

Nano-biobots Unit

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Lesson 1 - What is Alive?

Overview

Students will be posed with the question "What is alive?". They will brainstorm a list of criteria for life to start a discussion on what is alive. They will then begin to research viruses, bacteria, plant and animal cells.

Essential Questions & Enduring Understandings

1. What is alive?
 - a. Living things share common characteristics such as DNA, nutritional and energy needs, growth, response to environment, and reproduction.

Time = 1 Lesson, 40 minutes

Materials

- Walls
- Laptops or iPads
- Criteria for life table

Start

- Prompt students with questions "What are some examples of living things". Ask "What makes something "living"?", ask them to write down some ideas of the criteria for life on the walls

Do

1. Break into small groups and share ideas of what is alive. Then students create a group list for the criteria for life. (10 min)
2. Each group shares their list with the class to create one criteria for life list. (10 min)
3. Individually they make a table with their criteria on left column and "viruses, bacteria, plants and animal cells" on the top row. They then use the internet to find examples of how each of these clades fits into the criteria they listed. (20 min)

Homework

- Complete Criteria for Life table if not completed in class.

Lesson 2 - Criteria for Life

Overview

Students will discuss viruses, bacteria, plant and animal cells and how they fit into their criteria for life list.

Essential Questions & Enduring Understandings

1. What is alive?
 - a. Living things share common characteristics such as DNA, nutritional and energy needs, growth, response to environment, and reproduction.
 - b. Students understand that life is a process rather than a state or a category

Time = 1 Lesson, 40 minutes

Materials

- Wall
- Criteria for life table
- Is it Alive? Video
<http://www.pbslearningmedia.org/resource/tdc02.sci.life.colt.alive/is-it-alive/>
- What is life?
 - Options
 - <https://www.youtube.com/watch?v=phgASkTaIW0>
 - <http://youtu.be/VvTfkMhEw3g>
 - <http://www.brainpop.com/health/diseasesinjuriesandconditions/viruses/>

Start

- Divide students into 4 groups (viruses, bacteria, plant cell and animal cell)

Do

1. In groups students shared what they found about their clade and how it fits into their Criteria for Life list. They see if they need to add or remove any criteria they came up with.
2. Each group presents their refined Criteria for Life list and debate Criteria to come up with a final list.
3. Watch Is it alive? and What is life? video clips and end with class discussion.

Lesson 3/4 - What are single celled organisms?

Overview

Students will investigate Protozoa (Volvox, Euglena, and Paramecium) through direct observation of living specimens under microscopes.

Essential Questions & Enduring Understandings

1. What are the parts of a protozoa cell and how does it function?
 - a. Protozoa consist of organelles which allow them to obtain energy, move and replicate.

Time = 2 Lessons, 80 minutes

Materials

- Notebook
- Protist Data Sheet
- Prepared slides
- Toothpicks
- Well slides
- Cover slips
- Live Protozoa

Start

- Demonstrate proper use of microscope

Do

1. Each student sets up a microscope and makes a drawing of 2 different prepared slides, practicing focusing on different magnifications.
2. After, students can swab their cheek to view their own cheek cells.
3. Students observe 3 different living protozoa: Euglena, Paramecium, and Volvox.
 - a. Students are guided to observe how the protozoa have different types of motion, and to consider what structures each protist might have that can explain its motion.
 - b. Students also make other observations and consider what structures the protists need to live.
4. If time remains, students can observe other protists or mix the protists together.

Homework

- Complete worksheet questions

Lesson 5 - How do protists work?

Overview

Students will discuss their observations and try to figure out how organelles help protists live.

Essential Questions & Enduring Understandings

1. What are the parts of a protozoa cell and how does it function?
 - a. Protozoa consist of organelles which allow them to obtain energy, move and replicate.

Time = 1 Lesson, 40 minutes

Materials

- Notebook
- Protist Data Sheet from previous lesson
- Wall/Whiteboard
- Structure to Function Presentation

Start

- Students draw their ideas for how *Paramecium* and *Euglena* move up on the wall.

Do

1. Students are guided through a discussion of how structure relates to function, specifically surrounding motion.
 - a. Students describe motion in *Euglena* and *Paramecium*, and discuss what structures could explain their observations.
2. Students learn about protist specific organelles: eye spot, flagella, and cilia.
 - a. The Structure to function presentation contains videos of the protists.
 - i. Students then compared their motion to the motion of other living things: shark, sting ray, and a row boat. Students then had to infer flagella and cilia from the comparison.
3. Students are introduced to other organelles and connect them to different life functions: chloroplasts, mitochondria, cell membrane, and nucleus.

