Life Science – General Biology
Kidneys! Need 'em or not?

Disciplinary Core Ideas

LS1.A: Structure and Function

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
- Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)
- Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

Science & Engineering Practices

- Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
- Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)

Analyzing and Interpreting Data

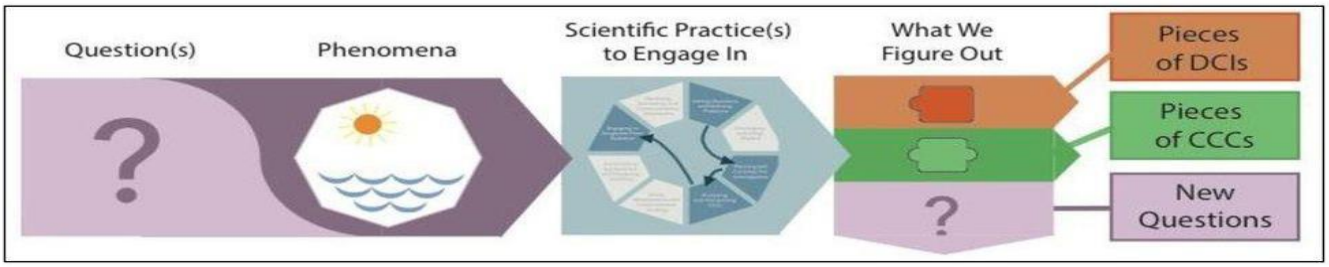
Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3)

Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

- Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)
- Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations

- Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. · Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
- Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.
- Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).



Questions	Phenomena	Science & Engineering Practices	Activity	Learning Targets/ Figuring out
#1 **Kidneys, Need 'em or not?**	Selena Gomez Kidney Story – video https://www.youtube.com/watch?v=3HaqZjj0qvY and/or Diary of a Dialysis Kid-video Diary of a Dialysis Kid - Medium.m4v	**Asking Questions & Defining Problems**	Students watch one or two videos and ponder what they know and wonder about kidneys and their importance. Students record their questions and wonderings on post-it notes to develop a **Driving Question Board**. Students in small groups create initial models of how kidneys function in the body. Use a diamond pattern on whiteboard to encourage all students to draw their model before developing a small group model where they can agree.	Students raise questions and wonderings about the importance of kidneys in humans. They may use the term homeostasis and should be coached to develop a working definition for the class. Look for student ideas around interactions with other systems: circulatory, nervous, respiratory, immune systems, etc. Encourage them to define interactions and functions as deeply as possible. This will help them in the culminating argument challenge. Students work in small groups to create an initial model that describes their understanding of the role and functioning of kidneys (formative assessment opportunity for teachers to learn what students already know or think they know). · Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) · Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2) · Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range

#2 **How do kidneys work?**	**Going deeper into the role of kidneys and semipermeable membranes.** **Option 1:** Start with osmosis activity using a semipermeable membrane (dialysis tubing), then a classroom or a web-based simulation. Then use https://eaglesoftworks.github.io/Diffusion/ to encourage students testing out a simulation. **OR Option 2:** Reverse the process to begin with a simulation and then the lab activity.	**Asking Questions & Defining Problems** **Developing & Using Models** **Revising Models** **Explanation** **Argument with Evidence**	Students work in teams to test out 2 different scenarios and use additional resources (text, YouTube Videos, or teacher-directed descriptions) to figure out how kidneys filter the blood. Remote access to dialysis tubing might be difficult; this video can help Small groups improve their models of the kidney as part of multiple body systems. How does the kidney works in the body and why it is so critical in maintaining homeostasis? *Additional activities around kidney functioning can br found online. Here is the original resource for the dialysis lab activity. Be aware that too much information can muddy the flow of understanding, and consulting the NGSS grade area standards helps to reduce vocabulary as well as unnecessary concepts.	Students refine their understanding of how kidneys work in maintaining body functioning or homeostasis (big picture understanding; not little parts). The teacher should orchestrate a public viewing of the adjusted models accomplished by the small groups (Gallery Walk). Then use the ideas from the smaller groups to help build a class **consensus model** about how kidneys work to maintain the body. Building a consensus model should always include ideas with explicit evidence, which is a perfect opportunity to advance students' listening and communication skills. Please visit the **Productive Talk resources**. The teacher introduces the **Summary Table** as a record of learning experiences and the questions answered as well as new ones that come up. We find that students engage in more emotional and ethical concerns about organ loss and access to treatment or transplants. **Assessment:** *Why is a urine sample required for an annual physical to judge your health?*

