

ACLA COURSE STUDY GUIDE

One Health: People, Animals & Ecosystems

From Nipah to avian influenza and AMR — how human, animal and ecosystem health connect, and how to intervene.

Dr. Amara Okafor · Beginner

10 modules · 63 lessons · 12 weeks

About This Course	4
Module 1: Foundations of One Health and the Human-Animal-Ecosystem Interface	5
1.1 What Is Global Health at the Interface?	5
1.2 History and Evolution of One Health	6
1.3 Core Principles and the One Health Triad	6
1.4 Key Terminology and Concepts	7
1.5 Case Study: In the late 1990s, an outbreak of severe encephalitis among pig farmer	7
1.6 Hands-On Activity	7
Module 2: Ecosystems, Biodiversity, and the Roots of Health	7
2.1 Ecosystem Services and Human Health	8
2.2 Biodiversity Loss and Disease Emergence	8
2.3 Land-Use Change, Deforestation, and Habitat Fragmentation	8
2.4 Ecological Drivers of Pathogen Spillover	8
2.5 Case Study: Research across the Brazilian Amazon has repeatedly linked deforestation	9
Module 3: Zoonotic Diseases: Emergence, Transmission, and Spillover Dynamics	9
3.1 Classification of Zoonoses	9
3.2 Spillover Mechanisms and Pathogen Ecology	10
3.3 Drivers of Emerging Infectious Diseases	10
3.4 Comparative Case Dynamics	10
3.5 Case Study: H5N1 avian influenza is maintained in wild waterfowl, which can carry	11
3.6 Hands-On Activity	11
Module 4: Antimicrobial Resistance at the Interface	11
4.1 Understanding AMR as a One Health Issue	11
4.2 Antimicrobial Use in Agriculture, Aquaculture, and Veterinary Medicine	12
4.3 Environmental Reservoirs and Transmission Pathways of AMR	12
4.4 Global and National AMR Action Plans	12
4.5 Case Study: Colistin is a 'last-resort' antibiotic used to treat serious infection	13
4.6 Hands-On Activity	13
Module 5: Food Systems, Animal Production, and Health Security	13
5.1 Livestock Systems and Global Food Security	14
5.2 Intensification of Animal Production and Disease Risk	14
5.3 Food Safety Along the Value Chain	14

5.4 Sustainable and Resilient Food Systems	15
5.5 Case Study: Live bird markets — where poultry are sold live and often slaughtered	15
5.6 Hands-On Activity	15
Module 6: Climate Change and Environmental Drivers of Disease	15
6.1 Climate Change as a Driver of Disease	16
6.2 Vector-Borne Disease Dynamics Under Climate Change	16
6.3 Extreme Weather Events, Displacement, and Health	16
6.4 Adaptation and Mitigation Strategies	17
6.5 Case Study: Dengue fever, transmitted by Aedes mosquitoes, has historically been c	17
6.6 Hands-On Activity	17
Module 7: Surveillance, Early Warning, and Outbreak Investigation	17
7.1 One Health Surveillance Systems	18
7.2 Event-Based and Indicator-Based Surveillance	18
7.3 Laboratory Networks and Diagnostics	18
7.4 Case Study: Rift Valley fever (RVF) is a mosquito-borne viral disease affecting li	19
7.5 Hands-On Activity	19
Module 8: Governance, Policy, and Multisectoral Coordination	19
8.1 Global Governance Architecture	20
8.2 National One Health Coordination Mechanisms	20
8.3 International Health Regulations and Legal Frameworks	20
8.4 Financing One Health	21
8.5 Case Study: Several countries facing repeated zoonotic disease events have establi	21
8.6 Hands-On Activity	21
Module 9: Community Engagement, Risk Communication, and Equity	21
9.1 Risk Communication Principles	22
9.2 Community-Based Surveillance and Participatory Approaches	22
9.3 Social, Cultural, and Gender Dimensions	22
9.4 Health Equity and Environmental Justice	23
9.5 Case Study: In several countries with limited veterinary infrastructure in rural a	23
9.6 Hands-On Activity	23
Module 10: Emerging Tools, Technologies, and Innovations	23
10.1 Genomic Epidemiology and Pathogen Genomics	24

10.2 Digital Health, Big Data, and Artificial Intelligence	24
10.3 Remote Sensing and Geographic Information Systems	25
10.4 Innovations in Diagnostics and Vaccines	25
10.5 Case Study: International genomic surveillance networks, coordinating sequence dat	25
10.6 Capstone Overview and Requirements	26
10.7 Step 2: Situation and Driver Analysis	26
10.8 Capstone Rubric	27
10.9 Course Glossary	28
10.10 Foundational One Health Texts	28
10.11 Adapting Activities to Local Context	29
Final Assessment & Certificate	29

About This Course

One Health: People, Animals & Ecosystems is the catalogue's most comprehensive health course, built around the insight that human, animal and environmental health are one system. Ten modules span the foundations of One Health, ecosystems and biodiversity, zoonotic disease emergence and spillover, antimicrobial resistance, food systems and health security, climate as a disease driver, surveillance and outbreak investigation, governance and multisectoral coordination, community engagement and risk communication, and emerging tools — with a capstone in which you design a feasible One Health intervention.

Course information

Course	One Health: People, Animals & Ecosystems
Instructor	Dr. Amara Okafor
Level	Beginner
Structure	10 modules · 63 lessons · 12 weeks
Assessment	Module quizzes (pass mark 60%) and a final test (pass mark 80%). Certificate issued on final success, verifiable at acla.io/verify .

What you will be able to do

1. Define One Health, Ecohealth, and Planetary Health, and explain how these frameworks relate to one another.
2. Trace the historical development of integrated approaches to human, animal, and environmental health.
3. Describe the core principles and the 'One Health triad' of human, animal, and environmental sectors.
4. Identify examples of health issues that require a human–animal–ecosystem interface perspective.
5. Use foundational One Health terminology accurately and consistently.
6. Explain the concept of ecosystem services and categorize its main types.
7. Describe the relationship between biodiversity loss and infectious disease emergence, including the dilution effect hypothesis.
8. Analyze how deforestation, habitat fragmentation, and land-use change alter disease dynamics.

How to use this study guide

This guide is the complete companion to the Tapi Learn mobile course. Each chapter corresponds to one course module and reproduces every lesson in full, including the key takeaways. Read a lesson in the app, then revisit the same text here to revise; the structure and headings match the in-app lesson reader. After finishing a module, take the module quiz in the app (60% to pass), and after all modules, the final test (80%

to pass) to earn your verified ACLA certificate of completion.

Module 1: Foundations of One Health and the Human-Animal-Ecosystem Interface

This module introduces the conceptual foundation for the entire course: the idea that human, animal, and environmental health are interconnected and interdependent, and that sustainable improvements in global health require action across all three domains simultaneously. You will trace the history of this thinking from early comparative medicine to the modern One Health movement, examine its guidi

6 lessons · 13m

1.1 What Is Global Health at the Interface?

The 'human–animal–ecosystem interface' refers to the zone of interaction — physical, biological, and social — where people, domestic and wild animals, and the surrounding environment meet and influence one another's health. This interface is not a fixed line but a dynamic, expanding space shaped by agriculture, urbanization, trade, travel, and environmental change. Pathogens, contaminants, and health risks routinely cross between these domains: a pathogen circulating harmlessly in a wildlife reservoir can spill over into livestock or people; antimicrobial residues used in animal production can enter waterways and select for resistant bacteria that later infect humans; and the degradation of an ecosystem's regulating services can increase human exposure to disease vectors. Global health at the interface is therefore the study and practice of understanding, anticipating, and managing these cross-domain risks. It asks not only 'what disease is this?' but 'why did it emerge here, now, in this combination of ecological and social conditions, and what would it take to prevent recurrence?'