Lesson 6/7 - What are organelles?

Overview

Students will research different organelles and create a short play to explain what they are and how they connect to the life function of the cell.

Essential Questions & Enduring Understandings

1. What are organelles and what is their purpose in a cell?
 - a. Within cells, organelles, such as chloroplasts, mitochondria, and nucleus, are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.

Time = 2 Lessons, 80 minutes

Materials

- Notebook
- Parts of the Organelle Worksheet
- Cell Analogy Worksheet
- Wall
- iPads

Start

- Students draw their ideas for how an inside of a cell works.

Do

1. Students are divided into groups and are given a list of organelles.
2. Students research the form and function of these organelles and are then tasked to make a play to explain them.
 - a. Students are encouraged to be creative and use props!
3. Students perform plays for each other.
4. Final review
 - a. Review organelles. Come up with a cell analogy (e.g. cell town or cell theme park) for the different organelles.

Notes

Lesson 8/9 - Nano-biobots - Part 1

Overview

Students are introduced to Dr. Saif's lab and research on nano-biobots.

Essential Questions & Enduring Understandings

1. What are nano-biobots and why are we interested in them?
 - a. Nano-biobots are tiny inorganic structures that are powered by living cells.

Time = 2 Lessons, 80 minutes

Materials

- Article: http://news.illinois.edu/news/14/0117bio-bots_TaherSaif.html
- Video 1: <https://www.youtube.com/watch?v=RmU4rWq4KGg>
- Video 2: <http://news.illinois.edu/WebsandThumbs/saif,taher/freeSwimmer.avi>
- Research site: <http://saif.mechse.illinois.edu/>
- iPads

Start

- Pose the question "Are robots alive?" and have students write a "tweet" on the wall to answer the question.

Do

1. Show research site and introduce Dr. Saif
 - a. Focus on "Can we provide mechanical cues to living cells such that they self organize and emerge as biological machines?"
2. In small groups have students read the article and watch the video. Then they should create a 1 - 2 minute newscast to summarize the research.
 - a. They should pick one or two main points from the article to focus on.
3. Watch all newscasts and then discuss article.

Teacher follow-up

1. Can give *A self-propelled biohybrid swimmer at low Reynolds number* article to students who are interested and able.

Lesson 10 - 12 - Design a Nano-biobot

Overview

Students will design their own nano-biobot that can detect and locate a tumor in the body.

Essential Questions & Enduring Understandings

1. How can new technology and scientific advancements be used to solve problems.

Time = 3 Lessons, 120 minutes

Materials and Prep

- Nano-biobot Challenge
- Tinkering and building materials in Drish

Start

- Open Nano-biobot Challenge

Do

1. Review cell analogies with a think-pair-share.
2. Read through Nano-biobot Challenge as a class and answer questions.
3. Start!

Homework

- Answer the research questions in Nano-biobot Challenge
- Finish up any design work not done in class.

Lesson 13 - Present Nano-biobot designs

Overview

Students will present their nano-biobot designs that can detect and locate a tumor in the body.

Essential Questions & Enduring Understandings

1. How can new technology and scientific advancements be used to solve problems.

Time = 1 Lesson, 40 minutes

Materials and Prep

- Nano-biobot Challenge
- Tinkering and building materials in Drish
- Nano-biobot designs
- laptops
- GMO article:
<http://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732>

Start

- 5 minutes to prep for presentation

Do

1. Each group presents nano-biobot designs.
 - a. time after each presentation for Q&A

Homework

- Read about GMOs

Lesson 14 - Are nano biobots alive?

Overview

After what students have learned about Life/Protozoa and nano-biobots they engage in a final presentation/debate on what is alive.

Essential Questions & Enduring Understandings

1. What dictates what is alive? Are humans capable of creating synthetic life?

Time = 1 Lesson, 40 minutes

Materials and Prep

- Nano-biobot designs

Start

- Pose question “Is your nano-biobot design alive?” Have students write down answers.

Do

1. Separate class into 2 groups: “Nano-biobots are alive” and “Nano-biobots are not alive”.
2. Give groups 15 minutes to prepare arguments.
3. Debate for 15 minutes!
4. Final reflections on unit.
 - a. Some scientists are working on genetically modified organisms (GMOs). They think that they can alter living things we use as food to make them healthier. Some people are worried that these GMOs will be dangerous. What do you think?
 - b. Should humans tinker with living things?