How Does an Axolotl Regenerate (regrow) Damaged Limbs?

Middle School Biofabrication Storyline - Activity Sheet

Lesson 1 (A & B)
45 Minutes

This Lesson:

The Anchoring Phenomenon of the Mexican salamander, Axolotl (ACK-suh-LAH-tuhl) that can regrow damaged limbs is introduced with a picture and/or a short video provided below. Students are given the opportunity to share their prior knowledge and their initial understandings of the regeneration of the limb of the Axolotl. Students create a base of class understanding through the development of the class consensus model.

Materials:

- **Axolotl Video** (1:12 minutes) Curious Creatures; ZSL - Zoological Society of London
- **Axolotl Pictures**
- Teacher's choice of materials for Class List & Consensus Model (examples: white board/markers, poster paper/markers, document camera/paper/pen, digital device(s))
- 1 Large whiteboard or poster paper for each group of 2-4 students
- White board markers or poster markers for each group

Science Background (Teacher only):

The Axolotl is a unique creature that can be used for a variety of life science units. In the wild, their natural habitat and population is threatened by human impact. In captivity, their genetic future is in danger from limited genetic diversity. In this unit, the connection to Biofabrication is made as they are a vertebrate with the ability to regenerate damaged body parts.

Vocabulary:

organism - an individual living thing

regenerate - (initial definition) regrow new parts to replace lost or damaged parts of a living thing

What Students Figure Out?:

Students

- establish prior knowledge/experience with regeneration

What Students Do?:

- identify similar phenomena
- develop questions about the Anchoring Phenomenon
- develop initial group models on the process of regeneration
- develop a class model (consensus) of what students agree on.

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Differentiation:

- If it has not been done, establish norms with the class for science discussions that include respect of others and their ideas.
- Implement strategies to promote discussion with students who are not comfortable with speaking in groups. Providing, practicing, and using student sentence prompts are examples (see additional resources). This will support all students including ELL.
- Discussions and consensus will take additional time. Allot extra time for student interactions and learning (ELL students will benefit from extra time).
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.
- Give students time for self reflection on their participation in discussions.

Lesson Progression:

The entire unit builds on K-2 and 3-5 grade span standards. This is the first lesson of the middle school biofabrication unit introducing the Anchoring Phenomenon and establishing initial student understanding.

Supporting Resources:

- **Axolotl Video** (1:12 minutes) Curious Creatures; ZSL - Zoological Society of London
- **Axolotl Pictures**
- **Sample Discussion Norms and Student Sentence Prompts**
- **Teacher Questioning Prompts/Talk Moves Checklist**
- **Talk Moves Map - What Do I Say?**

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Lesson 2 (A & B)
45 minutes

This Lesson:
This lesson begins with students doing a quick digital search of questions from the DQB that will not be addressed in the lessons (example: How long do Axolotls live?). The second part of this lesson initiates the journey from macro body systems (whole organism-organ systems-organs) to micro body systems (cells) with a card sort to identify organs that make up organ systems. Students also make the connection of the similarity of the organ systems between Axolotls and humans in their science notebook/journal. The discussion that follows revolves around organ systems working together and a whole organism working as a system.

Materials:
Digital devices for the digital search (one to one is not needed as students can be paired)
1 set of organ cards for each group of 2-3 students (these can be purchased from science supply stores)
1 large picture of the internal systems of the Axolotl/similar animal or 1 smaller picture per group
1 large picture of the internal system of a human or 1 smaller picture per group
1 student science notebook/journal per student

Science Background (Teacher only):
In middle school, the level of organization of living things (organisms) has been traditionally taught from cells, tissues, organs, organ systems, to the whole organism (micro to macro). This unit begins with the concrete understanding of macro from the elementary standards and progresses to build understanding of the abstract, micro. This lesson and the discussion focuses on the body as a group of systems working as a whole system. The systems addressed are the **circulatory, excretory, digestive, respiratory, muscular, skeletal, and nervous system** (Discussion prompts are in the storyline under Lesson 2B)

Vocabulary:
organism*: a living thing*
system*: a group of parts that work together as a whole*
organ system*: a group of organs that work together to perform one or more function(s)*
organ*: (initial definition) individual part of an organ system that performs a specific function (students have not been introduced to tissues and cells at this point)*

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What Students Figure Out?