#3 **Are trans-plants the best solution?** **Why not get a new kidney?** **Students can be asked to consider** **"What is currently available to patients who have failing kidneys?"**	**Initial Video: Meet Blake: https://serpmedia.org/scigen/l6.6a.html** **Sample web-accessible resources for students to peruse and cite. There are hundreds, so encourage** **Waitlists & Transplants** **https://www.kidney.org/atoz/content/transplant-waitlist** **https://www.kidney.org/atoz/content/Antibodies-and-Transplantation** **•Concerns with rejection immunosuppressants** **https://www.kidney.org/atoz/content/immuno** **https://transplantliving.org/after-the-transplant/preventing-rejection/side-effects/** **https://kidshealth.org/en/teens/kidney-transplant.html** **https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/life-sciences-learning-center/documents/TEACHERRejection7-23-09.pdf**	**Asking Questions & Defining Problems** **Revising Models as Solutions to Kidney loss.** **Defining Problems** **Analyzing & Interpreting Data**	The "Meet Blake" video provides another look at a successful transplant. The student question asks, "Is a transplant better than dialysis?" Students can be asked to vote publicly on whether they think transplants are better than a mechanical device performing organ functions. Students research and use evidence to support their view. Students can work in teams during a class or individually as a homework assignment. They can use the suggested resources and research additional or more current articles. This opens their world to additional organs, needs, and human body systems. These videos and the short article could be used in a class jigsaw where different groups see different pieces and extract the new learning from them to report to others or partially as an assignment. Then as an assignment or exit card, ask students, "If you were experiencing kidney disease, what would you consider as a course of action and what additional issues or questions would you have?"	Considering the possibilities of solving kidney loss? These videos help to frame the dilemma of kidney loss. At the same time, the short article on Mini-Kidneys offers hope for the treatment of kidney disease and the potential for the regeneration of organs. From the homework create a table to discuss the issues and questions, perhaps as an Organ Solutions list with specific evidence gleaned so far as to the pros & cons. Additional ARMI BioFab & NGSS Practices videos: ● X-Therma - Problem Solving *Additional videos available at YouTube Channel BioFab – NGSS

#4 **Why can't we just make our own new organs?**	**National Geographic** documentary: How to Make a Heart Beat. Intro: 3:28 mins. Full Episode 11: National Geographic explores the latest science that may be on the verge of producing a limitless supply of replacement body parts. What is Regenerative Medicine? Replacing failing organs! Personalized Cellular Therapies – video of different types of stem cells from conception to adult Introduction to Regenerative Medicine How cells become specialized! Tissue Regeneration in Animals Scientists Successfully Grow a Full-Sized Beating Heart Using Stem Cells	**Asking Questions & Defining Problems**	Personalized medicine is growing by leaps and bounds. The ability of researchers to understand the characteristics of a condition and then use that understanding to design treatments has grown significantly. Personalized cellular therapies are in the process now! Many believe we are in "The Biology Century" where incredible solutions to long-experienced illnesses and diseases will take place. This lesson moves students to consider regenerative medicine as the wave of the future! Pig Kidneys Transplanted to Human in Milestone Experiment: Experts predict that "xenotransplants" may become a viable option within the next decade	STEM cells play a very specific role in regenerative medicine. Here lies the ability to go deeper into an understanding of STEM cells. Additional ARMI BioFab & NGSS Practice videos: ● RPT - Argument with Evidence In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. **Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)** Cutting-edge science - what is possible at this time? Keep in mind that new developments are taking place every day. This short (6:38 min) video presents a basic story about the advancement from the use of embryonic stem cells to the use of adult stem cells for regenerative medicine and research. Additional ARMI BioFab & NGSS Practice videos: ● DEKA - Communication ● Cellink - Explanation Have students consider "Are kidneys the only organs important to life?" in preparation for going beyond kidneys?

#5 **The Challenge** **If you had $100 million to advance regenerative medicine, which organ research area would you invest in and why?**	In small groups, students use data and their understanding of various organs, systems, and homeostasis to advance an argument for research around a particular organ. Student teams might randomly select an organ (heart, liver, kidney, lung, etc.) to make a pitch, or better, use student interests to organize teams around specific organs. **Potential Resources:** U.S. Dept of Health & Human Services - Organ Procurement and Transplantation Network This is a type of engineering challenge, as students are asked to prepare their arguments optimizing benefits and considering risks. You can use questions and wonderings from the Driving Question Board or Summary Table to help students take a deep dive into organ needs, viability, research progress, ethics, accessibility, and economics.	**Argument from Evidence** **Explanation** **Data Analysis & Computation** **Communication**	Sophomore level "Gen Biology" students are learning to drive (asked to become organ donors), learning to write persuasively (ELA), and this project will engage them in many ways. Student teams prepare arguments (pitch - persuasive writing) and use their accumulated background knowledge of organ growth/repair/need to develop an argument and make a case for the monies to be directed to their area of concern. Push for both quantitative and qualitative arguments! Student teams debate most viable options for research investment. Present their arguments to the class for class decision.	Students learn about multiple organs, areas of research, and to prepare arguments considering the science and the socio-ethical-economic decisions to be made. As possible, push for statistical analyses and offer a variety of media for the public (class) presentations. If time allows students can debate the importance of the research for particular organs. For example, "Are kidneys more important than hearts? Why?" **SEP:** **· Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.** **· Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.** **· Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.** **· Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.** **· Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).**

Assessment Which organ is most needed for the research to advance?	Reviewing the Summary Table and learning from the arguments presented by the other teams, individual students choose the organ they believe is most deserving and communicate that with explicit evidence as to why that organ's research should be supported.	**Argument with Evidence**	A final summary review reflecting back on the question "Kidneys, Need 'em or Not?" and questions that still need to be answered (science continues).	Reflection on learning can take many forms, but using a Summary Table to organize learning benefits students and teachers. Teachers may contemplate changes in how they used this storyline and involve new resources discovered by students and/or adjust the order of the lessons.

*Please note that every day, new videos and research info are broadcast on the web. Involving students in the search for current information that is valid, is an important 21st century skill they will need. As a facilitator of learning, you might make suggestions, but promoting active student research for cutting edge developments empowers students in their learning!

Be sure to check out the Example Summary Chart, the Employable Skills aligned with the Science and Engineering Practices, and the STEM Teaching Tools!

Here's an overview of the BioFab project your students might find interesting:

Introduction and Overview of BioFabUSA