1.2 History and Evolution of One Health

Integrated thinking about human and animal health is far from new. Nineteenth-century physician-scientists such as Rudolf Virchow argued that there was 'no dividing line' between human and veterinary medicine, coining the concept of zoonosis and championing comparative pathology. Through the twentieth century, veterinary epidemiology, public health, and ecology developed largely as separate disciplines, even as outbreaks of diseases such as rabies, brucellosis, and bovine tuberculosis repeatedly demonstrated their interdependence. The modern One Health movement gained momentum in the early 2000s, catalyzed by the emergence of severe acute respiratory syndrome (SARS), highly pathogenic avian influenza (H5N1), and growing recognition that the large majority of emerging infectious diseases are zoonotic in origin. A landmark moment was the 2004 'One World, One Health' symposium, which articulated principles for integrated disease prevention. Since then, the concept has been formalized through the creation of the Quadripartite — the World Health Organization (WHO), the Food and Agriculture Organization (FAO), the World Organisation for Animal Health (WOAH, formerly OIE), and the United Nations Environment Programme (UNEP) — and through the adoption of a joint One Health definition and Joint Plan of Action in the early 2020s, accelerated by lessons from the COVID-19 pandemic. Related frameworks emerged alongside One Health. Ecohealth emphasizes ecosystem-based, participatory, and transdisciplinary approaches, often with a strong focus on social equity and community engagement. Planetary Health, articulated more recently, situates human health within the broader context of planetary-scale environmental change, including climate change, biodiversity loss, and the degradation of Earth's natural systems. While these frameworks differ in emphasis, they share a common premise: health cannot be understood, protected, or improved by focusing on a single sector in isolation.

1.3 Core Principles and the One Health Triad

At its core, One Health rests on a small number of guiding principles: **Interconnectedness:** The health of people, domestic animals, wildlife, plants, and the environment are linked through shared, interdependent systems. **Collaboration:** Effective prevention and response require coordinated action across human health, animal health, and environmental sectors, rather than parallel or siloed efforts. **Communication:** Timely, transparent information sharing across sectors and with affected communities is essential to early detection and effective response. **Multisectoral and transdisciplinary engagement:** Durable solutions draw on epidemiology, veterinary medicine, ecology, social science, economics, and local knowledge together. **Prevention orientation:** One Health aims not only to respond to health events after they occur, but to address upstream drivers — ecological, agricultural, and social — that create the conditions for disease emergence. These principles are often visualized as a triad or as three overlapping circles representing human health, animal health (both domestic and wild), and environmental health, with One Health action occurring in the overlapping space where these domains interact.

1.4 Key Terminology and Concepts

A shared vocabulary is essential for effective cross-sectoral communication. Key terms used throughout this course include: zoonosis (a disease naturally transmissible between vertebrate animals and humans); spillover (the transmission of a pathogen from its reservoir host species into a new host species, including humans); reservoir host (a species in which a pathogen persists and from which it can be transmitted to other species); vector (an organism, typically an arthropod, that transmits a pathogen between hosts); emerging infectious disease (EID) (a disease that has newly appeared in a population, or that has existed but is rapidly increasing in incidence or geographic range); and antimicrobial resistance (AMR) (the ability of microorganisms to resist the effects of drugs that once controlled them). A full glossary of terms used throughout the course is provided at the end of this document for reference.

1.5 Case Study: In the late 1990s, an outbreak of severe encephalitis among pig farmer

In the late 1990s, an outbreak of severe encephalitis among pig farmers in Malaysia was eventually traced to a previously unknown virus, later named Nipah virus, harbored naturally by fruit bats. Large-scale deforestation and the expansion of intensive pig farming into areas bordering bat habitat brought fruit bats into close proximity with pig farms, where bats fed on fruit trees planted near pig enclosures. Bat saliva and urine, containing the virus, contaminated fruit and pig feed, allowing spillover into pigs, which then amplified the virus and transmitted it to farm workers in close contact with sick animals. Investigating and controlling the outbreak required veterinary, medical, and ecological expertise working together — precisely the kind of multisectoral collaboration that One Health calls for. The event remains one of the clearest illustrations of how land-use change and agricultural intensification can create novel pathways for pathogen spillover at the human–animal–ecosystem interface.

1.6 Hands-On Activity

1. Identify a setting you know well — your community, workplace, or region — where humans, animals (domestic or wild), and the environment interact closely.
2. List at least five specific points of interaction (for example: a live animal market, a farm bordering forest, a shared water source, a wildlife trade route, or an urban area with high stray-animal density).
3. For each interaction point, briefly note what health risks could plausibly move between domains at that point (for example: a pathogen, a chemical contaminant, or a vector).
4. Rank your five interaction points from highest to lowest perceived risk, and briefly justify your ranking.
5. Retain this list — you will build on it in the Module 11 capstone project.

Module 2: Ecosystems, Biodiversity, and the Roots of Health

Human health depends on a functioning natural environment in ways that are often invisible until they are disrupted. This module examines the concept of ecosystem services, explores how biodiversity loss and ecosystem degradation increase disease risk, and analyzes land-use change as one of the most significant modern drivers of disease emergence.

2.1 Ecosystem Services and Human Health

Ecosystem services are the benefits people obtain from natural systems, commonly grouped into four categories: provisioning services (food, fresh water, timber, medicinal plants), regulating services (climate regulation, water purification, pollination, natural pest and disease control), supporting services (nutrient cycling, soil formation, primary production), and cultural services (recreational, spiritual, and aesthetic value). Regulating services are especially relevant to global health, because intact ecosystems often naturally suppress the abundance of disease vectors and reservoir hosts, filter pathogens from water, and buffer human populations from direct contact with wildlife. When these services are degraded, the natural checks on disease transmission can weaken, sometimes in ways that only become visible after an outbreak has occurred.

2.2 Biodiversity Loss and Disease Emergence

A substantial body of ecological research examines how biodiversity influences infectious disease risk. The 'dilution effect' hypothesis proposes that in diverse ecological communities, pathogens and vectors are distributed across many host species — including species that are poor amplifiers or 'dead-end' hosts for a given pathogen — which reduces the overall probability of transmission to humans. As biodiversity declines, ecological communities often become dominated by a smaller number of generalist, disturbance-tolerant species that are frequently more competent reservoir or amplifying hosts, potentially increasing transmission risk. This relationship is not universal — the strength and direction of the dilution effect vary by pathogen system and landscape context — but the underlying insight is important: biodiversity loss is not merely an environmental concern but can be a direct driver of human disease risk.

2.3 Land-Use Change, Deforestation, and Habitat Fragmentation

Land-use change — driven by agricultural expansion, logging, mining, road construction, and urban growth — is consistently identified as one of the leading drivers of emerging zoonotic disease. Converting forest to farmland or settlement fragments continuous habitat into smaller patches, increasing 'edge effects' where human, livestock, and wildlife populations are pressed into closer and more frequent contact. Fragmentation can also alter the ecology of reservoir species: some wildlife species that thrive in disturbed, edge habitats (often generalists tolerant of human proximity) may increase in relative abundance, while specialist species requiring intact habitat decline. Because generalist species are often more competent pathogen reservoirs, this shift can elevate spillover risk even as overall biodiversity declines.

2.4 Ecological Drivers of Pathogen Spillover

Beyond land-use change, several interacting ecological drivers shape spillover risk: climate variability altering species ranges and vector activity; wildlife trade and hunting that bring people into direct, high-risk contact with wild animals and their body fluids; livestock intensification that creates dense, genetically similar animal populations capable of amplifying and transmitting pathogens; and water resource development, such as dams and irrigation schemes, that can expand vector habitat for diseases like malaria and schistosomiasis. Understanding spillover therefore requires integrating ecological, agricultural, and social analysis rather than focusing on a pathogen in isolation.

2.5 Case Study: Research across the Brazilian Amazon has repeatedly linked deforestation

Research across the Brazilian Amazon has repeatedly linked deforestation to increased malaria transmission. Newly cleared land creates open, sunlit pools of standing water at forest edges that are highly favorable breeding habitat for *Anopheles darlingi*, the region's primary malaria vector, while also drawing in human settlers whose homes are frequently sited at the forest edge, placing them in close proximity to vector breeding sites. Studies have found that malaria incidence tends to rise sharply in the years immediately following forest clearing, then decline somewhat as land use stabilizes and settlements mature. This pattern illustrates how the timing and pattern of land-use change, not simply its overall extent, shapes disease risk, and underscores the value of integrating vector ecology into land-use planning and health surveillance.