Students learned more about the Axolotl as a living thing *(organism)* through their digital search**.** Through the card sort and science discussion students figure out that the body of an Axolotl or human is a *system* made of smaller parts called *organ systems*. These *organ systems* are made of smaller parts called *organs* (muscles, bones; Axolotls have gills-humans have lungs). These organ systems work together as a larger system. Humans are not able to regenerate limbs.

What Students Do?:

- Conduct a digital search of quickly answerable Axolotl questions
- Compare and contrast internal and external parts of humans & Axolotls
- Discuss how the whole organism is a system made of smaller systems (body to organs) and similarities and differences between humans and Axolotls

Differentiation:

- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote discussion with students who are not comfortable with speaking in groups. Provide, practice, and use student sentence prompts (see additional resources). This will support all students including ELL.
- Discussions and consensus will take additional time. Allot extra time for student interactions and learning (ELL students will benefit from extra time).
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.
- Give students time for self reflection on their participation in discussions.

Lesson Progression:

Supporting Resources:

- **Organ Systems Cards**
- **Axolotl Skeletal System Picture**
- **Axolotl Circulatory System Picture**
- **Axolotl Digestive & Excretory Systems Picture**
- **Axolotl External View**
- **Teacher Reference Only Organ Systems (not for direct instruction)**

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Lesson 3
45 Minutes

This Lesson:
Students take a closer look at how multiple organ systems work together to accomplish a common task. Students dissect chicken wings to see how the muscular system (muscles & tendons) and the skeletal system (bones, cartilage, & ligaments) work together to move a body part. They record their observations in their science notebook/journal.

Materials:
1 per group: Sanitized chicken wings (soaked overnight in a 10% bleach 90% water solution; keep wings refrigerated/cold)
1 per group: Dissection Tray (disposable lunch/fruit tray/Heavy duty paper plate)
1 per group: Scissors
1 per group: Probe
Rubber or Nitrile Gloves (all students)
Goggles (all students)
Aprons (all students)
Student notebooks (all students)
Materials for group models if not done in notebooks (See lesson 1)

Science Background: (Teacher only)
A classic lab connecting the idea of parts working as a whole to perform functions (organs, organ systems, whole body). If this lab does not fit your teaching style, using a small mechanical system such as a flashlight or other multi-piece system could be substituted. The discussion can still come back to body systems.

Vocabulary:
Previously introduced words

What Students Figure Out?
Students figure out that organisms are a system made up of smaller systems. When parts of the system are broken the system does not work as well or possibly not at all. They also figure out that different parts of the system look and feel different.

What Students Do?:
- Dissect chicken wings and observe how the muscular and skeletal systems work
- Model how the systems work to make the arm (wing) move
- Discuss systems in small groups and as a class

Differentiation:
- Continue to refer to the group discussion norms as needed to promote equity.
- Strategic grouping of students for small group work will facilitate deeper understanding for all students.

- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Discussions will take additional time. Allot extra time for student interactions and learning (ELL students will benefit from extra time).
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.
- Give students time for self reflection on their participation in discussions.

Lesson Progression:

This lesson is moving from the whole body as a system made of smaller systems and is a launching point for specialized organs being made from smaller material (tissues) and how the tissues are specialized

Supporting Resources:

- **Chicken Wing Lab**

Lesson 4
45 Minutes

This Lesson: A lesson that introduces the idea of what makes up organs. This investigation can be done with the virtual microscope link provided. An alternative is to use prepared slides of tissue samples and microscopes.

Materials:

Digital devices for the virtual microscope slides (one to one is not needed as students can be paired)
1 student science notebook/journal per student

Optional Materials for alternative activity:

1 set of prepared tissue slides per group
1 microscope per group

Science Background: (Teacher only)

Here we are four days into a unit. It would have taken far less time to go the traditional route and give students information about microsystems (cells) and work up to macrosystems (body as a system) in one class. In that case, students are learning about science and not asking questions and figuring out science. Discussion and time are key components to student understanding.

Vocabulary:

microscopic: *too small to be seen with the naked eye*
tissue: *specialized material that together make an organ (temporary definition as cells have not been introduced, yet)*

What Students Figure Out?

Students figure out that different organ materials look different under a microscope.

What Students Do?:

Students observe different tissue samples and record their observations in their notebook/journal making sure to label their diagrams.

Differentiation:

- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Discussions will take additional time. Allot extra time for student interactions and learning (ELL students will benefit from extra time).

- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.
- Give students time for self reflection on their participation in discussions.

