**Measles Outbreak – To Vaccinate or Not?**

**Educational Standards**

1. Common Core
	1. Craft and Structure
		1. RST.9-10.4
		2. RST.11-12.4
		3. RST.11-12.5
	2. Integration of Knowledge and Ideas
		1. RST.9-10.7
		2. RST.11-12.7
		3. RST.11-12.8
		4. RST.11-12.9
2. Next Generation Science Standards
	1. Practices
		1. 4. Analyzing and interpreting data
		2. 6. Constructing explanations (for science)
	2. Crosscutting Concepts
		1. 1. Patterns
		2. 2. Cause and effect: Mechanism and explanation
		3. 4. Systems and system models
	3. Disciplinary Core Ideas
		1. LS4.B: Natural Selection
		2. LS4.C: Adaptation
		3. LS4.D: Biodiversity and Humans
3. Advanced Placement Biology - Essential Knowledge (EK), Learning Objectives (LO), Science Practices (SP)
	1. EK 4.A.5
		1. LO 4.11, SP 1.4, 4.1
		2. LO 4.13, SP 6.4

**Teaching Notes**

Each time the simulation is run, it yields different results regarding the communities that are protected versus those that are not. There are some key points that the students should take away from viewing this simulation and reading the accompanying article.

1. Only the populations with the highest percentage of vaccination are consistently protected from the measles infection.
2. Herd immunity is essential as it helps protect immune-compromised individuals (such as very young children, elderly individuals, individuals undergoing cancer treatment etc.) from getting sick.
3. Sometimes vaccinated individuals may not be protected (though this happens at a very low rate). To further reduce chances of vaccination failure, two doses of a vaccine may be administered after a suitable interval.
4. Learn more about vaccines in general and the measles vaccine specifically using resources listed in the curricular module at RCSB PDB.

**Key to “Protected or Not?”**

Based on the simulations at (<http://www.theguardian.com/society/ng-interactive/2015/feb/05/-sp-watch-how-measles-outbreak-spreads-when-kids-get-vaccinated>) the following answers were written. Note: the simulation results will vary; please make necessary adjustments to the responses reported by students.

1. 2 communities (out of 10) were protected
2. The percentage of vaccination in the protected communities was 90% and 99.7%
3. No, this time 5 (out of 10) communities were protected
4. Communities with higher percentages of vaccination were protected in the three trials of simulation. Note: sometimes the simulation may show that the 74.4% vax rate population is protected; yet the 83.8% and 86.0% vax rate communities are not.
5. Herd immunity is the protection that a community has against a disease based on the vaccination of most of its members – i.e. even without all individuals being vaccinated the entire community is protected against infection.
6. Vaccines protect the individual being vaccinated as well as other community members. The simulation illustrates this claim. Also in the accompanying text, a quotation from Dr. Elizabeth Edwards, professor of pediatrics and director of the Vanderbilt Vaccine Research Program, states the same.