DISCOVERING ONE HEALTH

LESSON SLIDE NOTES for ADULT STUDENTS

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Slide 1:
This lesson addresses:

United Nations Sustainable Development Goals: (these are addressed throughout the lesson but highlighted slides are listed)
Good Health and Well-being (slides 39-41)
Quality Education (slides 1-44)
Clean Water and Sanitation (slides 5-9)
Affordable and Clean Energy (slides 5-9- deforestation)
Sustainable Cities and Communities (slides 5-9- deforestation)
Responsible Consumption and Production (slides 5-9- deforestation)
Climate Action (slides 5-19)
Life on Land (slides 5-19)
Partnerships for the Goals (slides 41-43)

Overview:
Have you ever thought about how disease outbreaks start? Have you ever thought of explaining this to a child? With *Discovering One Health*, you will be able to effectively communicate complicated science-based phenomena to people without a science background.

Lesson Objectives:
1. Students will understand that the health of people is dependent on the health of animals and the environment (slides 3-19)
2. Students will understand the need for vaccines (slide 39-41)
3. Students will better understand the importance of protecting our environment (slides 3-20)
4. Students will better understand disease transmission and mutations (slides 4-11, 21-37)
5. Students will understand what health professionals are combating (slides 4-9, 21-38)
6. Students will understand the importance of good communication between different professions (slides 41-43)

Slide 2:
Emphasize: "A sick environment leads to sick people and animals. Sick animals can make people sick. Sick people can make animals sick. We are all connected."

Review: This Venn Diagram is simplified. Reality is more complicated.
Also note here that some people in 2023 call this connection "Planetary Health". "Planetary Health" has traditionally emphasized the interaction between the environment and people's health but advocates of "Planetary Health" are starting to include the effect of animals'

health on the planet. More information about Planetary Health can be found at: https://www.planetaryhealthalliance.org/planetary-health
The One Health Approach will be covered in the second half of the lesson. As a preview: From the US CDC website (https://www.cdc.gov/media/releases/2019/s0506-zoonotic-diseases-shared.html):

One Health is an approach that recognizes the connection between people, animals, plants, and their shared environment and calls for experts in human, animal, and environmental health to work together to achieve the best health outcomes for all.

Slide 3:
Remind the adult students that this lesson is designed with images for younger audiences but they are encouraged to use these images when teaching youth about One Health in their community.

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Slide 4:
(Note: This slide requires slideshow view. If you are not already using this method of review, it is best to start now.)

***Emphasize** that these diseases jump to people.*

***Tip for teachers**: Emphasize the "zoo" in zoonotic. Think of all the different types of species within a zoo. This is a good way to remember the new term.*

From the US CDC website (https://www.cdc.gov/media/releases/2019/s0506-zoonotic-diseases-shared.html):
60% of all infectious diseases in people are zoonotic. This makes it crucial that a nation strengthens its capabilities to prevent and respond to these diseases using a One Health Approach. One Health is an approach that recognizes the connection between people, animals, plants, and their shared environment and calls for experts in human, animal, and environmental health to work together to achieve the best health outcomes for all.

Slide 5:
Ask the students: "what are the three parts of One Health?" (Answer: human health, animal health, and environmental health)
Review: this is a picture of a busy and **healthy** forest. The animals are evenly spread out and there is no stress to any of the animals. The trees look healthy too.

(The teacher can discuss that clean water also plays a role in this forest ecosystem. This slide covers UN Sustainable Development Goals of "Clean Water and Sanitation" and "Life on Land".)

Slide 6:
Ask the students:

1. "Why are there less trees?" (Either from deforestation due to people or because of climate change which makes life for those plants more difficult in that area of the world.)
2. "Where are the animals going when there are less trees?" (They are starting to crowd together in a smaller area. They are more stressed because they have more competition for food/shelter and have less space to live in. Some animals are even leaving the forest to find food and are now near people).

(The teacher can discuss that water quality also plays a role in this changing ecosystem. If animals drink dirty water that is contaminated by either people or animals then they can get sick. Besides deforestation, the teacher can discuss how Climate Change can alter natural habitats and lead to animals (including insects) move into new territories. This slide would then cover the UN Sustainable Development Goals of "Climate Action", "Affordable and Clean Energy", "Sustainable Cities and Communities", "Responsible Consumption and Production", "Clean Water and Sanitation" and "Life on Land".)