Module 3: Zoonotic Diseases: Emergence, Transmission, and Spillover Dynamics

This module examines zoonotic diseases in depth — how they are classified, the biological mechanisms that allow pathogens to cross species barriers, and the combination of ecological, agricultural, and social drivers that shape when and where spillover events occur. You will study several major emerging infectious disease events to see these dynamics in practice.

6 lessons · 12m

3.1 Classification of Zoonoses

Zoonoses can be classified in several complementary ways. By transmission route, they include direct zoonoses (transmitted through direct contact, bites, or bodily fluids, such as rabies), vector-borne zoonoses (transmitted via an arthropod vector, such as plague or Lyme disease), foodborne and waterborne zoonoses (transmitted through contaminated food or water, such as salmonellosis or brucellosis), and airborne zoonoses (transmitted via respiratory droplets or aerosols, such as certain strains of avian influenza). By reservoir type, they may be classified as maintained in wildlife reservoirs, domestic animal reservoirs, or both. A further useful distinction is between diseases with sustained human-to-human transmission after spillover (such as SARS-CoV-2) and 'dead-end' zoonoses in which humans are typically infected only from an animal source and rarely transmit the pathogen onward (such as most cases of rabies).

3.2 Spillover Mechanisms and Pathogen Ecology

Spillover is best understood as a multi-stage process rather than a single event. First, a pathogen must be present and circulating within a reservoir host population at sufficient prevalence. Second, there must be an opportunity for exposure — physical contact, a shared environment, a vector bridging species, or a contaminated food or water source connecting the reservoir species to a new host. Third, the pathogen must be biologically capable of infecting cells of the new host species, which depends on compatible receptor binding and the pathogen's ability to evade or overcome the new host's immune defenses. Fourth, for an outbreak to develop beyond isolated spillover events, the pathogen typically must achieve efficient onward transmission within the new host population — a step that is often the hardest evolutionary hurdle, and one that many spillover events never clear, resulting in dead-end infections rather than epidemics.

3.3 Drivers of Emerging Infectious Diseases

Analyses of emerging infectious disease events over recent decades point to a consistent set of driver categories: ecological and environmental change (land-use change, biodiversity loss, climate change); agricultural intensification (dense livestock production, close human–animal contact in farming systems); demographic and social change (population growth, urbanization, informal settlements); mobility and trade (international travel, live animal trade and markets, global supply chains); and health system and behavioral factors (antimicrobial use practices, healthcare-associated transmission, cultural practices involving animal contact). Most major emergence events reflect a convergence of several of these drivers rather than a single cause, which is precisely why a One Health, multisectoral response is usually required.

3.4 Comparative Case Dynamics

Different zoonotic emergence events illustrate different combinations of these drivers. Highly pathogenic avian influenza outbreaks are closely tied to interactions between wild waterfowl reservoirs, domestic poultry production systems, and live bird markets. Ebola virus disease outbreaks in Central and West Africa have been linked to contact with infected wildlife, including through hunting and bushmeat handling, in areas of forest disturbance. The emergence of SARS-CoV-2, while its precise origins remain the subject of ongoing scientific inquiry, is broadly understood in the context of wildlife trade, high-density urban markets, and the general ecological pressures that bring wildlife, livestock, and dense human populations into proximity. Comparing these cases highlights that while every emergence event is unique in its details, the underlying convergence-of-drivers model provides a consistent analytical lens.

3.5 Case Study: H5N1 avian influenza is maintained in wild waterfowl, which can carry

H5N1 avian influenza is maintained in wild waterfowl, which can carry the virus with limited clinical signs and disperse it over long distances during migration. Spillover into domestic poultry typically occurs through shared water sources, contaminated feed, or direct contact at farms located along migratory flyways. Once established in dense poultry populations — particularly in live bird markets with limited biosecurity — the virus can amplify substantially, increasing the opportunity for further spillover into humans and other mammals in close contact with infected birds. In recent years, H5N1 has also demonstrated an expanding host range into mammals, including dairy cattle in some regions, illustrating that spillover dynamics are not static and require continuous, cross-sectoral surveillance rather than a one-time risk assessment.

3.6 Hands-On Activity

1. Choose one zoonotic disease relevant to your region or professional interest (for example, rabies, brucellosis, Rift Valley fever, or another disease of local significance).
2. For your chosen disease, identify the primary reservoir host(s), the transmission route(s) to humans, and any intermediate or amplifying hosts involved.
3. Map the spillover process for this disease using the four-stage model presented in section 3.2 (pathogen presence, exposure opportunity, cross-species infection, onward transmission).
4. Identify at least two points in this pathway where an intervention (ecological, veterinary, agricultural, or behavioral) could realistically interrupt transmission.
5. Summarize your analysis in half a page; you will be able to draw on this in the Module 11 capstone.

Module 4: Antimicrobial Resistance at the Interface

Antimicrobial resistance (AMR) is among the most pressing global health threats of this century, and it is fundamentally a One Health problem: resistant organisms and resistance genes move fluidly between humans, animals, food, and the environment. This module examines how antimicrobial use across sectors drives resistance, how resistance spreads through environmental pathways, and how countries a

6 lessons · 12m

4.1 Understanding AMR as a One Health Issue

Antimicrobial resistance occurs when bacteria, viruses, fungi, or parasites evolve mechanisms that render antimicrobial drugs less effective or ineffective. While resistance can arise wherever antimicrobials are used, the scale of the challenge cannot be explained by human clinical use alone. Globally, a substantial share of antimicrobial consumption occurs in animal agriculture and aquaculture, and resistant bacteria and resistance genes readily move between humans, animals, food products, water, and soil. A resistant organism that emerges in a livestock population, for example, can reach humans through direct contact, contaminated food, or environmental exposure, and resistance genes can transfer horizontally between bacterial species even without direct contact between the original hosts. This interconnected ecology is why global bodies frame AMR explicitly as a One Health priority, alongside climate change and pandemic preparedness.

4.2 Antimicrobial Use in Agriculture, Aquaculture, and Veterinary Medicine

Antimicrobials are used in animal production for several purposes: treating clinically ill animals (therapeutic use), treating groups of animals in contact with sick individuals (metaphylaxis), preventing disease in at-risk but healthy animals (prophylaxis), and, in some systems, promoting growth and feed efficiency (growth promotion) — a practice increasingly restricted or banned in many countries due to its contribution to resistance with limited clinical justification. Intensive, high-density production systems are particularly associated with elevated antimicrobial use, as crowding increases disease pressure. Aquaculture presents distinct challenges, as antimicrobials are often administered directly into pond or cage water, creating substantial opportunity for environmental release and resistance selection in surrounding aquatic ecosystems. Responsible use frameworks promoted by veterinary and agricultural authorities emphasize using antimicrobials only when necessary, selecting appropriate drugs and dosing, and prioritizing prevention through improved husbandry, biosecurity, and vaccination over routine drug use.

4.3 Environmental Reservoirs and Transmission Pathways of AMR

The environment functions both as a reservoir for resistant organisms and resistance genes and as a pathway connecting human, animal, and ecological systems. Key environmental pathways include: wastewater and effluent from hospitals, farms, and pharmaceutical manufacturing, which can carry high concentrations of antimicrobial residues and resistant bacteria into surface water; manure and biosolids applied to agricultural land as fertilizer, which can introduce resistant organisms into soil and, subsequently, crops; and surface and groundwater used for drinking, irrigation, or recreation, which can serve as a mixing point where resistant organisms from multiple sources interact and exchange genetic material. Because resistance genes can transfer between unrelated bacterial species through mechanisms such as plasmid exchange, environmental reservoirs can act as a kind of 'genetic marketplace' that accelerates the spread of resistance even without a specific pathogen crossing from one host to another.

