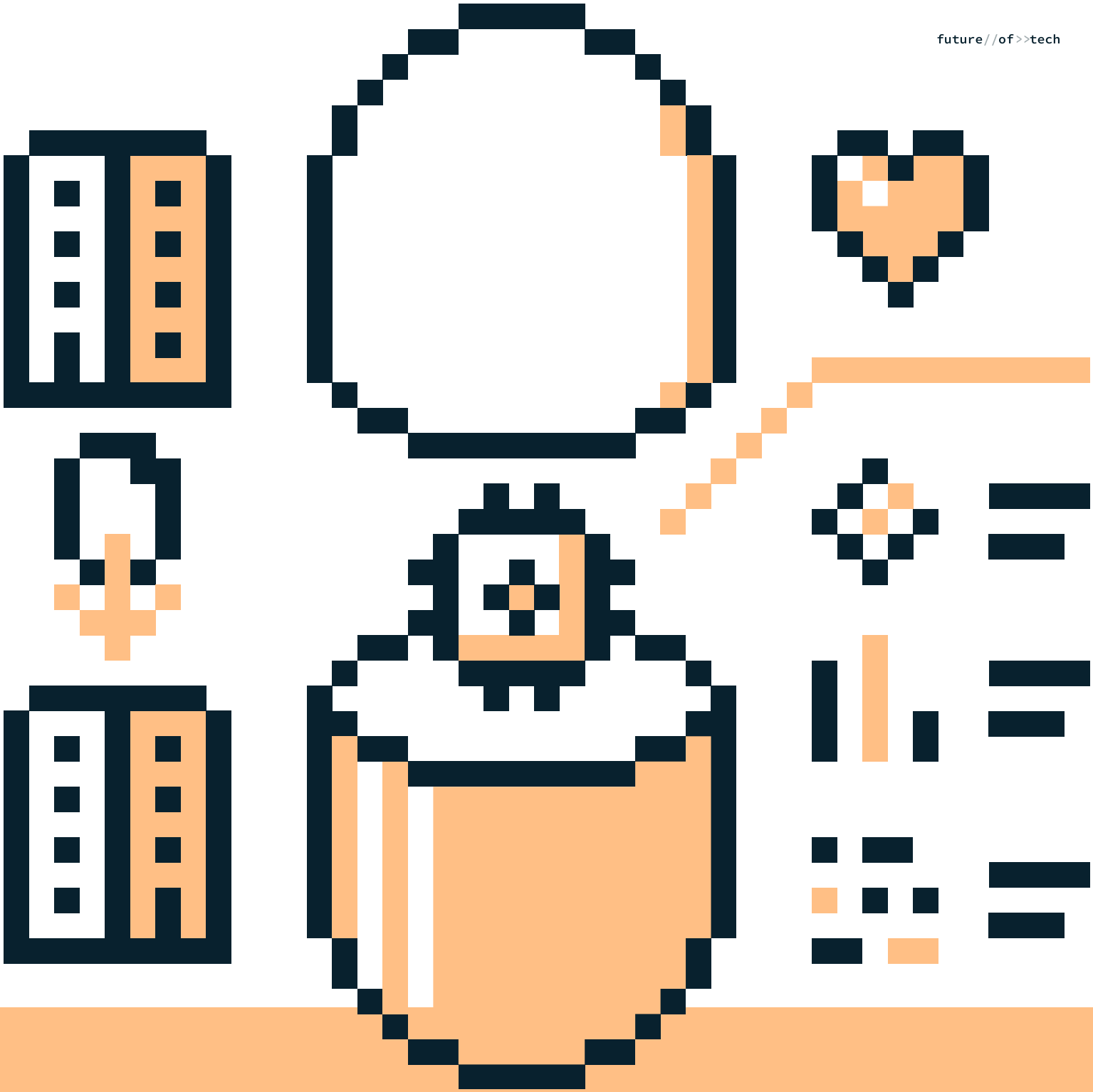

Lesson Plan >

DIGITAL HEALTH

SNAPSHOT:

Tiny bots in our arteries. Virtual visits to the doctor. Profiling diseases. Precision medicines to address genetic defects. Such seemingly futuristic applications represent currently emerging technologies in the medical field. This lesson will introduce the students to these health innovations and more through various interactives and simulations. Digital health is here and its impacts will drastically change our way of life and communities.

STUDENT LEARNING OBJECTIVES: **Students will be able to:**

- Define digital health, precision medicine, mHealth and telemedicine.
- Explain nanotechnology and its impact on digital health.
- Assess the challenges and concerns with digital health.