Slide 7:
Ask the students:

1. "What changes do you see with this slide compared to the previous slide?" (there are more people, less trees, more animals near people). Note that there are no actual changes to the number of animals between the slides.
2. "What is a zoonotic disease?" Review that, in this slide, there are more people in the area where animals have been living. **This is an area where zoonotic diseases can easily "spill over" and spread** between animals and people.

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Slide 8:
Review that the birds are either leaving the smaller forest or they are dying because of the increased competition for food and shelter (trees).

Climate change can further shrink an animal's habitat and lead to species extinction by changing what plants grow in the area or make the temperature unsuitable for life for that (animal or plant) species. Climate change affects animals, people and plants in this way. (This slide addresses UN Sustainable Development Goal: "Climate Action")

Slide 9:
Compare and contrast this slide with the previous slide. Slowly go back-and-forth several times.
Ask students if they can name the 5 changes between the two slides. (The answers are in the "notes" section of the next slide.)

Slide 10:
Teacher answers:

1. No more birds– because too much competition for food and shelter (due to habitat loss)
2. Less trees– because either people are chopping them down or because some birds are responsible for eating fruits and dispersing seeds and they can serve as pollinators
3. More mice– because other types of birds eat mice and when there are no longer these birds in the forest, the mouse population increases
4. More foxes- when the mouse population increases, there are more mice for foxes to eat
5. More animals in human areas- because the animals have no other choice (their home is gone or it is easier for them to survive/find food near people). **Emphasize that this situation can increase the spread of zoonotic diseases.**

Slide 11:
Ask for the definition of a "zoonotic disease"

Review: Now is a good time to discuss that some people eat wild animals (known as "bush meat") in some areas of the world. They do this for several reasons. **Ask** the students for reasons. Possible **answers** include: bush meat can be considered a fancy delicacy, or it is culturally accepted as normal, or the people have no other option for their dietary protein. Regardless of the reason, eating bush meat increases the chance of a person getting sick from the animal's germs. Live animal "wet markets" are known to have animals in cages sitting next to (or on top of) other animals that they are not naturally exposed to. This unnatural environment increases an animal's stress level and makes it susceptible to showing signs of sickness. If one animal defecates or urinates into the area (or cage) of another animal then there is increased risk of disease spread between the two animals (regardless of species differences because mutations are possible).

Slide 12:
Review here that the bats are now missing (the birds are staying in the forest). **Ask** the students about possible consequences.

Ask about how certain animals and plants have specific roles they play in the ecosystem. Discuss that certain characteristics (speed of flight, length of wings, size of head) illustrate

variation of traits that they have inherited from their parents. Over time (over many generations), the physical traits that make the animal (or plant) live longer (and reproduce more efficiently by attracting more mates) will become more common in a population. This concept is called "Natural Selection" and leads to overall "Adaption" within a species.

Ask the students to tell you what environmental pressures would change the need of certain physical traits of the animal or plant. *(For example, there can be a forest where there are many plants that thrive in drier conditions. If there starts to be more cyclones/hurricanes/rain storms in the region, then, over time, there will be more plants that live best with damp environments. Ask the students, would this change of plants affect the animals in the ecosystem?)*

(The teacher can discuss that clean water also plays a role in this forest ecosystem. This slide covers UN Sustainable Development Goals of "Clean Water and Sanitation" and "Life on Land".)

Slide 13:
Do not explain the definition of "Keystone Species" at this point. Have the students deduce the definition and explain it to you after talking through slides 14-21.
Review: we are looking at another healthy forest but with a different environmental pressure. **Ask** what environmental change can decrease the number of bats? (Ex. Deforestation if the bats live in trees, manmade closure of caves if the bats live in caves, etc.)

Slide 14:
Keep in mind bats are very important- they eat insects and they are pollinators and disperse seeds.