Lesson Progression:

This lesson is the basis for the discussion on cells. Students will have seen organs and organ tissue from the previous investigation. In this investigation, under the microscope, they have observed the smaller pieces that make up different organ tissues. They will be ready for a discussion on cells and why cells are similar and different in the next lesson.

Supporting Resources:

- **Virtual Microscope - Tissue Samples**

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Lesson 5A
45 Minutes

This Lesson: This lesson focuses on the small structures of tissue samples seen under the microscope from the previous lesson. The lesson revolves around a discussion on these small structures. Students identify major parts of an animal cell: nucleus & cell membrane. All the cells seen have these parts, but the cells of different tissues look different.

Materials:

Diagrams of the tissue samples from the previous investigation.
Chart paper and markers for a group discussion

Science Background: (Teacher only)

This lesson is fully discussion based on student observations. The key is to establish what we call *cells* as the tiny structure that makes up tissues. Use discussion strategies available in Lesson 1 to promote deeper thinking. Include all participants and do not be satisfied with one or two “right” answers.

Vocabulary:

microscopic: *too small to be seen with the naked eye*
cell: *tiny structures that make up tissues (initial definition)*
nucleus: *The largest organelle in a cell; controls the cell and its functions (tells the cell what it is and what it does/structure & function)*
cell membrane: *a layer of material on the outside of a cell that separates the material inside a cell from the outside surroundings.*
organelles: *specialized structures inside a cell like a nucleus*
specialized cell: *a cell that has a specific structure and function in a multicellular organism. Groups of specialized cells make specialized tissue.*

What Students Figure Out?:

Students figure out that organ tissues are made of smaller parts called cells. The different cells have similar parts (nucleus & cell membrane), but look different depending on the type of tissue. An initial connection to the structure of cells and their function is established.

What Students Do?:

Students discuss their observations from the diagrams they drew of different tissue samples. They discuss their observations establishing cells as the next smallest entity of a living thing.

Differentiation:

- Continue to refer to the group discussion norms as needed to promote equity.

- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Discussions will take additional time. Allot extra time for student interactions and learning (ELL students will benefit from extra time).
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.

Lesson Progression:

The students have established that a body is a whole system that is made of many organ systems, made of specialized tissues, and those are made of specialized cells. These organizational levels should be reviewed at this time. Students leave off with the question of whether all things are made of cells?

Supporting Resources:

None

Lesson 5B
45 Minutes

This Lesson (optional): An extension to establishing that tissues are made of smaller systems called cells is to incorporate a cheek cell lab. Make sure this lab does not reinforce the idea that cells are on living things, and not built of cells.

Materials:

Methylene Blue solution (0.5% to 1%)
pipette or dropper
(materials for each group of students)
microscope slides
slip covers
sterile cotton swabs
paper towel/tissue
microscope

Science Background: (Teacher only)

Methylene blue stains negatively charged molecules in the cell. This includes DNA and RNA. **This dye is toxic when ingested and it causes irritation when in contact with the skin and eyes. Make sure students use gloves and wear goggles.**

The cells seen are squamous epithelial cells. These are from the outer epithelial layer of the mouth. The small blue dots that are seen are bacteria from the teeth and mouth.

Vocabulary:

microscopic: *too small to be seen with the naked eye*
cell: *tiny structures that make up tissues (initial definition)*
nucleus: *The largest organelle in a cell; controls the cell and its functions*
cell membrane: *a layer of material on the outside of a cell that separates the material inside a cell from the outside surroundings.*
organelles: *specialized structures inside a cell like a nucleus*
specialized cell: *a cell that has a specific structure and function in a multicellular organism. Groups of specialized cells make specialized tissue.*

What Students Figure Out?

Students reinforce the idea that they are made of cells, too.

What Students Do?:

Students prepare slides of their own cheek cells by swabbing the inside of their cheek and smearing the swab on a slide. They stain the samples and cover with a cover slip. Students view the cells under a microscope.

Differentiation:

- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.

Lesson Progression:

This is an optional lesson and can be skipped if time is short.