SYNOPSIS:

Teacher Input	(5 minutes)
Interactive - Reshaping the Home: Telemedicine Design Challenge	(25 minutes)
Teacher Input	(10 minutes)
Wrap Up	(5 minutes)
Assessment	

TEACHER'S GUIDE:

MATERIALS:

- KWL Worksheet
- The Future of Precision Medicine is Bionic: Part Human, Part Machine.
- Reshaping the Home: Telemedicine Design Challenge
- Digital Health Assessment
- Digital Health Assessment Answer Key
- Internet Access
- Graph Paper
- Optional: Google Sketch-Up or a CAD program

You'll want to refer often to the Future of Tech Website: **futureoftech.org**

To receive the answer key to the assessment, please email Eric Larson at elarson@comptia.org

TEACHER INPUT:

- [For middle school students] In the movie Big Hero 6, Bayamax is a robot who is a personal care assistant. Ask the students, "Do you think robots like Bayamax will ever be a reality?" Discuss their responses. Ask the students to consider our smartphones and the health information that they collect. As technology progresses, could these devices evolve into smaller versions of Bayamax? Discuss the possibilities.

Or

- [For secondary students] Share the following information with the students:

  Despite an exponential increase in scientific knowledge, healthcare costs are rising at an unsustainable rate. The United States spends more than any other country – over $3 trillion a year – on health care. For example, Americans live shorter lives than the citizens living in 30 other countries, according to the World Health Organization. Many experts believe that in order to solve the current healthcare crisis, medicine needs to become smarter. It needs to harness advances in technology to catch and treat diseases faster than ever, to place the power of health care more squarely in the hands of the consumer, and to grant greater access to everyone, not just those located close to major academic hospitals.

  Ask the students to brainstorm ways that the United States can help address the healthcare crisis through technology.

Distribute the KWL Worksheet. Have the students to complete the first column and write down what they know about digital health. Ask the students what comes to their mind when they think about digital health. Record their responses on the board. Have the students complete the second column of the KWL Worksheet - "What do you want to learn about digital health?" Allow the students to share what they want to learn about digital health. Tell the students that today's lesson will focus on real world applications of digital health and how it will impact our lives and communities. Below is some background information for the teacher to share with the students.

Digital health is defined as the use of high-tech tools to tailor more precise and economical care to individual patients.

Three of the hottest topics in digital health are precision medicine, mHealth and telemedicine.

- *Precision medicine, also known as personalized medicine or individualized medicine, is the tailoring of treatments to an individual's genes, environment, and lifestyle.*
- *mHealth, or mobile health, refers to the use of smartphones, fitness bands, and other wireless technology in medical care.*
- *Telemedicine is the use of telecommunication and information technology to provide clinical care from a distance.*

Each of these areas is revolutionizing the medical industry in ways that are hard to comprehend. Today we will investigate these areas as we work to determine their impacts on our lives and communities.

Ask the students to provide examples of how various medical technologies have helped them or someone they know. Use the following as a resource to start the conversation: The Future of Precision Medicine is Bionic: Part Human, Part Machine.

Discuss the impacts. Be sure to have the students consider what life would be like without these advances in medical technology. Below is information for the teacher to share with the students during the discussion:

Emerging medical technologies that we will be investigating can be broken down into simple machines used to solve complex problems.

Mobile health, or **mHealth**, involves monitoring a patient's health through wireless technology, sensors and algorithms. Similar to our weather apps, we can now monitor heart rates, steps, sleep, menstrual cycles, glucose levels, pain levels, blood pressure from anywhere and at anytime.

Precision Medicine (Personalized Medicine): Similar to creating your own playlist on Spotify, personalized medicine allows doctors and health professionals to tailor treatments to an individual's genes, environment, and lifestyle. According to Jackson Laboratory, precision medicine is beginning to overcome the limitations of traditional medicine. Increasingly it is allowing health care providers to:

- shift the emphasis in medicine from reaction to prevention
- predict susceptibility to disease
- improve disease detection
- preempt disease progression
- customize disease-prevention strategies
- prescribe more effective drugs
- avoid prescribing drugs with predictable side effects
- reduce the time, cost, and failure rate of pharmaceutical clinical trials
- eliminate trial-and-error inefficiencies that inflate health care costs and undermine patient care.

Finally, **telemedicine** enables doctors and health care professionals to provide health care remotely.

INTERACTIVE:

Divide the students into groups of four. Distribute the Interactive: Reshaping the Home: Telemedicine Design Challenge. Go over the challenge with the students. Direct the students to online resources that explain Alzheimer's Disease and ADA requirements. Allow time for the students to complete the challenge. Have each group present their solution to the class.

Encourage the students to evaluate their designs and consider how homes might change in the future as our population ages.