Review that some bats are considered keystone species *(this term means that the entire ecosystem/life in the area depends on the survival of the bats).*

For more information on this topic:
General information: https://www.bats.org.uk/about-bats/why-bats-matter
PDF for bats that live in caves (and mentions White-Nose Syndrome):
https://www.fs.fed.us/biology/resources/pubs/tes/wns-brochure8310.pdf
"Why do bat viruses keep infecting people?" Nature article (November 2022) can be found here:
https://www.nature.com/articles/d41586-022-03682-9
"What's So Important about Bats?" (2017 article) found at
https://capitalscoalition.org/whats-so-important-about-bats/

Slide 15:
Review here that the bats are now missing (the birds are staying in the forest). **Ask** the students about possible consequences.
Ask the students to watch the changes closely because you are now talking about a Keystone Species. *(Move quickly-approximately 3 seconds per slide- through the next 5 slides without talking.)*

Slide 16:
Move quickly to the next slide.

Slide 17:
Move quickly to the next slide.

Slide 18:
Move quickly to the next slide.

Slide 19:
Move quickly to the next slide.

Slide 20:
Ask how the students would define a "keystone species".
Ask what does it mean to have an ecosystem collapse *(means the ecosystem cannot support life).*

Slide 21:
Ask: how would you explain a mutation to a child?

Emphasize here that viruses and bacteria and parasites and even cells inside people and animals can mutate (ex. some people have an extra finger or toe – just like this cat!)

A good tip here is to have all the students **repeat the phrase: "Mutation is Change".** This phrase can be repeated throughout the class. (Later on, the students learn that a mutation can strengthen or weaken a virus' ability to infect a cell and replicate. Sometimes a mutation does not make much of a difference, it is just a benign change. Other times, the difference is important.)

Slide 22:
Review that "mutation is change". **Explain** that these are the questions that should be asked to children to ensure they understand the term.

Ultimately, mutations ultimately, over many generations lead to adaptation in populations. Sometimes, new subspecies of animals and plants are made from mutations that allowed their ancestors to survive and thrive and reproduce.

The **answer** to "*Is a mutation good or bad or neither?" is that "it depends on the environment". If the environment has changed and the mutation makes the organism survive better in the new environment, then this is a good thing for the organism. Sometimes mutations do not affect the survival of the organism. Other times the organism with the mutation cannot survive well.*
The **answer** to "How do mutations happen?" is "there are several different ways a mutation can happen but it always involves the most basic form of life within the organism (most of the time this means DNA)." *(NOTE: the virus that causes COVID actually has RNA affected, and not DNA, because SARS-CoV-2 is an RNA virus.)*

Slide 23:
Review that "mutation is change". **Ask** for 2-3 volunteers to quickly read this bold sentence five times.
This tongue-twister serves as a model for a type of mutation- the simplest kind of mutations (called "point mutations") - because there are skipped letters in words or added letters to words. Simple small changes like this can occur at the level of DNA and may have drastic consequences if the cell does not correct it by various means.

Slide 24:
Choose two student volunteers before moving to the next slide

(Note: "Translation" was a vocabulary word covered in "The History of the COVID Vaccine" lesson that is found at www.OneHealthLessons.org. It is the process of creating a protein.)

Review: This activity would work for any age group but would need to be replaced with audiences who are visually impaired.

Review: This activity models what can happen during translation- or when a protein is being made inside a cell. The instructive message is found on the mRNA but the new protein is not what was meant to be created. Often a cell can correct this error by several methods. Sometimes, however, errors are not corrected and mutated or new types of proteins are made. This lack of correction can sometimes be seen with the influenza (flu) virus. This makes developing flu vaccines very tricky because scientists need to <u>try to predict</u> which mutations will happen when and where in the world and then distribute the vaccine (in that area of the world) to protect a person against the newly mutated virus! <u>That is why there is a new flu vaccine each year</u>. (This topic is revisited later on in slide 32).

For the next slide:
The two volunteers will one-by-one mute their computers and say one of the choices in each example. The rest of the students need to guess which word or phrase the student "mouthed". (Have the students hold up one finger if they think it is the first word option and two fingers if they think it was the second word option.) Once all the votes are in, the student volunteer can be unmuted and say the word again for everybody to hear.

