



Lesson & Question	Student Activities and Key Resources	Vocabulary	Biology Objectives- Evolution, Genetics, Ecology NGSS - PEs, DCIs, SEPs, & CCCs	Notes
1. What does “sustainable food production” mean?	<p><b>Students build Driving Question Board</b></p> <p>Post-discussion website/video  <a href="https://www.fao.org/sustainability/en/">https://www.fao.org/sustainability/en/</a>            Sustainable Food and Agriculture: fao.org/sustainability/en/            or  <a href="https://www.ecoandbeyond.co/articles/food-sustainability/">https://www.ecoandbeyond.co/articles/food-sustainability/</a>            Eco &amp; Beyond: What does food sustainability really mean?</p>	Sustainable food production	<p>Asking questions (for science) and defining problems (for engineering)</p> <p>Developing and using models</p>	FOUNDATION – Students think about what ‘sustainability’ means to them and how the concept applies to the world’s food supply.
2. How can technology make food production more sustainable?	<p><b>Introduction video and discussion: Hydroponic tomatoes</b></p> <p><a href="https://www.youtube.com/watch?v=bRyBKWqLzI8">https://www.youtube.com/watch?v=bRyBKWqLzI8</a>            The Future of Farming: Hydroponic Tomatoes (4:39)            KCET SoCal Connected            or  <a href="https://www.youtube.com/watch?v=5cIOYWsNhhk">https://www.youtube.com/watch?v=5cIOYWsNhhk</a>            Farmers on the Netherlands are Growing More Food Using Less Resources (2:53)            Pioneers for Our Planet   World Economic Forum            _____  <a href="https://fb.watch/v/asi1NQSfW/">https://fb.watch/v/asi1NQSfW/</a>            TikTok video of vine crops at American Hydroponics (0:26)</p>	Hydroponics	<p>Asking questions (for science) and defining problems (for engineering)</p> <p>CCCs, Science is a Human Endeavor: Technological advances have influenced the progress of science and science has influenced advances</p>	FOUNDATION – Introduce students to hydroponics and other technologies associated with food production. Relating technology to sustainable food production includes discussion of potential to reduce water use

			<p>in technology. (HS-LS3-3</p> <p><b>HS-ESS3-3</b> Earth and Human Activity, Illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.</p>	<p>and increase yield, but downsides (such as increased energy consumption) may be brought up.</p>
<p>3. How might growing plants in a greenhouse or plant factory alter light, and thus plant growth?</p>	<p><b>Problemizing:</b> Have students brainstorm about how growing food in a greenhouse or plant factory could cause unintended problems. E.g power failure, disease problems, leak intumescence phenomenon (Why do some plants grown in a greenhouse or plant factory have abnormal growth?)</p> <p><b>Introduce intumescence phenomenon:</b> Show live intumescence tomato from back-of-the-classroom demonstration and/or <a href="#">[Examples of Intumescence .pptx]</a>.</p> <p>Why might intumescence occur on tomatoes in a glass or plastic-covered greenhouse (intumescent) or in a plant factory (intumescent), but not when they are grown outside in the field (normal)? This comparison allows narrowing of the problem to light source.</p> <p><b>Draw what you see.</b> What happened to the cells?</p>	<p>Intumescence</p> <p>Cell hypertrophy</p> <p>Cell proliferation</p>	<p><b>LS1.B</b> Growth and Development of Organisms, Complex organisms are composed of systems of tissues and organs that work together to meet the needs of the whole organism.</p> <p><b>LS3-3</b> Variation of traits, Environmental factors also affect expression of traits, and hence the probability of occurrences of traits in a population. Variation depends on both genetic and environmental factors.</p>	<p>Discussion of how light is not only an energy source, but also a signal to higher plants can build on other lessons <a href="#">[Lettuce Laments]</a>. When we modify the environment to manipulate plant growth, there may be unintended consequences such as intumescence.</p>