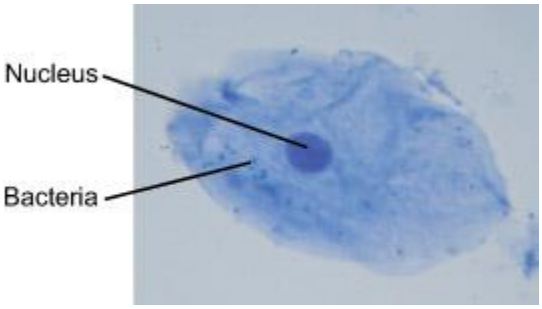
Supporting Resources:

Preparing slides

1. Take a clean cotton swab and gently scrape the inside of your mouth.
2. Smear the cotton swab on the centre of the microscope slide for 2 to 3 seconds.
3. Add a drop of methylene blue solution and place a coverslip on top.

Caution: Concentrated methylene blue is toxic if ingested. Wear gloves and goggles during prep. Do <u>NOT</u> allow children to handle methylene blue solution or have access to the bottle of solution.

4. Remove any excess solution by allowing a paper towel to touch one side of the coverslip.
5. Place the slide on the microscope, with 4 x or 10 x objective in position and find a cell. View cell at a higher magnification.



Teacher reference: Example of what students see.

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Lesson 6
45 Minutes

This Lesson:
Students use a card sort to put pictures (side A) on cards into 2 distinct groups. They look for patterns of how the cards were sorted. They flip the cards to side B to see if there is a pattern visible. If not, they sort side B into 2 separate groups. They see if there is now a pattern to the side A of the cards. Through discussion, students end up with the idea that living things (organisms) are made of cells.

Materials:
1 set of macro/microscopic versions of living & nonliving things per group

Science Background: (Teacher only)
Students might sort cards into a number of different groups (ex: what we eat or not eat, living & non-living, animals & not animals. Through discussion and looking for patterns on both sides of the cards, students determine that the items made of cells are things that are alive. They have already been introduced to cells with the virtual microscope. Many students have a limited understanding of the idea that all living things are made of cells and what that really means. Students may think that cells are inside or on living things, but not that cells make up most of an organism's structure. Some students know that cells make up humans and/or other animals. They are often surprised to learn that plants and bacteria are made of cells.

Vocabulary:
microscopic: *too small to be seen with the naked eye*
cell: *tiny structures that make up tissues (initial definition)*
nucleus: *The largest organelle in a cell; controls the cell and its functions*
cell membrane: *a layer of material on the outside of a cell that separates the material inside a cell from the outside surroundings.*
organelles: *specialized structures inside a cell like a nucleus*

What Students Figure Out?
Students figure out that only living things are made of cells

What Students Do?
Students work in pairs to sort side "A" of the cards into 2 groups (their choice). Students share their results and explain their reasoning for sorting as they did. They turn the cards over to see if side B has a pattern grouped as they are. If not, students group side B into 2 groups and discuss the patterns from their choices. Students compare side A to side B in their groups to make the connection of cells and organisms.

Differentiation:
- Strategic grouping of students for small group work will facilitate deeper understanding for all students.

- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.

Lesson Progression:

Students have been introduced to cells and that specialized cells make up specialized tissue. This activity helps students make the connection that cells make up living things (organisms).

Supporting Resources:

Living & Non-Living Card Sort

Middle School Biofabrication Storyline - Activity Sheet

Lesson 7
30-45 Minutes

This Lesson:
This lesson focuses on the structure & function of different cells. The drawing or pictures from the virtual microscope are used. The cells of different tissues look different and have different functions. This true is true in multicellular organisms

Materials: (teacher choice)
Diagrams from student notebooks
Larger copies/photos/projections of the virtual microscope picture for group discussion

Science Background: (Teacher only)
This activity is revisiting the idea of structure and function and introducing the term multicellular as organisms that have specialized cells are multicellular. A big question that can be raised is can a specialized cell change into a different cell? A structure & function lab could be placed here if desired.

Vocabulary:
multicellular: *made of more than one cell*
specialized cell: *a cell that has a specific structure and function in a multicellular organism. Groups of specialized cells make specialized tissue.*
non-specialized cell: *a cell that does not have a specific structure and function and can become any type of specialized cell*

What Students Figure Out?
Students figure out organisms can be multicellular. Multicellular organisms have specialized cells based on structure and function.

What Students Do?
Students discuss the structure and function of different cells and tissues they have observed. They determine that organisms with specialized cells/tissues are multicellular.

Differentiation:
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.