Slide 25:
The two volunteers will one-by-one mute their computers and say one of the choices in each example. The rest of the students need to guess which word or phrase the student "mouthed". (Have the students hold up one finger if they think it is the first word option and two fingers if they think it was the second word option. Another option is to have the observing students' wave if they think the mouthed word was "hi" and wink if they think the mouthed word was "eye" for the first example. Similar corresponding actions can be taken with the second example.) Once all the votes are in, the student volunteer can be unmuted and say the word again for everybody to hear.

Slide 26:
Explain that another way viruses can mutate is by mixing in an animal (ex. a bird, pig). Review that this "animal" could also be a person!
The first animal example here is a bird. The second is a pig. Swine flu (an influenza virus) can have bits of different viruses inside of it. (A pig virus can mix with a bird virus, human virus or another pig virus! https://www.ncbi.nlm.nih.gov/pubmed/19565018)
Review: this slide models a style of mutation called genetic reassortment (and, more specifically, "antigenic shift"). Through "genetic reassortment", a new virus can be made.

Slide 27:
This next example models another way a virus can mutate, through "genetic reassortment".

Slide 28:
This "Once Upon a Time" example models genetic reassortment, more specifically- with "antigenic shift".

Review that creating a fill-in-the-blank activity is an excellent way to explain to children the concept of genetic reassortment, seen when there is merging of two viruses to create a new virus.

For science-oriented (particularly, molecular biology) students, **ask** them what the words "once upon a time" could represents at the cellular level- a hint is that it has to do with mRNA and the ribosome. The **answer** is: the START codon. More information about START codons can be found at: https://en.wikipedia.org/wiki/Start_codon and https://www.pbs.org/wgbh/nova/genome/expl_02_start.html

Explain that, like this sentence model, the cell's equipment follows a certain template or pattern in order for the cell to work properly. There are special parts of the mRNA that never change (just like the phrase "Once upon a time" in this sentence example). However, the "fill in the blank" sections of this sentence allow for variations in the sentence. In some viruses (like the flu virus), there can be a mixing of multiple viruses to create a new virus that is different- either is stronger or weaker or has no change to its strength.

Slide 29:
Review that the red sentence is like the red virus. The blue sentence is like the blue virus. What happens when we combine these two sentences together to make a mutated sentence? (see next slide)

Slide 30:
Review the example of the mutated sentences.
Ask if these mutated sentence are better or worse compared to the original sentences.

Slide 31:
Review:
There are essentially two main parts to a virus: the outer shell and the inner core.
The outer shell decides how infectious a virus is. The inner core decides how easily the virus can replicate.

Slide 32:
Review that this slide shows the composition of a “normal” virus (red shell + red core)

Slide 33:
Review that this slide shows the composition of a “mutated” virus (red shell + blue core)
Ask: What if the blue core made the virus better at replicating? Would the mutant be more or less of a problem for the host cell? (Answer: While both viruses look the same on the outside with their red shells, the mutated virus [seen on the top] would be more problematic for the host cell because it will replicate much more in the cell.)

Slide 34:
Ask:
What are the two mutated viruses (the top virus with a red shell and blue core; the bottom with the blue shell and red core)

Slide 35:
Review:

- The outer shell represents the ease to which a virus can enter into a cell
- The inner core represents the ease to which a virus can replicate inside of a cell

Ask:
How do you think a mutation can change a virus? (It can change either the shell or the core or both! Therefore, a mutation can change the ease to which a virus can enter into a cell AND/OR it can change the amount of replication inside of a cell.)

Slide 36:
If time permits:
Have the students write their numbers in the chat box.
This slide prepares the class for the next activity with demonstrates that a mutation can strengthen or weaken a virus.

Slide 37:
Review that, when working with children, this activity would work with addition or multiplication to prove the point that the mutations either weaken or strengthen the virus. Choose which type of math is best to do with the group of children that is being taught.

Have the students look at what path their numbers take them.

This activity is done slowly and step-by-step.

For example, a student who chooses the numbers 1 and 2 will eventually have the weakest virus (the bottom mutation, whose sum is 3). A student who chooses the numbers 3 and 4 will eventually have the strongest virus (the top mutation, whose sum is 7). The students who chose the other number combinations (either 1 and 4 or 3 and 2) will have “normal” type of viruses (with sums of 5, respectively).