4.4 Global and National AMR Action Plans

The Global Action Plan on Antimicrobial Resistance, endorsed by WHO member states and supported by FAO and WOAHA, establishes five strategic objectives: improving awareness and understanding of AMR; strengthening surveillance and research; reducing the incidence of infection through effective sanitation, hygiene, and infection prevention; optimizing the use of antimicrobial medicines in human and animal health; and ensuring sustainable investment in countering AMR. Most countries have translated this global framework into National Action Plans (NAPs) that typically include a multisectoral coordinating mechanism, surveillance systems spanning human and animal health laboratories, stewardship programs to guide appropriate antimicrobial prescribing and use, and public awareness campaigns. Effective implementation depends heavily on sustained political commitment, adequate laboratory capacity, and functioning coordination between ministries of health, agriculture, and environment — precisely the multisectoral governance challenges explored further in Module 8.

4.5 Case Study: Colistin is a 'last-resort' antibiotic used to treat serious infection

Colistin is a 'last-resort' antibiotic used to treat serious infections caused by multidrug-resistant bacteria when other options have failed. For decades, colistin was also widely used in livestock production, particularly in pig and poultry farming, both therapeutically and for growth promotion in some regions. In 2015, researchers in China identified a plasmid-borne resistance gene, *mcr-1*, in bacteria from pigs, pork products, and hospital patients, demonstrating that colistin resistance could spread readily between animal and human bacterial populations via horizontal gene transfer, and that this resistance mechanism was already widespread by the time it was detected. The discovery prompted many countries to restrict or ban colistin use in animal agriculture and significantly elevated global attention to the risks of using critically important human antimicrobials in food-animal production. This case remains one of the clearest illustrations of the direct, demonstrable link between agricultural antimicrobial use and the erosion of last-resort treatment options in human medicine.

4.6 Hands-On Activity

1. Identify a food production system in your region (for example, poultry, dairy, aquaculture, or crop production) about which you have some knowledge.
2. Describe, to the best of your knowledge, how antimicrobials are likely used in this system (therapeutic, prophylactic, or growth promotion) and note any regulations you are aware of.
3. Trace at least two plausible environmental pathways by which resistant organisms from this system could reach humans (for example, via food consumption, water contamination, or occupational exposure).
4. Propose one stewardship intervention and one environmental intervention that could reduce AMR risk along this pathway.
5. Retain this analysis for potential inclusion in your Module 11 capstone project.

Module 5: Food Systems, Animal Production, and Health Security

Food systems sit directly at the human–animal–ecosystem interface, connecting livestock production, food safety, nutrition, and environmental sustainability. This module examines how the structure of modern animal production shapes disease risk and food security, traces food safety hazards along the value chain, and explores what a more sustainable and resilient food system could look like.

6 lessons · 12m

5.1 Livestock Systems and Global Food Security

Livestock provide a substantial share of global dietary protein and micronutrients, and for hundreds of millions of smallholder households, animals also represent savings, draft power, fertilizer, and social capital. Livestock systems range enormously in scale and structure, from extensive pastoral systems in which animals graze widely with low input intensity, to highly intensive confinement systems producing large volumes of meat, milk, or eggs on a comparatively small land footprint. Each system type carries a distinct profile of health risk, environmental impact, and resilience, and effective food security policy must weigh these trade-offs rather than assume that any single production model is universally superior.

5.2 Intensification of Animal Production and Disease Risk

Intensification — raising larger numbers of genetically similar animals at higher density — improves production efficiency but can elevate certain categories of disease risk. Dense housing increases opportunities for pathogen transmission between animals, favoring rapid outbreak spread once a pathogen is introduced. Genetic uniformity, often selected for production traits, can reduce natural variation in disease susceptibility across a herd or flock. Intensive systems also frequently rely more heavily on antimicrobials to manage disease pressure, connecting this module directly to the AMR dynamics discussed in Module 4. At the same time, well-managed intensive systems with strong biosecurity can sometimes achieve better disease control than poorly resourced extensive systems, illustrating that risk depends as much on management quality as on production model. Sound biosecurity practice includes controlled farm access, quarantine of new or returning animals, appropriate waste management, and routine veterinary oversight.

5.3 Food Safety Along the Value Chain

Food safety hazards can be introduced at multiple points along the value chain, from production through processing, distribution, retail, and preparation. On-farm hazards include pathogen carriage in live animals (such as *Salmonella* or *Campylobacter*), chemical residues from veterinary drugs, and contamination from feed or water. Processing-stage hazards include cross-contamination during slaughter and handling, inadequate temperature control, and unsanitary equipment. Distribution and retail hazards include breaks in the cold chain and extended storage under unsafe conditions. Household-level hazards include improper storage, cross-contamination between raw and cooked foods, and insufficient cooking temperatures. The Hazard Analysis and Critical Control Points (HACCP) framework, widely used in food safety management, formalizes this thinking by identifying critical control points along the chain where preventive measures can be applied to eliminate or reduce a hazard to an acceptable level.

5.4 Sustainable and Resilient Food Systems

A One Health approach to food systems looks beyond individual hazard control toward system-level sustainability and resilience. This includes reducing reliance on antimicrobials through improved husbandry and vaccination, integrating animal and crop production to close nutrient loops (agroecological approaches), diversifying production to reduce vulnerability to a single pathogen or market shock, and strengthening food safety governance capacity, particularly in lower-resource settings where informal markets play a large role in food distribution. Climate resilience is an increasingly central consideration, as changing rainfall and temperature patterns affect feed availability, vector-borne livestock disease ranges, and heat stress on animals — themes explored further in Module 6.

5.5 Case Study: Live bird markets — where poultry are sold live and often slaughtered

Live bird markets — where poultry are sold live and often slaughtered on-site — are a vital source of affordable protein and livelihoods across much of Southeast Asia, but they have also been repeatedly implicated in avian influenza transmission due to the close mixing of birds from multiple sources and close human–bird contact during handling and slaughter. Public health authorities in several countries have piloted interventions such as periodic market 'rest days' for cleaning and disinfection, restrictions on overnight bird storage, and improved traceability of bird sources, aiming to reduce disease risk while preserving market access for vendors and affordable protein for consumers. These interventions illustrate a recurring theme in food system One Health work: effective solutions must balance disease control objectives against livelihoods, food access, and cultural practice, rather than pursuing disease control as an isolated goal.

5.6 Hands-On Activity

1. Select a specific animal-source food product relevant to your context (for example, raw milk, poultry meat, or farmed fish).
2. Sketch the value chain for this product from production to consumption, noting each major stage (production, processing, distribution, retail, household preparation).
3. Identify at least one plausible food safety or disease hazard at each stage.
4. Identify the critical control point(s) where intervention would most effectively reduce risk.
5. Propose one feasible intervention at your chosen critical control point, considering cost and practicality for the context you selected.

Module 6: Climate Change and Environmental Drivers of Disease

Climate change is reshaping the distribution, timing, and intensity of health risks at the human–animal–ecosystem interface. This module examines how a changing climate influences infectious disease dynamics, particularly vector-borne disease, explores the broader health consequences of extreme weather and displacement, and reviews adaptation and mitigation strategies relevant to One Health practice.

6 lessons · 12m

6.1 Climate Change as a Driver of Disease

Climate change affects health at the human–animal–ecosystem interface through multiple, often interacting pathways. Rising temperatures can expand the geographic and seasonal range of disease vectors and pathogens into previously unsuitable areas. Changing precipitation patterns alter the availability of vector breeding habitat and the distribution of waterborne pathogens. Ocean warming and changing sea conditions influence the range and toxicity of marine pathogens and harmful algal blooms. Climate variability also affects agricultural productivity and food security, with downstream effects on nutrition and, indirectly, on disease susceptibility. Because these effects operate on top of existing ecological and social drivers discussed in earlier modules, climate change is best understood as a risk multiplier that interacts with land-use change, biodiversity loss, and social vulnerability rather than as an isolated, independent driver.