Lesson Progression:

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This lesson is a precursor to the lessons on the size of cells (scale) and unicellular organisms

Supporting Resources:

None

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Lesson 8
45 minutes

This Lesson:
Students use a computer simulation to understand the scale of cells
Materials:
Digital Devices for students to work in pairs
1 Science notebooks/journals per student for observations
Science Background: (Teacher only)
Students might realize that cells are small, but they may not comprehend that molecules are smaller than cells.
Vocabulary:
microscopic: *too small to be seen with the naked eye*
scale: *the relative size of objects*
What Students Figure Out?
Students figure out the relative size of cells and how to show microscopic processes on their models of how the Axolotl regenerates limbs.
What Students Do?
Students use a computer simulation to identify the relative size of objects down to cells and molecules. They document their findings and have a group discussion.
Differentiation:

- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.

Lesson Progression:
This lesson precedes the Pond Water Lab and unicellular organisms
Supporting Resources:
Scale of the Universe 2 Simulation

Middle School Biofabrication Storyline - Activity Sheet

Lesson 9
45 Minutes

This Lesson:
Students are introduced to unicellular organisms through a standard Pond Water Lab.
Materials:
1 Microscope per pair/group
Slides
Cover Slips
1 Dropper per pair/group
Fresh pond water in clear jars
1 science notebook/journal per student
Science Background: (Teacher only)
This lab is to help students understand that all life forms are made up of cells—from single-celled bacteria and organisms found in ponds to human beings, who are made up of trillions of cells. Students should be able to grasp that even microscopic, single-celled organisms are alive. There is a link to a video that shows many unicellular organisms that live in pond water as a back up to the lab.
Vocabulary:
unicellular: *an organism made of one cell*
microorganism: *a microscopic organism that exists as a single cell or colony of single cells*
What Students Figure Out?
Not all organisms are multicellular. Some organisms are unicellular
What Students Do?
Students examine pond water under a microscope and record their findings
Differentiation:

- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.

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Lesson Progression:

Students understand that organisms are made of cells and can be unicellular or multicellular. The next step is to establish the roll of the cell membrane in survival as it regulates what enters and leaves a cell

Supporting Resources:

[Organisms Found in Pond Water Video]

Lesson 10
Multiple Days

This Lesson:
The Egg Lab (Osmosis Lab); If time is limited an onion cells and salt water lab could be substituted

Materials:
See Supporting Resources for the Lab
Whiteboards and markers or paper and markers/colored pencils for modeling in groups
Teacher's choice of materials for consensus model/discussion

Science Background: (Teacher only)
Start the prep of this lab (removing the shell of the eggs) on the day you do the Onion Lab if you are doing both. The Egg Lab is an excellent opportunity for students to dive into data and what the data means as they record the mass of the egg over multiple days after being submerged in different liquids. Acetic acid makes up 5% of the liquid in vinegar. Water makes up the other 95% of the liquid in vinegar. Remember: Osmosis is the process of water moving through a semipermeable membrane. Osmosis makes the concentration of water molecules inside and outside a cell the same. Diffusion is the transport of other material from an area of higher concentration to an area of lower concentration. Corn syrup has a much lower water concentration than vinegar. Have students think about whether water entered or left the egg depending on the liquid it was submerged in. This lab can be used in higher grade levels, bringing in High School level vocabulary.

Vocabulary:
osmosis: *the movement of water through a semipermeable membrane from a region of higher concentration to a region of lower concentration, equalizing the concentrations of the water on both sides*
diffusion: *movement of molecules other than water from an area of higher concentration to an area of lower concentration*
cell membrane: *a barrier that separates the inside of a cell from the outer surroundings. It is semipermeable.*
semipermeable: *allows some substances through and not others*

What Students Figure Out?
Students figure out that the cell membrane is semipermeable and that water moves from an area of higher concentration to an area of lower concentration..

What Students Do?
Students collect data in the Egg Lab over multiple days to observe the process of osmosis. Students model what they think is happening with osmosis/diffusion. Students participate in a group discussion of the data to determine what happened and come to consensus.

Differentiation:

- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.

Lesson Progression:

This lesson builds understanding of the structure and function of the cell membrane and cell survival.

Supporting Resources:

Basic Egg Lab Directions

Lesson 11
30-45 minutes

This Lesson:
This lesson is a class discussion of the cell membrane and its structure and function. How do the cell membrane of the Axolotl's cells help the Axolotl survive?