Review:

- Mutations do not happen all the time (the teacher can further explain that RNA viruses mutate much more than DNA viruses)
- Sometimes, a mutation can make a virus WEAKER (like for the blue shell example).
- Sometimes, a mutation can make a virus STRONGER (like in the red shell example).
- Viruses can be difficult to predict! (Remind students this is important for scientists to consider when creating the next flu vaccine.)

Review that a virus has an opportunity to mutate whenever it replicates. Also, for the COVID-related virus (SARS-CoV-2), this virus can only replicate when it is inside of a body. Therefore, it is important to stop the virus from entering a body. **Review** with the adult students that children need to understand that hands often carry the most germs because we touch objects and hold those objects with our hands and then we eat with our hands. Therefore, thoroughly washing hands with soap and clean water is one of the best ways to avoid getting sick.

TIP: A more challenging activity is to make the students multiple the numbers to get products: 3 x 4=12, 3 x 2=6, 1 x 4= 4, 1 x 2= 2 (Note that this does not change the identification of the strongest and weakest viruses.)

Slide 38:
Emphasize that mutations can be difficult to predict. *Go through this slide quickly for the adult students.*

When adults teach children with this slide, here are the directions:
Do this activity slowly. Explain that the viruses on the left side of the slide are replicating (multiplying) and will either have the original color or will show a mutation (with the purple color). Have the children guess when the purple virus will show up. They have 3 guesses! (The teacher can say that the purple virus will appear <u>at least</u> once)

Review: The flu virus (called influenza virus) is another example of a virus that mutates a lot. **That is why new flu vaccines need to be made each year.** Scientists need to look at the flu virus closely (by sequencing it) to see where they think the next mutation will happen so that they can develop the right type of vaccine.

Slide 39:
Ask "how would you explain a vaccine to a young child?"

Slide 40:
Ask: how would you explain the "immune system" to a child?
Answer: In "The Story Behind the COVID-19 Vaccine" lesson (found at www.onehealthlessons.org), the immune system is explained with "The part of a body that fights anything out of the ordinary."
Ask: how would you explain a vaccine to a child?
Answer: Vaccines are meant to strengthen a body to fight an upcoming germ. Note that a person (or animal) who gets a vaccine does not become invincible against that particular germ/microbe (which the vaccine is developed to fight). A person or animal can still get sick

from the germ but, often, not nearly as sick as a person or animal that never received that vaccine.

Ask: how would you explain the difference between a vaccine and a medication to a child?
Answer: Explain that a vaccine is NOT a medication. A vaccine is given BEFORE somebody gets exposed to a germ (ex. virus or bacteria) and a medication (ex. antiviral drug or an antibiotic) is only given AFTER somebody gets sick from that germ.

Ask: who is involved in creating and distributing vaccines?
Veterinarians, physicians, chemists, biochemists, other researchers, transportation and logistics professionals collaborate to develop the best vaccine to protect people and animals and bring the vaccines out to populations. Ultimately, they all must communicate efficiently so that they do not waste any time. This is **the One Health approach!**

Slide 41:
Ask: what are the three parts of One Health?

For the first point- Emphasize that veterinarians work closely with other scientists to develop HUMAN and animal vaccines (because animal models are used in a vaccine's development process). Also, veterinarians and environmental health scientists (like ecologists) have been surveying viruses in wild animals for years. Because of this work, researchers in different parts of the world know what communities are at higher risk of different zoonotic diseases.

Slide 42:
Tip: Spend up to 2 minutes on this slide.

Ask: What is a word that is understandable to a 6-year-old child but also summarizes collaboration, cooperation and coordination?
Answer: Teamwork.
Explain that the **One Health approach:** teamwork between people of different backgrounds, strengths and disciplines to prevent and solve health problems.

Remind students that the earlier slide reviewed the One Health ***concept*** and this current slide reviews the One Health **Approach*.***

Also, today, more One Health advocates are talking about the Approach (rather than the concept) when they say the words "One Health".
Definition from the United States' CDC website (https://www.cdc.gov/media/releases/2019/s0506-zoonotic-diseases-shared.html) covers the Approach part of the definition: "One Health is an approach that recognizes the connection between people, animals, plants, and their shared environment and calls for experts in human, animal, and environmental health to work together to achieve the best health outcomes for all."