6.2 Vector-Borne Disease Dynamics Under Climate Change

Vector-borne diseases are particularly climate-sensitive because vector survival, reproduction, and pathogen development within the vector are all temperature- and moisture-dependent. Mosquito-borne diseases such as malaria, dengue, and chikungunya have shown documented range expansion into higher-altitude and higher-latitude areas as warming has made these regions climatically suitable for vector survival. Tick-borne diseases, including Lyme disease, have similarly expanded their geographic range in parts of North America and Europe as warming winters improve tick survival and extend the seasonal window of tick activity. However, the relationship is not simply linear: some regions may become too hot or too dry for certain vectors to persist, illustrating that climate-driven risk projections must account for species-specific thresholds rather than assuming uniform expansion everywhere.

6.3 Extreme Weather Events, Displacement, and Health

Beyond gradual climatic shifts, acute extreme weather events — floods, droughts, heatwaves, and intensified storms — carry direct and indirect health consequences. Floods can displace disease vectors and reservoir hosts into human settlements, disrupt water and sanitation infrastructure, and increase waterborne and vector-borne disease risk in the aftermath. Droughts can concentrate wildlife, livestock, and human populations around dwindling water sources, increasing contact rates and spillover opportunity, while also threatening food security and livestock nutrition. Displacement caused by extreme weather can place affected populations into crowded, under-resourced settings with limited health infrastructure, elevating vulnerability to both infectious and non-infectious health threats. These dynamics illustrate why disaster preparedness and climate adaptation planning increasingly incorporate One Health considerations alongside traditional humanitarian response frameworks.

6.4 Adaptation and Mitigation Strategies

A One Health response to climate-related health risk operates on two complementary tracks. Mitigation strategies aim to reduce the underlying drivers of climate change, including reducing greenhouse gas emissions from livestock production and land-use change, protecting and restoring carbon-sequestering ecosystems such as forests and wetlands, and supporting lower-emission agricultural practices. Adaptation strategies aim to reduce the health impact of climate change that is already occurring or unavoidable, including climate-informed disease surveillance that anticipates shifting vector ranges, early warning systems linked to climate and weather forecasting, strengthening water and sanitation infrastructure resilience, and integrating climate risk into veterinary and public health emergency planning. Because ecosystems that provide climate regulation often simultaneously provide disease-buffering regulating services (as discussed in Module 2), ecosystem restoration frequently functions as both a mitigation and adaptation strategy at once.

6.5 Case Study: Dengue fever, transmitted by *Aedes* mosquitoes, has historically been c

Dengue fever, transmitted by *Aedes* mosquitoes, has historically been concentrated in tropical lowland areas where temperatures reliably support mosquito survival and viral replication. In recent decades, dengue transmission has been documented at increasingly higher elevations in parts of East Africa and Latin America, in areas previously considered too cool for sustained transmission. Researchers attribute this expansion to a combination of rising average and minimum temperatures, which extend the window during which highland areas fall within the vector's viable range, alongside urbanization, which creates abundant artificial water-holding containers that serve as mosquito breeding sites. Public health authorities in affected highland areas have had to extend dengue surveillance and vector control programs into populations with historically low exposure and correspondingly low population immunity, illustrating how climate-driven range expansion can outpace the adaptation of existing health system infrastructure.

6.6 Hands-On Activity

1. Select a geographic region you know well or are professionally interested in.
2. Identify one or two vector-borne or climate-sensitive diseases relevant to that region, whether currently present or plausible under future climate scenarios.
3. Describe how projected changes in temperature, precipitation, or extreme weather in that region could plausibly alter disease risk (expansion, contraction, or seasonal shift).
4. Identify one adaptation measure and one mitigation measure that would be relevant for local health authorities to consider.
5. Note any data or monitoring gaps that would need to be addressed to track this risk over time.

Module 7: Surveillance, Early Warning, and Outbreak Investigation

Detecting health threats early — before they become large-scale outbreaks — is central to One Health practice. This module introduces the design and operation of integrated surveillance systems spanning human, animal, and environmental sectors, distinguishes event-based from indicator-based surveillance, and

walks through the practical steps of outbreak investigation and risk assessment.

5 lessons · 10m

7.1 One Health Surveillance Systems

One Health surveillance refers to the collaborative monitoring of health events across human, animal, and environmental sectors, with structured mechanisms for sharing data and coordinating analysis and response across these domains. Rather than three separate surveillance systems operating in parallel, an effective One Health surveillance architecture establishes formal linkages — shared case definitions where relevant, joint data platforms or interoperable databases, and routine communication channels between human health, veterinary, and environmental authorities — so that a signal detected in one sector can be rapidly cross-checked against data from the others. The goal is to shorten the time between an unusual health event occurring and a coordinated, appropriately scoped response being initiated.

7.2 Event-Based and Indicator-Based Surveillance

Indicator-based surveillance relies on the routine, structured reporting of defined health indicators — for example, notifiable disease case counts reported through an established reporting system on a regular schedule. It provides reliable, comparable data over time but can be slow to detect novel or unexpected events, particularly for diseases not already on a reporting list. Event-based surveillance complements this by capturing unstructured, real-time information from a wide range of sources, including media reports, informal community reports, clinician alerts, and even social media, allowing much faster detection of unusual clusters or novel events, at the cost of requiring active verification before signals can be acted upon. Effective One Health surveillance typically combines both approaches: indicator-based systems provide a stable baseline for known threats, while event-based systems provide the sensitivity needed to catch emerging or unexpected ones.

7.3 Laboratory Networks and Diagnostics

Timely, accurate laboratory confirmation is essential to translating a surveillance signal into a confirmed health event that can guide response. One Health laboratory systems ideally include coordinated networks spanning human clinical laboratories, veterinary diagnostic laboratories, and environmental or food-testing laboratories, with agreed protocols for sample referral, shared quality assurance standards, and mechanisms for rapid results sharing across sectors. Diagnostic capacity gaps — particularly in veterinary and environmental laboratories, which are frequently under-resourced relative to human clinical laboratories in many countries — represent one of the most persistent structural weaknesses in global One Health surveillance capacity, and closing this gap is a recurring priority in national and global health security strategies.

7.4 Case Study: Rift Valley fever (RVF) is a mosquito-borne viral disease affecting li

Rift Valley fever (RVF) is a mosquito-borne viral disease affecting livestock and, through spillover, humans, with outbreaks historically linked to periods of unusually heavy rainfall that expand mosquito breeding habitat. In several East African countries, early warning systems have been developed that combine climate and rainfall forecasting, satellite-based vegetation monitoring (used as a proxy for flooding-favorable conditions), livestock disease surveillance reports, and human clinical surveillance data into a single integrated risk assessment. When climate indicators suggest elevated flooding risk in RVF-prone areas, animal health authorities can intensify livestock surveillance and consider pre-emptive vaccination or movement restrictions before large-scale livestock outbreaks occur, ideally reducing the human spillover events that tend to follow livestock epidemics. This system illustrates the practical value of combining environmental, animal, and human surveillance data streams into a single early warning product rather than relying on any single data source alone.

7.5 Hands-On Activity

1. Choose a disease or health hazard relevant to your context that has both animal and human health relevance.
2. Identify at least one plausible indicator-based data source (for example, a routine disease reporting system) and one plausible event-based data source (for example, community reports or clinician alerts) that could detect this hazard.
3. Sketch a simple pathway showing how a signal from each source would be verified and escalated, and which sector(s) would need to be notified.
4. Identify the laboratory capacity (human, veterinary, or environmental) that would be needed to confirm a suspected event.
5. Note one realistic barrier to timely cross-sector communication in your context, and propose one way to address it.