Materials:
Any materials the teacher prefers for large group discussions

Science Background: (Teacher only)
Organisms need food, water, and a way to dispose of waste. Individual cells in a multicellular organism need to perform these functions. This happens through the cell membrane. In the putting it together discussion, no need to go as deep as "stem cells" or DNA. Genetic material in the nucleus is deep enough for most students

Vocabulary:
osmosis: *the movement of water through a semipermeable membrane from a region of higher concentration to a region of lower concentration, equalizing the concentrations of the water on both sides*
diffusion: *movement of molecules other than water from an area of higher concentration to an area of lower concentration*
cell membrane: *a barrier that separates the inside of a cell from the outer surroundings. It is semipermeable.*

What Students Figure Out?
Organisms (living things) need food, water and a way to dispose of waste. Individual cells need these items as well. The cell membrane allows the cell to receive food, water and remove waste.

What Students Do?
Students discuss the question posed (How do the cell membrane of the Axolotl's cells help the Axolotl survive?) and support their ideas with evidence from previous activities.

Differentiation:
- Continue to refer to the group discussion norms as needed to promote equity.
- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.

- Discussions will take additional time. Allot extra time for student interactions and learning (ELL students will benefit from extra time).
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.

Lesson Progression:

This is a great time to summarize what students understand about cells (specialized and non specialized; this is “big” to understanding why Axolotls regenerate) unicellular and multicellular organisms (cells, tissues, organs, organ systems, whole organism), & the cell membranes and how this might help explain the Axolotl regenerating damaged limbs. Unanswered is how humans heal when damaged?

Supporting Resources:

None

Middle School Biofabrication Storyline - Activity Sheet

Lesson 12
45 Minutes

This Lesson:
Through a video about human healing of wounds and class discussion, students begin to make the connection that humans do not have undifferentiated cells to regenerate severely damaged material, but they form scar tissue when damaged.

Materials:
Wound Healing Time Lapse Video - See Supporting Resources

Science Background: (Teacher only)
Suggestion for the video: Playback at ¼ speed after showing it in regular time.
https://drive.google.com/file/d/1hq_giuKMY5PtdMvEXUlw8pH6NXDiSx7i/view?usp=sharing
Caution: The video on YouTube (if students Google it) has a note that the wound was intentional. The above link is the same as below and only has the video. If students are interested in viewing this again at home, please copy the above link into a Google Classroom or copy the link as written in Supporting Resources and do not mention the video is on YouTube. The message on YouTube from the person creating the video is not appropriate for students.
Questions to pose in the discussion to prompt discussion is... Do humans grow new cells? (hair grows, nails grow, new skin forms???…); Can skin cells change their structure & function and become another type of cell? That abrasion/wound healed, but what happens with more severe injuries in humans? How would knowing how to heal major injuries or replace damaged organs/parts without scaring be helpful?

Vocabulary:
cell: *The smallest organism (living thing). Cells are unicellular, individual or in colonies, or groups of specialized cells form specialized tissues in multicellular organisms*
specialized cell: *a cell that has a specific structure and function in a multicellular organism. Groups of specialized cells make specialized tissue.*
non-specialized cell: *a cell that does not have a specific structure and function and can become any type of specialized cell*

What Students Figure Out?
Students figure out that humans can grow new cells (Specialized cells can replace specialized cells) and heal minor damage or scar over major injuries (ie: loss of a limb).

Middle School Biofabrication Storyline - Activity Sheet

What Students Do?

Students discuss (guided by the teacher) the ideas that humans do grow new cells, and can repair small wounds and larger wounds with scarring, but they cannot regrow a limb.

Differentiation:

- Continue to refer to the group discussion norms as needed to promote equity.
- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Discussions will take additional time. Allot extra time for student interactions and learning (ELL students will benefit from extra time).
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.

Lesson Progression:

This lesson is beginning to wrap up the idea of how humans heal and specialized cells do not change structure or function. The next step is to answer why the Axolotl responds differently to damage.

Supporting Resources:

Wound Healing Time Lapse

The pictures were taken every 4 hours for 33 days.

Middle School Biofabrication Storyline - Activity Sheet

Lesson 13
45 Minutes

This Lesson:
Teacher finds a video clip of embryonic development or an age appropriate article explaining how undifferentiated cells differentiate to make specialized cells. (unspecialized cells forming specialized cells) Discussion follows with the end goal of students understanding Axolotls have specialized cells/tissue as well as non-specialized cells available to become specialized forming new specialized tissues (Reviewing basic ideas from Lessons 5A-7A)

Materials:
Teacher provided article/video clip

Science Background: (Teacher only)
Undifferentiated or non-specialized cells receive chemical messages either internally or externally to prompt them into action to begin to specialize ("turning on" the specific genes in the DNA housed in the nucleus). As they specialize, the cells are also receptive to their position to other like and different cells assisting in tissues forming in the correct areas. Middle school students do not go further than the term genetic material. DNA and more details are in the high school standards.