			CCCs, Cause and Effect, Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	
4. What is plant grafting and how might it be used to make food production more sustainable?	<p><a href="#">Towards sustainable food production: Tomato grafting</a></p> <p><a href="#">What is plant grafting? Why might it be desirable?</a></p> <p><a href="https://youtu.be/RGSp_xcGDO">https://youtu.be/RGSp_xcGDO</a></p> <p>Houweling's Tomatoes – The Story from Seed (4:00) provides overview of entire tomato production process; starting at 1:38, grafting is mentioned and shown as one of the 10 steps of propagation.</p> <p>This is the same business featured in “The Future of Farming: Hydroponic Tomatoes” in Lesson 2</p> <p>or</p> <p>Brief overview</p> <p><a href="https://www.youtube.com/watch?v=a6gCx9eRGU0">https://www.youtube.com/watch?v=a6gCx9eRGU0</a></p> <p>Tomato Grafting (3:02)</p> <p>Backyard Farmer, Josh Rezicek, University of Nebraska Extension</p> <p>Detailed commercial process:</p> <p><a href="https://www.youtube.com/watch?v=zhgsPkeZEBk">https://www.youtube.com/watch?v=zhgsPkeZEBk</a></p> <p>Tomato Grafting: The Process (7:00)</p> <p>K-State Research and Extension, Cary Rivard</p>	<p>Grafting</p> <p>Xylem</p> <p>Phloem</p> <p>Scion</p> <p>Rootstock</p> <p>Yield</p> <p>Disease resistance</p>	<p><b>LS1.A</b> Structure and Function, Systems of specialized cells within organisms help them perform the essential functions of life.</p> <p><b>LS1.B</b> Growth and Development of Organisms, Complex organisms are composed of systems of tissues and organs that work together to meet the needs of the whole organism.</p>	<p>Discussion about why grafting is desirable allows exploration of benefits from two different genotypes to make crop production more sustainable: drought resistance, pest/disease resistance, yield increase, shorter plant height to aid in automation or harvest</p>
5. What are examples of how other	<a href="#">Brainstorming in small groups: What are examples of how other organisms, besides plants, use or respond to UV</a>	Mutualism (bee example)	<b>LS4.B</b> Natural Selection, Traits that positively affect	All organisms on earth evolved under the light

<p>organisms, besides plants, use or respond to UV light?</p>	<p>light?</p> <p>Bees use UV sight to locate and pollinate flowers:  <a href="https://www.youtube.com/watch?v=N1TUDFCOWjY">https://www.youtube.com/watch?v=N1TUDFCOWjY</a>  How Bees Can See the Invisible. Its OK to be smart. (2:57)  PBS digitalstudios  or  How Bees See and Why It Matters:  <a href="https://www.beeculture.com/bees-see-matters/">https://www.beeculture.com/bees-see-matters/</a></p> <p>OR</p> <p>Reptiles bask in sun to absorb UV light, necessary for heat (food digestion, reproduction) and/or for their bodies to manufacture vitamin D3 required for proper calcium absorption from food  <a href="https://www.youtube.com/watch?v=8ojGfBGrwJg">https://www.youtube.com/watch?v=8ojGfBGrwJg</a>  Science at Chester Zoo Reptiles: UV Lights and Heat (6:23)  or  <a href="https://reptifiles.com/reptile-uvb-light-necessity/">https://reptifiles.com/reptile-uvb-light-necessity/</a>  Why All Pet Reptiles Need UVB Light (1:51)</p>	<p>Herpetology (reptile example)</p>	<p>survival are more likely to be reproduced, and thus are more common in the population.</p> <p><b>LS4.C</b> Adaptation, Evolution is a consequence of four factors</p> <p>CCCs, Patterns, Different patterns may be observed at each of the scales at which a system is studied</p>	<p>spectrum of the sun. An add-on lesson could focus on another organism’s reliance on or adaptation to UV light to help students make this connection.</p>
<p>6. Wrap up and review</p>	<p>Find out more: How do we solve the problem of feeding the planet’s growing population?</p> <p><a href="https://www.youtube.com/watch?v=jhVlxCTAEDE&amp;t=236s">https://www.youtube.com/watch?v=jhVlxCTAEDE&amp;t=236s</a>  Houwelings Hot House Future of Sustainable Agriculture (5:34)  Technology and engineering used by this operation for sustainable food production</p> <p>Discussion: High-tech and Small distributed farming are both options  <a href="https://www.youtube.com/watch?v=2MlrXExzenU">https://www.youtube.com/watch?v=2MlrXExzenU</a>  Visiting the Farm of the Future (High-tech vs. Small distributed)  VICE News</p>		<p>CCCs, Science is a Human Endeavor: Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3)</p> <p><b>HS-ESS3-3</b> Earth and Human Activity, Illustrate the relationships among</p>	<p>Wrap-up of this module provides an opportunity to engage students with ‘big questions’</p>

	<a href="https://www.youtube.com/watch?v=xFqecEtdGZ0">https://www.youtube.com/watch?v=xFqecEtdGZ0</a> Can We Create the Perfect Farm? TED-Ed, Brent Loken		the management of natural resources, the sustainability of human populations, and biodiversity.	
<p><b>NGSS:</b>          Asking questions (for science) and defining problems (for engineering); Developing and using models; Planning and carrying out investigations; Analyzing and interpreting data; Constructing explanations (for science) and designing solutions (for engineering); Engaging in argument from evidence; Obtaining, evaluating, and communicating information          Patterns; Cause and effect; Structure and function; Science is a Human Endeavor.          HS-ESS3-3, LS1.A, LS1.B, LS3-3, LS4.B, LS4.C</p>				