Module 8: Governance, Policy, and Multisectoral Coordination

Technical solutions alone cannot deliver One Health outcomes without functioning governance structures to coordinate across sectors, mobilize resources, and hold institutions accountable. This module surveys the global governance architecture for One Health, examines national coordination mechanisms, reviews relevant international legal frameworks, and discusses the persistent challenge of financi

6 lessons · 12m

8.1 Global Governance Architecture

Global One Health governance is anchored by the Quadripartite: the World Health Organization (WHO), responsible for human health; the Food and Agriculture Organization (FAO), responsible for agriculture, food security, and food safety; the World Organisation for Animal Health (WOAH), responsible for animal health standards; and the United Nations Environment Programme (UNEP), responsible for environmental protection. These four organizations formalized their collaboration through a joint definition of One Health and a Joint Plan of Action, which establishes shared priorities across six action tracks, including strengthening health systems, reducing zoonotic disease risk, controlling AMR, and integrating environment into the One Health agenda. Each organization retains its own mandate, governance structure, and member-state relationships, meaning Quadripartite collaboration functions through coordination and joint initiatives rather than a single unified command structure — a design that reflects the practical reality of international governance but also requires continuous diplomatic and technical effort to sustain effective collaboration.

8.2 National One Health Coordination Mechanisms

At the national level, effective One Health governance typically requires a formal coordination mechanism — often a multisectoral, multidisciplinary One Health platform, committee, or technical working group — bringing together ministries of health, agriculture, environment, and often livestock or wildlife authorities, along with academic and sometimes civil society representation. Well-functioning national platforms typically have a clear legal or administrative mandate, dedicated (even if modest) staffing and budget, agreed terms of reference defining roles and decision-making authority, and regular meeting cycles tied to concrete deliverables such as joint risk assessments, coordinated outbreak response plans, or national action plans on priority issues such as AMR or zoonotic disease prioritization. A common implementation challenge is that these platforms are sometimes established on paper but under-resourced in practice, functioning well during acute events but losing momentum between crises — underscoring the importance of sustained investment even in the absence of an active outbreak.

8.3 International Health Regulations and Legal Frameworks

The International Health Regulations (IHR, 2005), a legally binding instrument for WHO member states, require countries to develop core capacities to detect, assess, report, and respond to public health events of international concern, and establish a formal mechanism for countries to notify WHO of qualifying events. While the IHR is centered on human health, its implementation increasingly recognizes zoonotic and environmental dimensions of health security, and its core capacities substantially overlap with the surveillance and laboratory capacities discussed in Module 7. Complementary frameworks include WOAH's Terrestrial and Aquatic Animal Health Codes, which set international standards for animal disease reporting and trade-related risk management, and various regional and bilateral agreements governing cross-border animal movement, wildlife trade, and environmental protection. Learners working in specific national contexts are encouraged to identify the specific legal instruments — national public health law, animal health law, and environmental law — that govern One Health coordination in their own setting, as these vary considerably by country.

8.4 Financing One Health

Sustainable financing remains one of the most persistent challenges in One Health governance. Health, agriculture, and environment ministries are typically funded through separate budget lines with distinct accountability structures, creating structural barriers to pooled or coordinated investment even when the underlying health benefits are shared across sectors. Emerging approaches to address this include dedicated multisectoral or pandemic preparedness funds that explicitly support cross-sectoral activities, economic analyses that quantify the shared return on investment from One Health interventions (helping build the case for joint budget allocation), and development partner financing mechanisms that condition support on demonstrated multisectoral coordination. Ultimately, financing structures shape institutional incentives: as long as budgets and performance metrics remain siloed by sector, coordination will tend to remain the exception rather than the norm, regardless of how strong the technical case for collaboration may be.

8.5 Case Study: Several countries facing repeated zoonotic disease events have established

Several countries facing repeated zoonotic disease events have established formal multisectoral One Health coordination platforms following major outbreaks, often initially convened as an emergency response mechanism before being formalized into a standing institution. A common pattern in these experiences is that the platform's credibility and durability depend heavily on early, visible wins — such as jointly conducting a zoonotic disease prioritization exercise to identify the highest-priority diseases for coordinated action, or successfully managing a real outbreak using the new coordination structure — which build institutional buy-in and justify continued investment. Equally common is the challenge of sustaining engagement once the initial outbreak recedes from public and political attention, as competing priorities draw ministry staff time and budget elsewhere. Long-term success has generally depended on embedding One Health coordination functions into existing government structures and budgets, rather than treating the platform as a standalone, donor-dependent project.

8.6 Hands-On Activity

1. Identify a country or jurisdiction you know well (this can be your own).
2. Research or recall whether a formal multisectoral One Health coordination mechanism exists there, and briefly describe its structure if known (or note if you are uncertain).
3. Identify which sectors (health, agriculture, environment, wildlife) appear to be most and least engaged in coordinated health governance in this context.
4. Identify one specific governance gap (for example, absence of a joint budget line, lack of a formal mandate, or absence of environment-sector representation).
5. Propose one concrete, low-cost step that could begin to address this gap.

Module 9: Community Engagement, Risk Communication, and Equity

Technical excellence in surveillance, science, and policy is insufficient without effective communication and genuine community engagement. This module examines the principles of risk communication, explores

participatory and community-based approaches to surveillance and response, and addresses the social, cultural, gender, and equity dimensions that shape how One Health interventions succeed or

6 lessons · 12m

9.1 Risk Communication Principles

Effective risk communication is built on a small number of well-established principles: trust and credibility, built through consistent, transparent, and timely communication, particularly before a crisis occurs, rather than only during one; honesty about uncertainty, acknowledging what is and is not yet known rather than projecting false confidence; audience-appropriate messaging, tailored in language, channel, and cultural framing to the specific audience rather than delivered in generic, technical terms; two-way communication, treating affected communities as partners whose questions, concerns, and local knowledge inform the response, rather than as passive recipients of information; and timeliness, recognizing that early, even partial, communication is generally more effective at maintaining trust than delayed but 'complete' communication. In One Health contexts, risk communication is further complicated by the need to coordinate consistent messaging across human health, veterinary, and environmental authorities, who may have different institutional communication cultures and, at times, differing initial assessments of a situation.

9.2 Community-Based Surveillance and Participatory Approaches

Community-based surveillance engages community members — often including community animal health workers, traditional healers, local leaders, or trained volunteers — as active participants in detecting and reporting unusual human or animal health events, extending the reach of formal surveillance systems into remote or under-resourced areas where formal health infrastructure is limited. Participatory epidemiology takes this further, using structured qualitative methods (such as participatory mapping, seasonal calendars, and matrix scoring) to draw on community members' own observations and knowledge of disease patterns, often generating insights that complement or even predate formal surveillance detection. These approaches depend on building genuine, sustained relationships of trust with communities, providing meaningful feedback on how community-reported information is used, and, where appropriate, providing fair compensation or other incentives that reflect the value of community members' time and knowledge.

9.3 Social, Cultural, and Gender Dimensions

Human–animal–ecosystem interactions are shaped by social roles, cultural practices, and gender dynamics that strongly influence exposure risk and the feasibility of interventions. In many settings, for example, women disproportionately handle food preparation and small livestock care, shaping their specific exposure profile to certain zoonotic risks, while men may be more involved in large livestock management, hunting, or wildlife trade, shaping a different exposure profile. Cultural and religious practices around food, animal handling, and burial can significantly influence both disease risk and the acceptability of proposed interventions — interventions that conflict with deeply held cultural practices are unlikely to be sustained regardless of their technical merit. Effective One Health practice requires understanding these dynamics through genuine community consultation rather than assuming a universal, one-size-fits-all approach to risk and behavior.

9.4 Health Equity and Environmental Justice

Health equity in the One Health context recognizes that exposure to environmental and zoonotic health risks, as well as access to the resources needed to prevent or respond to them, are not distributed evenly across populations. Communities living adjacent to degraded ecosystems, informal settlements with limited water and sanitation infrastructure, and populations economically dependent on high-risk activities such as bushmeat hunting or artisanal livestock keeping often bear a disproportionate share of interface health risks while having the least access to veterinary services, health care, and decision-making power over the policies that affect them. Environmental justice frameworks call attention to these disparities and argue that One Health interventions should explicitly consider who bears the risks and burdens of both disease emergence and control measures, and who benefits from and has voice in the interventions designed to address them, rather than treating equity as a secondary consideration to technical effectiveness.

