

**Discover the Interconnectedness of
Human Sustainability and Earth's ecosystems
with One Health!**
(One Health Lesson Plan for High School)

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Preparing Society to Create the World We Need through One Health Education

Lesson Plan Overview:

The concept of One Health for animals, humans and the environment is explained and taught through Case Studies that demonstrate how One Health fits and supports the Next Generation Science Standards. A teaching lesson set is provided. This material could be broken into many lectures or given as a one or two class overview of One Health and the interconnectedness of all life on earth.

Learning Objectives:

Three selected Next Generation Science Standards will be taught using One Health Case studies addressing food security, emerging vector-borne diseases, and food safety, each followed by a set of discussion questions. *At the end students will be able to:*

NGSS Standard HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

One Health Case Study #1: Class Debate: Human and Plant Health and Climate Change – Can Hummus Save Civilization?

Learning Objectives

- Students will be able to evaluate content from web sources to develop evidence-based arguments.
- Students will be able to evaluate alternative technological solutions to mitigate climate change.

NGSS Standard HS-LS2-7: Design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

One Health Case Study #2: Human, Animal, and Ecosystem Health – Why are Lyme Disease Rate so High in some state?

Learning Objectives

- Students will be able to use data to understand the relationship between biodiversity, habitat size, and disease risk.

- Students will be able to apply information about the ecology of Lyme disease to design strategies to reduce human disease risk

NGSS Standards 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.

One Health Case Study #3: Human, Animal, and Ecosystem Health – Why is Food Making us Sick?

Learning Objectives

- Students will understand the difference between food safety and food security.
- Students will be able to use data to understand the risk of foodborne illness.
- Students will be able to create strategies to combat foodborne illness and improve food safety.

Other trans-disciplines like One Health and Additional Resources:

Ecology of Health (EcoHealth)

<http://ecohealth.net/en/>

<https://www.ecohealthalliance.org/>

Conservation Medicine

<http://vet.tufts.edu/center-for-conservation-medicine/>

<https://www.stlzoo.org/conservation/institute-for-conservation-medicine/>

Geological Health (GeoHealth)

<https://liemohnjgrspace.wordpress.com/2016/12/02/agus-new-journal-geohealth/>

<https://geohealth.hhs.gov/arcgis/home/>

Planetary Health

<https://www.rockefellerfoundation.org/our-work/initiatives/planetary-health/>

<https://planetaryhealthalliance.org/>

<http://www.thelancet.com/infographics/what-is-planetary-health>

Additional References

Can we remain food secure amid climate change, Kahn, L, Bulletin of the Atomic Scientist, Sept 12, 2016, <https://thebulletin.org/2016/09/can-we-remain-food-secure-amid-climate-change/>

Harnessing plants for the future, Salk Institute Plants Initiative, 2017

<https://www.salk.edu/wp-content/uploads/2017/11/Harnessing-Plants.pdf>

(continued)

Answers to One Health Case Studies 2-3 Questions

Case Study #2 Why are Lyme Disease Rates So High In Some States?

Q1: The nymph stage is most dangerous to humans.

Q2: This stage is about the size of a poppy seed and can be easily unnoticed for days unlike the larger adult ticks.

Q3: According to CDC website, in 2015, 95% of confirmed Lyme disease cases were reported from 14 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, Wisconsin.

Q4: The maps show that Lyme disease cases have been increasing from 2012 to 2016.

Q5: Possible explanations include increasing white-footed mice populations and infected tick populations.

Q6: June and July have the highest number of reported Lyme disease cases.

Q7: Nymphs are most active during these months.

Q8: Short-tailed shrew

Q9: Skunk

Q10: White-footed mouse

Q11: Raccoon

Q12: Yes. As the number of host species decreases, the percentage of infected nymphs increases.

Q13: A more biodiverse ecosystem (with racoons, skunk, opossums, and deer) reduces the likelihood of nymphs becoming infected with the Lyme disease bacteria.

Q14: The smaller the forest patch area, the higher the density of infected nymphs.

Q15: White-footed mice, which are the host species most likely to infect nymphs, increase in population density in fragmented forests with low biodiversity.

Q16: The states with the highest Lyme disease rates likely have many small, fragmented forests with low biodiversity and high population densities of white-footed mice. This increases the risk of infected ticks spreading Lyme disease to humans and dogs.