Vocabulary:
Include any vocabulary that would help students read/watch and understand the article/video

What Students Figure Out?
Multicellular organisms develop from unspecialized cells. Specialized cells do not turn into other specialized cells. Humans do not have non-specialized cells ready when damaged to form specialized cells-tissues-organs-organ system ie: new limbs

What Students Do?
Student read/view an article/video and discuss how this applies to the phenomenon

Differentiation:
- Continue to refer to the group discussion norms as needed to promote equity.
- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Discussions will take additional time. Allot extra time for student interactions and learning (ELL students will benefit from extra time).

- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.
- Implement literacy strategies to support reading of the article

Lesson Progression:

This activity should give students the final ideas they need to explain the Anchoring Phenomenon

Supporting Resources:

None

Middle School Biofabrication Storyline - Activity Sheet

Lesson 14
45 minutes

This Lesson:
Students revisit their original model and any revisions they have made so far. They are able to a make final model as an assessment of what they now understand about cells and systems to explain the Anchoring Phenomenon

Materials: Teacher's Choice of medium below (individual or group work)

- Paper and markers/colored pencils
- Whiteboards and markers
- Student Notebooks
- Digital Drawing App (examples: JamBoard, Google Draw,

Science Background: (Teacher only)
The teacher and students should co-construct a *Gotta-Have Checklist* for the final model. Students are able to use the *Gotta-Have Checklist* to construct their final models

Vocabulary: (other vocabulary from the unit may be used)
regenerate
specialized cell
non-specialized cell
nucleus
semi-permeable membrane
tissue
multicellular

What Students Figure Out?
Students figure out their thinking has changed from the beginning of the unit as they revise their initial models.

What Students Do?
Students use the resources of their vocabulary list and Summary Board (Anchor Chart) that is in the classroom. Students revise their initial models and apply what they now understand about Axolotls and how they regenerate

Differentiation:

- All students are able to think deeply about scientific principles given the opportunity.
- Translate for ELL students if necessary.
- Encourage students to refer to classroom resources such as the summary table and posted vocabulary.
- Standard accommodations of having the question(s) read to the student(s), more time to express understanding, preferential seating, or other student accommodations should be used as needed/required.

Lesson Progression:

Middle School Biofabrication Storyline - Activity Sheet

This is the first assessment in a series of three for this unit. This assessment allows students to apply their understanding to the original question

Supporting Resources:

Rubric for Final Student Model

Middle School Biofabrication Storyline - Activity Sheet

Lesson 15
45 Minutes

This Lesson:
Teacher finds a current, age appropriate article/video on the regeneration of cells, tissues, organs and/or Bio-engineering for students. Students discuss.

Materials:
Teacher selected article/video

Science Background: (Teacher only)
This activity connects the unit and the Anchoring Phenomenon to Bio-engineering/Biofabrication. As this field is rapidly changing, the most current information is needed

Vocabulary:
Include any vocabulary that would help students read/watch and understand the article/video

What Students Figure Out?
Students figure out current advances in Bioengineering

What Students Do?
Students read/view and discuss a current article/video on the advances of Bio-engineering (cell-tissue-organ regeneration)

Differentiation:

- Continue to refer to the group discussion norms as needed to promote equity.
- Strategic grouping of students for small group work will facilitate deeper understanding for all students.
- Opportunities for student to student discussion increases student efficacy for group discussions
- Continue implementing strategies to promote deeper thinking with students as they work in small groups. (see Talk Moves Checklist from Lesson 1). This will support all students including ELL.
- Discussions will take additional time. Allot extra time for student interactions and learning (ELL students will benefit from extra time).
- Encourage students to use language with which they are familiar and increase the use of English phrases in the case of ELL students and scientific terms for all.
- As lessons develop, encourage students to refer to classroom resources such as the summary table and posted vocabulary.
- Implement literacy strategies to support reading of the article

Middle School Biofabrication Storyline - Activity Sheet

Lesson Progression:

This activity rounds out the unit and gives the connection to Bioengineering

Supporting Resources:

None

Middle School Biofabrication Storyline - Activity Sheet

Lesson 16
45 Minutes

This Lesson:
Students will use their understanding of cells to express a Claim - Evidence - Reasoning (CER) based on why humans cannot regenerate limbs and Axolotls can. To develop a CER, students will be Obtaining, Evaluating, and Communicating Information, Analyzing and Interpreting Data, Constructing Explanations, Engaging in Argument from Evidence to support their claim.