9.5 Case Study: In several countries with limited veterinary infrastructure in rural a

In several countries with limited veterinary infrastructure in rural and pastoral areas, community animal health worker (CAHW) networks have been integrated into formal rabies surveillance and control programs. CAHWs, often community members trained in basic animal health tasks, are frequently the first point of contact when livestock or domestic dogs show signs of illness, and their reports have in multiple documented instances led to earlier detection of rabies clusters than would have occurred through formal veterinary reporting alone, given the sparse distribution of formal veterinary services in these areas. Successful programs have generally combined CAHW reporting with clear referral pathways to confirm suspected cases, regular refresher training, and mechanisms to provide feedback to CAHWs on outcomes of their reports — reinforcing their sense that their contribution is valued and used, which sustains engagement over time. This case illustrates how community-based approaches can meaningfully extend surveillance reach in exactly the settings where formal infrastructure gaps are greatest.

9.6 Hands-On Activity

1. Select a One Health scenario relevant to a community you know (this may draw on your earlier module activities, for example your interface risk map from Module 1).
2. Identify the key community groups relevant to this scenario, and note any differences in their likely exposure, knowledge, or influence (considering gender, occupation, or social role where relevant).
3. Propose at least one specific mechanism for two-way communication with this community (for example, a community meeting format, a feedback loop for reported events, or a locally trusted messenger).
4. Identify one potential equity concern in your scenario (for example, a group bearing disproportionate risk or having limited voice in decision-making).
5. Propose one adjustment to your engagement approach that would address this equity concern.

Module 10: Emerging Tools, Technologies, and Innovations

New technologies are transforming what is possible in One Health surveillance, analysis, and response. This module surveys pathogen genomics, digital health and artificial intelligence applications, geospatial analysis, and innovations in diagnostics and vaccines, with attention to both their promise and their practical limitations.

11 lessons · 29m

10.1 Genomic Epidemiology and Pathogen Genomics

Genomic epidemiology uses the genetic sequence of pathogens to reconstruct how they are evolving, spreading, and moving between hosts and locations. By comparing genetic sequences from samples collected at different times, places, and host species, researchers can infer transmission chains, identify the likely animal source of a spillover event, detect the emergence of new variants with altered characteristics (such as increased transmissibility or drug resistance), and distinguish a single, ongoing outbreak from multiple independent introductions. The declining cost and increasing portability of sequencing technology has substantially expanded genomic surveillance capacity in recent years, including in resource-limited settings, though gaps in sequencing infrastructure, bioinformatics expertise, and data-sharing practices remain significant barriers to fully realizing this potential globally, particularly in the animal and environmental health sectors relative to human health.

10.2 Digital Health, Big Data, and Artificial Intelligence

Digital tools are increasingly used across the One Health surveillance and response cycle: mobile applications enable frontline health and veterinary workers to report cases in real time from remote areas; digital dashboards integrate data streams from multiple sectors into unified visualizations supporting rapid situational awareness; and machine learning and artificial intelligence models are being applied to tasks such as predicting outbreak risk from combined climate, ecological, and mobility data, automating disease detection from medical or diagnostic images, and scanning large volumes of unstructured text (such as news or social media) for early event-based surveillance signals. These tools offer real efficiency and reach benefits, but they also carry important limitations: model predictions are only as good as the data used to train them, and models trained primarily on data from well-resourced settings may perform poorly or generate misleading results when applied elsewhere; data privacy and governance questions require careful attention, particularly for community-level health data; and technology should be understood as a tool that supports, rather than replaces, the human expertise and relationships that underpin effective surveillance and response.

10.3 Remote Sensing and Geographic Information Systems

Satellite-based remote sensing and geographic information systems (GIS) provide powerful tools for understanding the spatial and environmental dimensions of interface health risk. Remote sensing data can track land-use change, vegetation health (often used as a proxy for rainfall and flooding conditions relevant to vector-borne disease, as seen in the Rift Valley fever example in Module 7), water body extent, and even some aspects of human settlement patterns, often at a resolution and frequency that would be impossible to achieve through ground-based monitoring alone. GIS platforms allow researchers and health authorities to layer this environmental data together with disease case data, human and livestock population data, and infrastructure data (such as roads and health facilities) to identify spatial risk patterns, prioritize surveillance and intervention resources geographically, and model how risk might shift under different environmental or land-use change scenarios.

10.4 Innovations in Diagnostics and Vaccines

Diagnostic innovation relevant to One Health includes point-of-care and field-deployable tests that do not require laboratory infrastructure, multiplex assays capable of simultaneously testing for several pathogens from a single sample (valuable when investigating an undiagnosed illness with several plausible causes), and environmental and wastewater surveillance methods that can detect pathogen presence in a community or animal population without requiring individual sampling. On the vaccine side, platform technologies such as mRNA and viral vector vaccines, which proved capable of rapid development and adaptation during the COVID-19 pandemic, hold promise for faster response to future emerging pathogens, including in veterinary applications. Vaccination of reservoir or bridging host populations — such as oral rabies vaccination of wildlife, or livestock vaccination against diseases with zoonotic potential — represents a particularly powerful One Health strategy, since preventing a pathogen from establishing or amplifying in an animal population can prevent human spillover altogether, often at lower cost than treating human cases after the fact.

10.5 Case Study: International genomic surveillance networks, coordinating sequence data

International genomic surveillance networks, coordinating sequence data from wild bird, poultry, and human samples across many countries, have played a central role in tracking the evolution and geographic spread of avian influenza viruses, including the identification of new reassortant strains and the documentation of expanding mammalian host range in recent years. By rapidly comparing new sequences against a global reference database, researchers and animal health authorities can assess whether a newly detected case represents a known, already-circulating lineage or a genetically distinct introduction, informing decisions about the geographic scope and urgency of response. This system depends on the willingness of countries and laboratories to share sequence data rapidly and openly, which has not always been consistent globally, illustrating that the value of even highly capable technology is ultimately constrained by the governance and data-sharing norms surrounding its use — a theme that connects directly to the governance challenges discussed in Module 8.

10.6 Capstone Overview and Requirements

Your capstone deliverable is a written intervention design document of approximately 1,500–2,500 words (or an equivalent structured format, such as a slide deck with presenter notes, if that better suits your context). It should address a specific, real or realistic health problem at the human–animal–ecosystem interface, ideally drawing on the context and analyses you developed in the applied activities throughout the course, particularly your Module 1 interface risk map, and any relevant analyses from Modules 2 through 10.

Select and clearly articulate a specific health problem at the interface. A well-scoped problem statement identifies the specific health outcome of concern, the relevant human, animal, and environmental dimensions, the geographic or population scope, and why the problem matters (its burden or consequence). Avoid problem statements that are too broad ('zoonotic disease in my country') in favor of specific, actionable framing ('recurrent brucellosis transmission between smallholder cattle and dairy-consuming households in [specific area], linked to informal raw milk sales').

10.7 Step 2: Situation and Driver Analysis

Briefly analyze the ecological, agricultural, social, and/or governance drivers contributing to your problem, drawing on frameworks from Modules 2, 3, 5, and 8 as relevant. Identify the key stakeholders across sectors (for example: veterinary services, public health authorities, environmental agencies, community leaders, and affected households or producers) and their respective roles, interests, and capacities relevant to your problem.

State one or two clear, specific, and realistic objectives for your intervention (for example: 'Reduce human brucellosis incidence linked to raw milk consumption in [area] by improving detection in livestock and safe milk-handling practices among producer households within 18 months'). Objectives should be specific enough to guide concrete activities and, ideally, measurable enough to support monitoring.

Propose a coherent set of activities addressing your objective(s), explicitly spanning more than one sector (for example, combining a veterinary/animal health activity, a human health or community engagement activity, and, where relevant, an environmental or governance activity). Draw on the tools introduced across the course — for example, surveillance design principles from Module 7, risk communication approaches from Module 9, or relevant technologies from Module 10 — as appropriate to your problem.