Q17: States with high Lyme disease prevalence might want to increase forest size, increase biodiversity, increase natural predators of mice such as owls and other birds of prey in high risk areas.

Case Study #3 Why is Food Making Us Sick?

Q1 to Q3: Answers are on the chart

Q4: Better surveillance and more research on foodborne diseases

Q5: Norovirus, nontyphoidal Salmonella, Clostridium perfringens, Campylobacter species, Staphylococcus aureus

Q6: Nontyphoidal Salmonella, Norovirus, Campylobacter, Toxoplasma gondii, E.coli (STEC) O157

Q7: Nontyphoidal Salmonella, Toxoplasma gondii, Listeria monocytogenes, Norovirus, Campylobacter species

Q8: Nontyphoidal Salmonella

Q9: Nontyphoidal Salmonella is a zoonotic pathogen, meaning that it comes from animal feces. Raw foods such as eggs, poultry, or meat can be contaminated with Salmonella.

Q10: Wash hands after handling raw meat or eggs. Cook food well.

<https://www.cdc.gov/salmonella/general/prevention.html> Wash hands after touching pets or cleaning their cages or feces.

Q11: Fish, Dairy, Chicken, Beef & Mollusks.

Q12: They are all animal products.

Q13: India. Almost 600 million people openly defecate in India.

Q14: 97% of total mammalian biomass

Q15: Population data for chickens, pigs, and cattle obtained from UN Food and Agriculture Organization, FAOSTAT

<http://www.fao.org/faostat/en/?#data>

	Chickens	Pigs	Cattle	Humans
2016 global population	22.7 X 10 ⁹	98 X 10 ⁷	1.5 X 10 ⁹	7.5 X 10 ⁹
Average Manure per Day (lbs)	70.3	63.1	70.0	0.28
Total Manure per Day (lbs)	1.6 X 10 ¹²	6.2 X 10 ¹⁰	1.1 X 10 ¹¹	2.1 X 10 ⁹
Total Manure per Year (lbs)	5.8 X 10 ¹⁴	22.6 X 10 ¹²	38.3 X 10 ¹²	7.7 X 10 ¹¹
Grand Total Manure Produced Per Year (lbs)	6.4 X 10 ¹⁴			
Grand Total Manure Produced (Tons)	3.2 X 10 ¹¹			

For teacher reference purposes only! References used to calculate the 2nd row numbers, average manure/day in lbs.

References for Average Manure per Day: *Units: lbs./day/1000-lb animal unit (Chicken manure output is averaged between layers (60.5) and broilers (80.0)); (Cattle manure output is averaged between beef (59.1) and dairy (80.0))*

**USDA Natural Resources Conservation Service Animal Manure Management.*

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/?cid=nrcs143_014211

***Wrick KL, Robertson JB, Van Soest PJ, et al. The Influence of Dietary Fiber Source on Human Intestinal Transit and Stool Output. The Journal of Nutrition. 1983; 113: 1464-1479. Table 5. Total human feces per day averaged between weekly fecal output of coarse bran or cellulose diet divided by 7. <http://www.ncbi.nlm.nih.gov/pubmed/6308191>*

Q16: Human waste is transported through underground pipes to sewage treatment plants. In some countries, people use latrines.

Q17: There are many websites that describe the process. Here is one:

<https://www.forbes.com/sites/lauriewinkless/2016/10/18/what-happens-when-you-flush-the-secrets-of-sewage/#5f5d088c2ed4> Poor countries need to ensure clean water. There are a number of organizations dedicated to providing clean water to poor countries. Here is one: https://thewaterproject.org/about_us But these organizations do not absolve political leaders from working to make clean water and sanitation a priority in their countries.

Q18: Students should go on the Internet to find uses for manure. Here is one site:

<http://www.thedairysite.com/focus/5m/2311/beneficial-uses-of-manure-and-environmental-protection>

Q19: Crops can become contaminated through dirty water or animals or humans defecating in fields. Poor food handling practices and storage can facilitate contamination with pathogens. Meat products can become contaminated during the slaughter process. Chickens harbor microbes in their guts, potentially contaminating their eggs.

Q20: There is no single answer to this question. Certainly, no human should be openly defecating in the 21st century. All manure/sludge used as fertilizer must be treated to kill deadly pathogens before placed on agricultural fields. Improved sanitation and hygiene is essential to reducing foodborne illnesses.