TEACHER INPUT:

If time permits or in a follow-up lesson, divide the students into pairs. Utilizing the Future of Tech website, ask each group to identify five interesting insights related to one of the following categories under the digital health learning unit:

- The Future Is Smart - What is Digital Health?
- Digital Health - What is Digital Health?
- Our DNA, Ourselves - Digital Health And Us
- Answers In Algorithms - Digital Health And Technology
- Rise Of The (Tiny) Machines - Digital Health And Technology
- Medicine On The Move - Digital Health And Technology
- The Computer Will See You Now - Digital Health And Technology
- The Grand Paradox - Challenges And Concerns
- A Moral Dilemma - Challenges And Concerns

Have the students record their insights on the Digital Health: Interesting Insights worksheet and share their insights with the class.

WRAP-UP:

According to Steve Krupa, CEO, HealthEdge Software Group, "Health care probably stands out as one of the great issues in our society from an access point of view, from a cost point of view, from an efficiency point of view, from a waste point of view. And if you think about technology as simply being able to do more with less, health care is a great place to apply those skills." Ask students to reflect on this statement and consider how advances in digital health will impact their lives and/or healthcare in the next five years.

ASSESSMENT:

Have the students complete column 3 on their KWL Worksheet –
What did they learn about digital health?

EXTENDED LEARNING OPPORTUNITIES:

- Arduino Project Ideas
- Arm Surgery
- Solve the Outbreak
- DNA Day Activities from the National Human Genome Research Institute
- Prosthetic Party:Build and Test Replacement Legs
- Lesson Plans from Personal Genetics Education Project
- At the Doctor's Office
- Virtual Labs - Gel Electrophoresis

WEBSITE RESOURCES:

Precision Medicine - This video introduces individuals to precision medicine in simple and easy to understand terms.
The Future of Medicine by Cambridge University - This video provides an introduction to nanobots.
"The Future of Medicine" by National Geographic - This video provides an overview of the future of medicine.
The Center for Disease Control provides an overview of precision medicine.
The Precision Medicine Initiative Cohort Program

STANDARDS ALIGNMENT:

CSTA K-12 Computer Science Standards (2017)

- 1A-IC-16 Compare how people live and work before and after the implementation or adoption of new computing technology.
- 1B-NI-04 Model how information is broken down into smaller pieces, transmitted as packets through multiple devices over networks and the Internet, and reassembled at the destination.
- 1B-IC-18 Discuss computing technologies that have changed the world, and express how those technologies influence, and are influenced by, cultural practices.
- 1B-IC-20 Seek diverse perspectives for the purpose of improving computational artifacts.
- 2-IC-20 Compare tradeoffs associated with computing technologies that affect people's everyday activities and career options.
- 2-IC-23 Describe tradeoffs between allowing information to be public and keeping information private and secure.
- 3A-CS-01 Explain how abstractions hide the underlying implementation details of computing systems embedded in everyday objects.
- 3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers.
- 3A-NI-04 Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.
- 3A-IC-24 Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
- 3B-IC-26 Evaluate the impact of equity, access, and influence on the distribution of computing resources in a global society.
- 3B-IC-27 Predict how computational innovations that have revolutionized aspects of our culture might evolve.

Next Generation Science Standards

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. (Addressed through Extended Learning Opportunities)

K-W-L CHART

WHAT I KNOW OR THINK I KNOW ABOUT DIGITAL HEALTH

WHAT I WANT TO LEARN ABOUT DIGITAL HEALTH

WHAT I LEARNED ABOUT DIGITAL HEALTH

The Future of Precision Medicine is Bionic
Part Human, Part Machine

Technology has become such a big part of our lives that it seems as if we are perpetually connected to our smart phones and wearable devices. But for some people, that connection is very real. Millions of Americans have already had various medical devices hardwired into their bodies. These implantable medical devices can regulate their heartbeat, enhance their vision and hearing, stimulate their nervous system, and help them walk after being paralyzed. Here are just a few of the ways that humans are going bionic, from routine procedures to the stuff of science fiction:

- **Preventing heart failure:** Countless lives have been saved since the first plate-sized pacemaker -- a device that manages irregular heartbeats -- was implanted into a patient in 1958. Today, pacemakers have shrunk to about the size of a tic-tac, and can be inserted directly into the heart.

- **Treating seizures:** Scientists have designed a small, battery-powered device called a neurostimulator that can be implanted in the skull of epilepsy patients. Like a cardiac pacemaker, this device detects abnormal brain waves that could lead to a seizure and delivers a small amount of current that could shorten the seizure or prevent it altogether.

- **Restoring sight:** Hundreds of blind patients have received a set of bionic eyes, or what doctors call a retinal prosthesis system. The system consists of a pair of glasses outfitted with a camera that can transmit signals to a microchip implanted in the eye. It doesn't completely restore sight, but it does helps patient distinguish light from dark and make sense of the outlines and shapes of people and objects.

