to maximize efficiency of time, each student group will be assigned to 1 of the 3 stations to begin, then they will transition through the other two. The information at the stations will be connected, but they will also be stand-alone and make sense in any order (the introduction will ensure that). An instructor (you, me, my mentor [Dr. Rachel Roberts-Galbraith], or another member of our lab if you do not feel comfortable leading a station) will be at each station leading the activity. (~*10 minutes per station*)
	1. **Station 1: subject = “Planarian flatworms can regenerate all tissues”.** This station is where the regenerative ability of planarians will be shown, and will probably be the most fun for the students. A *graphic* will be on display with a time-lapse of planarian regeneration and different amputation options. Observations will be made of the uninjured flatworms (such as their movement and characteristics) using the *magnifying devices*, then each student will choose an amputation option and cut their 2 worms using the *cutting devices*. 1 week later, we will return for a follow-up and will observe how the worms have started to regenerate from the injuries. Optionally, you could keep the worms and observe them until they have made a full recovery (where the pigment has returned to the new tissue).

***If you do not have time for a follow-up*:** We will bring worms that have been healing for a week with us to the initial visit. This way the students can see what the worms would look like a week later right after they make their amputations. We will bring worms that had their head amputated, tail amputated, and 1 side of their body amputated.

* 1. **Station 2: subject = “Biological organization must be re-established during the healing process”.** This station is where the students will learn about the hierarchy of biological organization. It is also the least specialized (planarian-focused), so it would be the easiest for the resident teacher to lead if needed. The instructor will re-iterate that in order for an organism to make a full recovery from injury, it must be able to re-build its biological hierarchy in the new body parts. The students will be shown a *visual of a neighborhood*, with *labels of the components* (bricks, walls, buildings, subdivisions, and neighborhood) laid out under it. The components will not be in hierarchical order. The students will then be *given labels of the levels of the biological organization hierarchy* (cells, tissues, organs, organ systems, and organism) and instructed to work together and match each biological level with the corresponding component in their neighborhood scenario (bricks=cells, walls=tissues, buildings=organs, subdivisions=organ systems, and neighborhood=organism). They must then put all of the levels into the correct hierarchical order.
	2. **Station 3:** **subject = “Organ systems must be connected and work together in order to keep the organism alive”.** This station will show the students the organ systems of a fully functional planarian and will help them consider how each system is connected, not mutually exclusive. The instructor will point out each individual organ system on the *planarian anatomy board* and give a brief description of its function. The students will then be able to see the intestines in live planarians by using *magnifying devices* to observe *planarians with dyed intestines*. The instructor will then ask the students questions that will cause them to reflect on how the systems are interconnected (“What causes muscles to move?”, “Why do animals eat?”, “How would these worms find food?”, “What organ systems would work together for an animal to eat?”, etc.).
1. **Final Assessment:** See “Final Product/Assessment” section. This could be a quiz or a reflection. If a reflection is done, it could fulfil a Georgia Standard(s) of Excellence for writing.
2. **(Optional) One week follow-up:** This is when my mentor and I return a week later in order to guide the students as they observe their worms that have started healing from the amputations. We would also be happy to answer any questions that the students have about the worms and/or a science career. (<*25 minutes*)

**Final Product/Assessment:** The development of this could be a collaboration between you and me or you could make one yourself. It could either be a quick quiz to show that they paid attention during the lesson (questions about biological hierarchy, organ system connectivity, etc.) or a written reflection (difficulty is to your discretion – this type of assessment could potentially satisfy writing standards).