Emphasize examples here of where teamwork can benefit communities: veterinarians (animal doctors) can work closely with physicians (human doctors) and environmental

health scientists to efficiently improve the health of the animals, people and the environment at the same time.
The One Health approach that has been used to address the COVID-19 pandemic involved:

- human health care workers- to treat patients and perform research to determine effectiveness of possible new treatment and/or a vaccine
- veterinarians - to help to develop possible treatments and/or a vaccine, and determine the risk of transmission between animals and people
- public health scientists (can include veterinarians and human health care workers)- to protect the general public against disease spread
- pharmaceutical scientists (ex. biochemists)- to develop treatment and/or vaccine
- virologists- to identify the virus and help guide human health care workers and pharmaceutical scientists
- immunologists- to provide guidance to the human health care workers and the pharmaceutical scientists
- ecologists- to determine the degree of environmental changes seen in the area of viral origin
- sociologists- to determine the effect of social distancing on the population, guide policy changes and determine what causes an increased interaction between people and animals
- economists- to determine how a society can manage through business closures
- educators- to teach the public about the importance of One Health
- lawmakers- to change or create laws which promote public safety

In short, the One Health Approach means teamwork.

Slide 43:
Note: This slide provokes a conversation.

Ask about how social structures, different populations of people based on income, location, ethnicity and more can play a role in their health. **Explore** 1-2 local problems that affect the health of people, animals, plants and the environment and brainstorm who locally can assist with a solution (hint: must be several different types of disciplines, sectors, etc.).

If the adult students are not very interactive, you can use this generic example to start the conversation:
Ask what types of people are important to fix big health problems like a disease outbreak or the loss of biodiversity (decreased variety of different species in an area)? (Any of the student answers will be correct.

Ensure the students understand that people outside of the typical health sciences are needed to protect communities from One Health problems like loss of biodiversity or climate change or contaminated water or contaminated air or deforestation or antimicrobial resistance. Here are some answers and the reasons for them:)

1. Physicians (human doctors) and nurses- they treat sick people
2. Veterinarians- they understand germs that can come from animals and spread to people (**review** the term: zoonotic disease)
3. Ecologists – they study the interaction between animals and their environment
4. Sociologists- they understand why people make certain decisions

5. Politicians- they create laws to protect the environment, people, animals, plants and more
6. Economists- they help businesses stay open and help livelihoods/income/well-being of families
7. Researchers- they help develop vaccines (ex .biochemists)- **ask** the students what other type of researchers can help solve other health problems
8. Teachers- they help spread awareness and knowledge to protect more people
9. Engineers- (software, mechanical, etc.)- software engineers can design websites or applications to provide health-focused resources for communities; mechanical engineers to design equipment that is carbon neutral or carbon negative to combat climate change

Slide 44:
2-minute survey for classroom teacher to complete:
https://forms.gle/rvie1WTAMEZ1e4W7A

Other One Health online activities for students:
Game for students to better understand microbes and zoonotic diseases:
http://webadventures.rice.edu/ed/Teacher-Resources/_games/MedMyst-Original/_301/Game-Overview.html
Interactive comic book that shows how a veterinarian can help detect a new virus in New York City.
(Loosely based on real life events with West Nile Virus in New York City in 1999):
https://nysci.org/school/resources/transmissions-gone-viral/
TEDx talk from veterinarian during the West Nile Virus outbreak is here:
https://www.youtube.com/watch?v=qm8NnL582uc) (duration of15:16)—would be appropriate for older students (≥15 years old)

Online One Health material that can be used in person or online
Reviews how to live safely with bats around and was developed for communities in Africa:
https://ucdavis.box.com/v/livingsafelywithbats-flipbook

Further information about how the environment and animals play into human health:
https://ensia.com/features/covid-19-coronavirus-biodiversity-planetary-health-zoonoses/

Follow-up material for the curious adult:
https://www.avma.org/javma-news/2020-04-15/can-veterinarians-prevent-next-pandemic
https://www.newyorker.com/science/elements/from-bats-to-human-lungs-the-evolution-of-a-coronavirus
https://www.theguardian.com/world/2020/mar/25/coronavirus-nature-is-sending-us-a-message-says-un-environment-chief?CMP=share_btn_fb