- **Helping the paralyzed:** The FDA recently granted approval to a motorized exoskeleton that is designed to help people who have suffered from spinal cord injuries walk again. The robotic suit was created by the Japanese company Cyberdyne, which ominously derived its name from the ill-fated company in the Terminator movie series.

- **Creating organs and limbs:** The convergence of stem cell biology and 3D printing could make it possible for scientists to build body parts from scratch to replace damaged organs or lost limbs. These "bioprinters" use human cells as ink to create functioning human organs stable withstand transplantation.

reshaping the home: telemedicine design challenge

Background Information

The next step in the evolution of the telemedicine movement is the development of smart medical homes, residences wired with devices that can monitor vital signs, detect accidents or injury, and screen fluids for signs of disease.

According to market research firm Frost and Sullivan, there will be 20 to 30 million connected medical devices by the year 2020. These devices could include sensors placed beneath floorboards that measure changes in gait and report back to the doctor if an elderly patient has had a fall. Computer screens projected behind mirrors could post reminders of doctor's appointments or of medication schedules. Refrigerators could track food intake or suggest healthier choices. Sinks and toilets could gather and analyze samples for biomarkers characteristic of colorectal cancer or other common conditions. As so many devices are seamlessly integrated into our living spaces, the hospital of the future could soon be your very own address.

Design Challenge

Your team has been contracted to design a safe living space for an elderly individual who suffers from Alzheimer's Disease.

Specifications

- The living space will include a sitting area with a small eating area, sleeping space and bathroom. The living space should be handicap accessible.
- The living space should be no more than 1000 square feet.
- The living space should incorporate appropriate smart devices for the individual to assist in their daily living and the management of their illness.
- The living space should also be able to accommodate the individual's primary caregiver.

Criteria:

- Provide a list of smart devices to incorporate in each area and explain why they should be used.
- Determine the dimensions and location of each area within the defined space.
- Using graph paper or a 3D modeling software, create a sketch of the living space.
- Present your solution to the class.

Evaluation Rubric	Does Not Meet Expectation	Meets Expectations	Exceeds Expectations
Design	The living space does not address the elements mentioned in the specifications and/or is not functional.	The living space addresses all of the elements mentioned in the specifications and is functional.	The living space creatively addresses all of the elements mentioned in the specifications and creates an environment that is appealing to the client.
Incorporating Smart Devices	The living space minimally addresses smart devices that will assist the individual, primary caregiver and/or physician. The living space does not address safety.	The living space efficiently incorporates the necessary smart devices that will assist the individual, primary caregiver and/or physician. The design of the living space ensures safety.	The living space creatively incorporates various smart devices that will assist the individual, primary caregiver and physician. The design of the living space ensures safety.
Presentation	The presentation is unorganized. The team minimally addresses or fails to address the areas outlined in the specifications.	The team effectively communicates their design and integration of smart devices in the living space. The team explains how the smart devices will assist the individual, the primary caregiver and/or physician.	The team creatively communicates their design, flow, and function of smart devices in the living space. The team explains how the various smart devices will improve the quality of life for the individual and primary caregiver. The team also explains how the data collected will assist the physician as the illness processes.
Participation in the Team	Members worked in silos and did not contribute to one or more elements outlined in the specifications.	All members contributed to the design, integration of smart devices and the presentation.	Members contributed to the design, integration of smart devices and the presentation in a way that allowed the audience to understand their proposed solution and access its viability.

digital health assessment >

Name: _____

Select the best response.

1. This harnesses the power of genomics, artificial intelligence, cloud computing, the internet of things, sensors, bionics, nanotechnology, and big data to understand and improve the human condition in ways that we could have never imagined.

a. Digital Health
b. Telemedicine
c. Human Genome Project
d. Genetic Engineering

2. This technology enables scientists to edit human DNA – completely rewriting the genetic code to erase any traces of disease.

a. CRISPR
b. Watson
c. Human Genome Project
d. Telemedicine

3. True or False. The FDA recently approved the first smart pill which is a combination of a drug and a small silicon chip that activates it upon coming into contact with stomach acid. As soon as the pill hits the patient's stomach, a signal gets sent to a smartphone app, where it can be viewed by the patient or sent to the healthcare provider.

Match the following.

___ 4. Precision Medicine
___ 5. mHealth
___ 6. Telemedicine

A. the use of smartphones, fitness bands, and other wireless technology in medical care
B. the use of telecommunication and information technology to provide clinical care from a distance
C. the tailoring of treatments to an individual's genes, environment, and lifestyle

7. Describe why you would or would not want to visit your doctor online

8. Describe two medical procedures that doctors can do through telemedicine.

9. Describe two features that you will find in Smart Medical Homes of the future.

10. Describe two of the privacy concerns and challenges associated with smart medical devices.

11. Describe two of the moral concerns and challenges associated with smart medical devices.

12. List three ways in which nanotechnologies will be able to help the medical field in the future.