Identify at least two realistic implementation barriers (for example, funding constraints, governance gaps, cultural acceptability, or data limitations) and propose how your intervention design accounts for or mitigates them. Propose two to three simple indicators that could be used to monitor whether your intervention is being implemented as planned and progressing toward its objective(s).

10.8 Capstone Rubric

Criterion — What Strong Work Demonstrates — Points Problem Definition — Problem is specific, well-scoped, and clearly framed at the human–animal–ecosystem interface. — 20 Driver & Stakeholder Analysis — Analysis identifies relevant ecological, social, or governance drivers and accurately maps key multisectoral stakeholders. — 20 Objectives — Objectives are clear, specific, and realistic for the stated context and timeframe. — 15 Multisectoral Design — Activities genuinely span more than one sector and draw appropriately on course concepts and tools. — 25 Feasibility & Monitoring — Barriers are realistically identified and addressed; monitoring indicators are simple, relevant, and measurable. — 15 Clarity of Communication — Document is clearly organized, well-written, and accessible to a mixed technical/non-technical audience. — 5 A minimum score of 70 out of 100 points, assessed through honest self-review against this rubric (or, where available, peer or facilitator review), is recommended as the threshold for capstone completion and course certification, as described in the Assessment and Certification section at the front of this document.

Because this is a self-paced course, there is no central submission portal by default. Save your completed capstone document, along with the activity outputs from Modules 1 through 10 that informed it, as a personal record of course completion. If you are completing this course through a sponsoring institution, program, or employer, follow any additional submission instructions they provide, which may include submitting your capstone for facilitator review or peer feedback.

Completing this course reflects a substantial investment in building the integrative, multisectoral skills that One Health practice demands. Whether you work in human health, veterinary medicine, environmental science, policy, or another related field, the frameworks and tools in this course are designed to travel with you into practice — revisit specific modules as reference material whenever a new interface health challenge arises in your work.

10.9 Course Glossary

Key terms used throughout this course, consolidated here for quick reference. Term — Definition

Antimicrobial resistance (AMR) — The ability of microorganisms (bacteria, viruses, fungi, parasites) to resist the effects of drugs that once controlled or killed them. Biosecurity — Practices designed to prevent the introduction and spread of disease-causing agents within an animal population or facility. Case definition — A standardized set of criteria used to determine whether an individual (human or animal) should be classified as a case in an outbreak investigation. Dilution effect — The hypothesis that greater biodiversity in a host community can reduce pathogen transmission by including species that are poor amplifying or 'dead-end' hosts. Ecohealth — An approach emphasizing ecosystem-based, participatory, and transdisciplinary methods to understand and improve health, often with a strong equity focus. Ecosystem services — The benefits people obtain from natural ecosystems, including provisioning, regulating, supporting, and cultural services. Emerging infectious disease (EID) — A disease that has newly appeared in a population or is rapidly increasing in incidence or geographic range. Event-based surveillance — Surveillance that captures unstructured, real-time information (e.g., media, community reports) to rapidly detect unusual health events. Indicator-based surveillance — Surveillance based on routine, structured reporting of defined health indicators through an established system. Genomic epidemiology — The use of pathogen genetic sequence data to reconstruct transmission chains, sources, and evolution of disease-causing organisms. International Health Regulations (IHR) — A legally binding WHO instrument requiring countries to build capacities to detect, assess, report, and respond to public health events of international concern. One Health — An integrated, unifying approach recognizing that the health of people, animals, plants, and the shared environment are closely linked and interdependent. Planetary Health — A framework situating human health within the context of planetary-scale environmental change, including climate change and biodiversity loss. Quadripartite — The formal collaboration among WHO, FAO, WOA, and UNEP to coordinate global One Health action. Reservoir host — A species in which a pathogen is maintained and from which it can be transmitted to other host species. Risk assessment — A systematic evaluation of the likelihood of further disease spread and the potential severity of consequences. Spillover — The transmission of a pathogen from its reservoir host species into a new host species, including humans. Vector — An organism, typically an arthropod (e.g., mosquito, tick), that transmits a pathogen between hosts. Zoonosis — A disease or infection that is naturally transmissible between vertebrate animals and humans.

10.10 Foundational One Health Texts

Zinsstag, J., Schelling, E., Waltner-Toews, D., Whittaker, M., Tanner, M. (Eds.) — *One Health: The Theory and Practice of Integrated Health Approaches*, CABI. World Health Organization, Food and Agriculture Organization, World Organisation for Animal Health, United Nations Environment Programme — *One Health Joint Plan of Action (2022–2026)*. Institute of Medicine (US) — *Sustaining Global Surveillance and Response to Emerging Zoonotic Diseases*, National Academies Press.

Millennium Ecosystem Assessment — *Ecosystems and Human Well-Being: Synthesis*, Island Press. Keesing, F. et al. — 'Impacts of biodiversity on the emergence and transmission of infectious diseases,' *Nature*. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) — *Workshop Report on Biodiversity and Pandemics*.

Plowright, R.K. et al. — 'Pathways to zoonotic spillover,' *Nature Reviews Microbiology*. Jones, K.E. et al. — 'Global trends in emerging infectious diseases,' *Nature*. World Organisation for Animal Health — World Animal Health Information System (WAHIS).

World Health Organization — Global Action Plan on Antimicrobial Resistance. Liu, Y-Y. et al. — 'Emergence of plasmid-mediated colistin resistance mechanism mcr-1,' *The Lancet Infectious Diseases*. Food and Agriculture Organization — The FAO Action Plan on Antimicrobial Resistance.

Food and Agriculture Organization — The State of Food Security and Nutrition in the World (annual). Intergovernmental Panel on Climate Change — Sixth Assessment Report, Working Group II (Health chapter). The Lancet Countdown on Health and Climate Change — Annual Report.

World Health Organization — International Health Regulations (2005), Third Edition. World Bank — People, Pathogens and Our Planet: Operationalizing One Health. World Health Organization — Risk Communication and Community Engagement (RCCE) Guidance.

Although designed for self-paced individual study, this course can be adapted for group or organizational training. Facilitators may wish to convene periodic discussion sessions after clusters of modules (for example, after Modules 1–3, Modules 4–6, and Modules 7–9) to allow learners to compare applied activity outputs and discuss context-specific adaptations. The Module 11 capstone project is particularly well suited to small-group peer review, in which learners exchange draft intervention designs and provide structured feedback against the rubric provided.

10.11 Adapting Activities to Local Context

Every applied activity in this course is intentionally designed to be completed using the learner's own professional, community, or regional context rather than a fixed, generic scenario. Facilitators supporting learners with limited direct professional exposure to One Health issues may wish to provide a small set of illustrative regional case scenarios that learners can use as an alternative starting point for the activities.

Learners with a strong quantitative background may extend Module 7 by practicing basic outbreak curve construction and descriptive epidemiological analysis using publicly available outbreak datasets. Learners with a policy or governance focus may extend Module 8 by conducting a more detailed institutional mapping exercise for their own country's One Health coordination structures. Learners with a technical or data science background may extend Module 10 by exploring open-access genomic or geospatial datasets referenced in that module's resources.

Global health guidance, governance structures, and technical best practices evolve continuously. While this course is grounded in well-established scientific and public health principles, learners are encouraged to verify current guidance, disease-specific protocols, and institutional structures against the primary sources listed in the References section, particularly before applying this material in a professional or decision-making context.

Final Assessment & Certificate

The final test draws on questions from every module. The pass mark is 80%. When you pass, Tapi Learn issues a certificate of completion bearing your name, the course title, your final score, a unique certificate number and the signature of the CEO of the Pan African Network for Climate Action (PANFCA). Each certificate carries a verification URL (acla.io/verify/<number>) so employers and partners can confirm its authenticity. You can download the certificate as a PDF directly from the app at any time, and your progress and certificates are backed up to the cloud under your email address.

The Africa Climate Leadership Academy (ACLA) is a pan-African education initiative of the Pan African Network for Climate Action. All Tapi Learn courses are free. Learn more at <https://acla.io> and get the app at <https://acla.io/tapi-learn>.