Materials:
Teacher choice of the mode of how students express their understanding...
Digital Devices
Materials to hand write the CER
CER Template (teacher provided)

Science Background: (Teacher only)
This is the second of three end of unit assessments. Students began their understanding through collecting and discussing evidence from investigations. With this evidence, they are ready to formulate a claim, evidence, reasoning product

Vocabulary:
Unit vocabulary

What Students Figure Out?
Students figure out how well they understand the material in this unit

What Students Do?
Students express their understanding of the concepts in this unit with a CER

Differentiation:

- The question(s) for the assessment should not be modified except for cultural sensitivity.
- All students are able to think deeply about scientific principles given the opportunity.
- The question(s) can be translated for ELL students if necessary.
- The differentiation for this assessment is grounded in the way students express their understanding. Suggestions include but are not limited to written explanations, typed explanations, scientific models, verbal expression, and/or a combination as long as it includes the components of a CER.
- Standard accommodations of having the question(s) read to the student(s), more time to express understanding, preferential seating, or other student accommodations should be used as needed/required.

Lesson Progression:

Middle School Biofabrication Storyline - Activity Sheet

This lesson is the second of three assessments. This assessment allows students to express their understanding of the unit in a CER format comparing humans and Axolotls and being able to regenerate or not.

Supporting Resources:

None

Middle School Biofabrication Storyline - Activity Sheet

Lesson 17
45 Minutes (more time if needed)

This Lesson:
Students apply their understanding of scientific principles from the Middle School BioFab Unit to a new situation (phenomenon). This is the third part of the summative assessment for this unit.

Example Questions:

MS-LS1-1 #1 A sample of material from a scientific expedition in a remote area was recently discovered and it is your job to identify if this is evidence that life existed in this area. What evidence could you look for to support whether the material was living or non-living and what is your reasoning to support whether this sample would be classified as living or non-living?

MS-LS1-3 #2 Maria was skateboarding along the sidewalk when a squirrel ran directly in front of her. She just barely misses the squirrel. Answer all questions a to d. Use evidence from the Axolotl unit to support your answers

a. Does Maria stay on her skateboard or does she fall?
b. List the body systems Maria uses to avoid hitting the squirrel.
c. Explain what each system you listed does to help Maria as she misses the squirrel.
d. How are cells related to Maria's body response to that squirrel?

Materials:
Summary Table
Vocabulary Words
Scientific Models completed by students/class
Teachers choice on the mode of collecting student responses
Possible choices:

- Written
- Typed (digital devices)
- Verbal
- Modeled

Science Background: (Teacher only)
No background
Vocabulary:
Unit vocabulary
What Students Figure Out?
This is an opportunity for students to demonstrate their understanding of the scientific principles from LS1.A
What Students Do?

Students answer questions to demonstrate their understanding of the scientific concepts figured out during the Axolotl Storyline applied to another phenomenon.

Differentiation:

- The question(s) for the assessment should not be modified except for cultural sensitivity.
- All students are able to think deeply about scientific principles given the opportunity. The question(s) can be translated for ELL students if necessary.
- The differentiation for this assessment is grounded in the way students express their understanding. Suggestions include but are not limited to written explanations, typed explanations, scientific models, verbal expression, and/or a combination.
- Standard accommodations of having the question(s) read to the student(s), more time to express understanding, preferential seating, or other student accommodations should be used as needed/required.

Lesson Progression:

This concludes the middle school BioFab unit. The DCIs, SEPs, CCCs, in this unit are the foundation to MS-LS1-7 (cellular respiration), MS-LS3 (heredity), HS-LS1 (structure & function) and HS-LS3 (heredity).

Supporting Resources:

Rubric

Middle School Biofabrication Storyline - Activity Sheet

Sample Activity Sheet Template

Lesson Title:
This Lesson: A paragraph describing the lesson
Time Frame:
Materials:
Science Background:
Vocabulary:
What Students Figure Out?
What Students Do?
Differentiation:
Lesson Progression:
Supporting Resources: