

## **CONSERVATION MEDICINE / ONE HEALTH PROGRAMS**

**June 29, 2018**

Conservation medicine aims to achieve overall global wellness by addressing the growing disease challenges that threaten the survival of wild animal species and that negatively affect human public health. The field of conservation medicine emphasizes a multidisciplinary approach to studying the interrelated nature of diseases in animals and humans in the context of environmental change. In recent years, the term One Health has evolved and has similar objectives to conservation medicine: aiming to merge animal and human health to benefit both. Human-related environmental changes have escalated in recent years, threatening animal and human health as well as all ecosystems on Earth. With the human population growing to eight billion, we are seeing more and more changes to the environment (e.g., habitat fragmentation and degradation, increased travel and trade, and climate change) that impact the health of all species. However, there is hope. Using a transdisciplinary conservation medicine approach, we are finding solutions to some of these major conservation and health challenges.

The Saint Louis Zoo Institute of Conservation Medicine is one of many organizations with opportunities for students and/or professionals to gain conservation medicine/One Health knowledge and experience. These institutions are working to increase interest and awareness while also training a new wave of conservation medicine practitioners.

Compiled below is a list of institutions for which we are aware exist and that offer opportunities for those interested in conservation medicine/One Health. Please feel free to share this list with others who may find the resource helpful, including any applicable organizations at your school or business. Also, please contact the Saint Louis Zoo Institute of Conservation Medicine (Kathleen Apakupakul at [apakupakul@stlzoo.org](mailto:apakupakul@stlzoo.org)) if you know of any opportunity that is not yet listed here.

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## **ZOOS**

### **Chicago Zoological Society / Brookfield Zoo – Chicago, IL**

<https://www.czs.org/Centers-of-Excellence/Center-for-Conservation-Leadership>

The Brookfield Zoo partners with the University of Illinois in One Health programs as described under the University of Illinois's program; the zoo does not have a separate Conservation Medicine or One Health department. See the University of Illinois program description below.

Centers of excellence at the Chicago Zoological Society include the Center for Science for Animal Care and Welfare and the Center for Conservation Leadership. The Center for Animal Science conducts research and includes projects related to Endocrinology (to improve the well-being and reproductive success of species, both in zoos and in the wild) and Population Genetics (to promote species health and survival and ensure genetic diversity). The Center for Conservation Leadership involves conservation projects around the world in collaboration with various partners.

### **Maryland Zoo – Baltimore, MD**

<http://www.marylandzoo.org/animals-conservation/conservation/>

<http://www.marylandzoo.org/support-the-zoo/volunteer/college-internships/>

The Maryland Zoo has a new Department of Conservation and Research led by Dr. Ellen Bronson. The goal of this newly formed department is to develop projects that involve multiple departments and all levels of stakeholders. The department is undertaking a strategic planning process, which includes collection managers, veterinary staff, education, marketing, public relations, grant-writing managers, and a conservation liaison to the Board. Keepers and other hourly staff provide input to the process and receive mentoring through a Conservation and Research Advisory Group.

The zoo's conservation projects are centered along the zoo's five signature animal programs: Panamanian golden frogs, African penguins, African elephants, polar bears, and chimpanzees. Future programs will add native species and other select species of interest. The zoo is currently heavily involved in the conservation of Panamanian golden frogs and African penguins in their native ranges, and in the conservation of multiple species native to Maryland in collaboration with the Maryland Department of Natural Resources such as black bears, pelicans, snowy owls, and bog turtles. The goal is for these existing programs and all new projects to include ecological, health, and educational components along with conservation initiatives. Multiple original research projects are ongoing at the Maryland Zoo and intersect frequently with the areas of conservation focus, especially involving Panamanian golden frogs and African penguins. Since sustainable solutions involve multiple stakeholders and all levels of personnel, the Zoo's Sustainability Committee is also an important part of the Department of Conservation and Research and continues to expand the green initiatives in the zoo and the surrounding park. The website for student positions, though not necessarily specific to conservation medicine, is included above.

### **National Aquarium – Baltimore, MD**

<https://aqua.org/care>

<http://aqua.org/learn/student-programs>

The National Aquarium has a Conservation Medicine program within the Animal Science and Welfare Department with Dr. Leigh Clayton as the Director. Dr. Kat Hadfield, a senior veterinarian, oversees the preventive medical care of animals in the Aquarium and Animal Rescue program, and “conducts clinical and conservation medicine research in aquatic animal health”. Dr. Hadfield also serves as the primary manager of all veterinary training and mentoring programs. The website for student positions, though not necessarily specific to conservation medicine, is included above.

### **New England Aquarium – Boston, MA**

<http://www.andersoncabotcenterforoceanlife.org/priorities/conservation-leadership/>

The New England Aquarium recently restructured its research and conservation department into the Anderson-Cabot Center for Ocean Life. Its mission is:

Transforming science into action by applying innovative, science-based solutions to combat the unprecedented threats to our oceans represented by climate change and other human activities.

Dr. Charles Innis, Director of Animal Health at the New England Aquarium, participates with the Center on specific projects and the Center staff includes Dr. Rosalind Rolland, Director of Ocean Health, and other experts in animal physiology, animal behavior and ecology. The Center has an innovative endocrinology laboratory specializing in reproductive and stress physiology of marine mammals. A long-term program on endangered North Atlantic Right Whales includes population surveys and monitoring, whale photo-identification and creation of a Right Whale Catalog, health assessments and reducing the impacts of human activities (fishing gear entanglement, underwater noise, vessel strikes). Other Center initiatives include a focus on reducing fisheries bycatch globally, sustainable fisheries and aquaculture, and a program empowering emerging global conservation leaders.

The New England Aquarium also has a rescue and rehabilitation program for stranded sea turtles and marine mammals, many of which are endangered species. This work is primarily conducted in the northeast area although Dr. Innis and his colleagues have been called to other parts of the world as consultants to assist in critical incidents.

### **Palm Beach Zoo – West Palm Beach, FL**

<https://www.palmbeachzoo.org/education>

The Palm Beach Zoo has a Center for Conservation Medicine located in the Animal Care Complex. The Center is described as “the hub for all Palm Beach Zoo conservation initiatives here at the Zoo and around the world.”

A key project at the Center for Conservation Medicine is helping to establish databases on nutritional values for a variety of species and assessing the impact of diet on health. The article “*Avian Influenza Testing & Surveillance*” also references avian influenza as an important emerging disease because the viruses transmit diseases among animals and humans.

### **Saint Louis Zoo – St. Louis, MO**

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

Saint Louis Zoo established the Institute for Conservation Medicine (ICM) in 2011. The ICM takes a holistic approach to research on wildlife, public health, and sustainable ecosystems to ensure healthy animals and healthy people.

Veterinarians, ecologists, and human medical professionals are recognizing the role of infectious disease as an increasing threat to the health of animals, humans, and ecosystems. A number of these pathogens, including rabies and Ebola viruses, directly affect the health of wildlife and human populations. Animals housed at zoos may serve as sentinels for emerging diseases of humans and animals in surrounding areas.

The Saint Louis Zoo's conservation medicine research focuses on diseases that affect the conservation of threatened and endangered wildlife species. Scientists study the origin, movement, and risk factors associated with diseases so they can better understand the impact on the conservation of wildlife populations; the links between the health of zoo animals and free-living wildlife populations; and the movement of diseases between wildlife, domestic animals and humans.

The ICM is involved in several projects spanning the globe. These include: a study of box turtles in Missouri focused on environmental factors that may affect their health and have implications for humans, health assessments of dromedary camels used for milk in Kenya since the lack of pasteurization results in humans being exposed to zoonotic pathogens in camel milk, and how exposure to endocrine disrupting compounds (EDCs) in water and can affect human and animal health. The ICM is also working with the Galápagos National Park (GNP) to conserve giant Galápagos tortoises by conducting applied science to study their health and movements and develop strategies to reduce threats to the tortoises.

### **Smithsonian National Zoological Park - Washington D.C.**

<https://nationalzoo.si.edu/SCBI/GlobalHealth/>

<https://nationalzoo.si.edu/smithsonian-global-health-program>

The Smithsonian National Zoo Conservation Biology Institute (SCBI) has a Global Health program that involves multidisciplinary expertise in wildlife medicine, conservation pathology, training of international professionals, and investigation of emerging infectious diseases to combat threats to conservation and public health worldwide.

Smithsonian's Global Health Program (SGHP) works with international partners to combat threats to wildlife, human, and ecosystem health and survival by addressing these challenges at their source: the human-wildlife interface. SGHP is based upon the One Health platform, which recognizes that the health of all species is intertwined and closely dependent upon each other. As such, SGHP scientists utilize a broad range of expertise to address wildlife health concerns, investigate disease at the human/wildlife interface, and conduct training in an effort to build intervention and response capacity worldwide.

As stated on the SGHP website:

The fate of human communities, wildlife, and ecosystems become more and more tightly interwoven as people continue to expand and the world becomes increasingly interconnected through the ease of travel. Animal trafficking and land-use change are constantly bringing humans and wildlife into close contact and providing opportunities for the spread of diseases into new locations and new species. Worldwide, an estimated 75 percent of diseases affecting human health are caused by pathogens originating in animals (zoonotic). These include HIV/AIDS, Ebola, SARS, influenza, and MERS coronavirus, just to name a few.

More information on SGHP programs is on the website, including sections on Public Health & Pathogen Detection, Global Health Exchange Program and Wildlife Outbreak Research & Response.

**Wildlife Conservation Society (WCS) – New York City, NY (HQ)**

<https://www.wcs.org/our-work/solutions/health>

<https://www.wcs.org/education/educators>

WCS is affiliated with the New York City area zoos: Bronx Zoo, Central Park Zoo, Prospect Park Zoo, Queens Zoo and the New York Aquarium.

Wildlife Conservation Society (WCS) recognizes that health and welfare of people and communities across the globe are inextricably connected to their mission of protecting wildlife and wild places, and is working with nations to achieve these goals. The website refers to WCS One World – One Health™ interdisciplinary approach and states:

In the last few decades, it has become increasingly evident that conservation, human health, and the health of wild and domestic animals are all inextricably linked. A single pathogen can wipe out the last populations of an endangered species and, in turn, threaten the stability of local human populations. Thus, there is an urgent need to simultaneously address the health of people and animals, recognizing that disease poses challenges to both conservation of the planet's biodiversity and efforts to improve the quality of human life.

WCS employs three primary strategies:

- Build local capacity to care for and protect the health of wildlife worldwide.
- Gather and apply critically needed information to protect the health of wildlife, people, and domestic animals, all underpinned by environmental stewardship.
- Promote policies, guidelines, and best practices to ensure a healthy planet.

WCS develops and implements solutions that achieve long-term conservation success and create a healthier world. By engaging partners across conservation, public health, agriculture, and beyond, WCS provides critical information that influences policy and action.

A Master degree for students interested in ecological and social change and a Conservation Education fellowship are both described on the WCS education page listed above.

### **Zoo New England / Franklin Park Zoo – Boston, MA**

<http://www.zoonewengland.org/protect/inside-our-zoos/conservation-medicine-program>

The Conservation Medicine program at Zoo New England (ZNE) is led by Dr. Eric Baitchman, the Director of Animal Health and Conservation Medicine. The program has a One Health approach and involves three tenets: Genomics, One Health Research and Education, and Preservation of Biodiversity.

Genomics applies genomic technologies and translational medicine to zoo and wildlife species. Four pilot projects will serve as proof of the concept that such studies will benefit both animal and human health. ZNE hopes to hold a workshop to present the results of these pilot projects and discuss a future center for genomic medicine for zoological species to serve the AZA and other institutions.

One Health Research and Education includes a ZNE and Harvard University Medical School clinical elective for 4<sup>th</sup> year Harvard Medical School MD and MD/PhD students, which involves a one-month rotation to illustrate that transdisciplinary collaboration and communication between human and veterinary medical professionals can benefit healthcare for both humans and animals.

Preservation of Biodiversity enhances ecological health and in turn, the health of animals and humans. ZNE has had a leadership role in the Panama Amphibian Rescue and Conservation Project for 10 years, working to conserve critically endangered species of amphibians in Panama. On a local level, ZNE initiated the Franklin Park Biodiversity Project with a survey of plants and animals in Franklin Park; future plans include collaboration with local ecologists and biologists, and community outreach using iNaturalist.

### **Auckland Zoo – Auckland, New Zealand**

<http://www.aucklandzoo.co.nz/sites/conservation/in-the-zoo/research>

The Auckland Zoo includes the New Zealand Centre for Conservation Medicine. The zoo website describes conservation medicine as focusing on the connections between human, animal, and environmental health, which often involves collaborating with many different experts to help solve disease-related problems. The Centre includes “a veterinary team who take a conservation medicine approach to everything that they do.” The Centre’s senior veterinarian, Dr. Richard Jakob-Hoff, is currently working with conservation partners to establish ecosystem health maps of sanctuary islands Tiritiri Matangi and Hauturu (Little Barrier). The Centre also works with breeding programs for critically endangered wild animals.

### **Perth Zoo - Perth, Australia**

<https://perthzoo.wa.gov.au/veterinary-services>

The Perth Zoo website notes, “Conservation Medicine is a growing scientific discipline which aims to understand the role of health and disease in wild animals (as ecosystems rather than individuals) and how it relates to their conservation.”

Veterinarians at the Perth Zoo published a paper (International Zoo Yearbook, 2010) stating key aspects of conservation medicine include the potential impact of wildlife disease on biodiversity and the importance of wildlife health within the continuum of human and ecosystem health. Challenges for future growth are examined, and the paper states that successful zoo-based conservation medicine activities rely on strong relationships and broad acceptance across the entire Zoo of the importance of conservation medicine outcomes.

**Zoological Society of London's Institute of Zoology – London, UK**

<https://www.zsl.org/science/about-the-institute-of-zoology>

The Institute of Zoology (IoZ) is the scientific research division of the Zoological Society of London (ZSL) and works on conservation biology and scientific issues relevant to preserving animal species and their habitats. Fundamental and applied research is performed in five thematic areas, two of which are related to Conservation Medicine.

The Wildlife Epidemiology area of research, led by Andrew Cunningham, involves the identification and investigation of wildlife diseases (both infectious and non-infectious) ranging from basic studies to the assessment of their likely impacts on human health and biodiversity conservation. IoZ uses inter-disciplinary approaches to understand how diseases influence their host populations and the mechanisms underlying disease emergence in wildlife, domestic animals and humans.

The People, Wildlife and Ecosystems area of research focuses on understanding processes that promote and impede human-wildlife coexistence, evaluating the contribution of ecosystem services to sustainable livelihoods, economies and society, and understanding and predicting the impacts of policy and management interventions on conservation outcomes.

## **OTHER ORGANIZATIONS**

### **Centers for Disease Control and Prevention – Atlanta, GA**

<https://www.cdc.gov/onehealth/>

<https://jobs.cdc.gov/students>

The One Health concept recognizes that the health of people is connected to the health of animals and the environment. CDC uses a One Health approach by working with physicians, ecologists, and veterinarians to monitor and control public health threats and learning how diseases spread among people, animals, and the environment. Animals also share human susceptibility to some diseases and environmental hazards and therefore they can serve as early warning signs of potential human illness. For example, birds often die of West Nile virus before people get sick with West Nile virus fever.

The Zoonoses Education Coalition (ZEC) has developed a set of evidence-based, plain language recommendations, which can be used by everyone involved in promoting healthy pets and healthy people. CDC, the United States Department of Agriculture (USDA), and the 4-H Public Health Youth Education Program have an ongoing partnership to educate youth on the transmission and prevention of zoonoses.

CDC scientists study how diseases in animals become threats to human health in the United States and around the world. They also look at how changes in the environment affect the health of animals and humans. Such research can aid in understanding:

- How viruses, bacteria, and parasites spread between animals and humans.
- How a person's behavior can increase the risk that they will get sick from an animal.
- How quickly these diseases can spread.

Diseases can spread around the world very quickly, so it is important for CDC to work closely with other countries to build strong partnerships with human and animal health organizations. The CDC website for students, though not necessarily specific to One Health, is included above.

### **National Oceanic and Atmospheric Association – Silver Spring, MD (HQ)**

<http://cpo.noaa.gov/Serving-Society/NOAA-One-Health>

<http://cpo.noaa.gov/AboutCPO/SocietalChallenges/NOAAOneHealth.aspx>

NOAA is a federal scientific agency that is part of the US Department of Commerce. NOAA is highly focused on data, modeling, and other “tools” to assess environmental conditions. NOAA’s original focus areas were weather, marine charts for coastal areas, and fisheries however, they have expanded into numerous other areas including One Health. The NOAA website states, “The One Health concept recognizes that the health of humans is inextricably linked with the health of animals and the environment.” NOAA One Health is an agency-wide group that aims to advance NOAA’s science and services to inform health decisions through improved understanding of the linkages between environmental conditions and health outcomes, and the delivery of useful products, data, and tools.

### **Veterinary Initiative for Endangered Wildlife (VIEW) – Bozeman, MT**

<http://www.viewwildlife.org/>

The Veterinary Initiative for Endangered Wildlife (VIEW) is a conservation organization that focuses on the need to address health threats as part of a comprehensive strategy for protecting endangered wildlife.

The VIEW website states that:

...the serious nature of infectious diseases transmitted across species is increasing. Numerous conservation efforts with endangered species have demonstrated the potential impact of disease to limit recovery of wildlife. For example, epidemics of canine distemper have been reported in wild African lions and captive tigers. Infectious and transmissible disease, when not identified, treated, and prevented, can do untold, yet preventable, harm to wildlife populations, domestic animals, and humans.

VIEW focuses on building local expertise and provides training and infrastructure to support locally sustainable wildlife disease investigation, prevention and treatment. VIEW also conducts research and promotes policies that ensure healthy environments for wildlife and the people and domestic animals that share their habitat.

### **World Wildlife Fund (WWF) – Gland, Switzerland (HQ)**

<https://www.worldwildlife.org/initiatives>

<https://www.worldwildlife.org/about/careers>

The World Wildlife Fund's mission is not focused on One Health and/or Conservation Medicine in the sense that the organization does not do research or study the interrelationships between animal and human health issues. The mission of the WWF has changed to include human populations however as described on the website:

WWF's work has evolved from saving species and landscapes to addressing the larger global threats and forces that impact them. Recognizing that the problems facing our planet are increasingly more complex and urgent, we have refined the way in which we work around an ambitious new strategy. Our new strategy puts people at the center and organizes our work around six key areas: forests, marine, freshwater, wildlife, food and climate. By linking these six areas in an integrated approach, we can better leverage our unique assets and direct all our resources to protecting vulnerable places, species and communities worldwide. People are at the center of our work because together we can change the trajectory of the threats to nature, and help ensure nature's ability to provide—for the sake of every living thing, including ourselves.

WWF works in 100 countries around the globe. The organization focuses on efforts to conserve specific species, particularly those whose protection influences and supports the survival of other species. WWF also works to protect specific places based on the wealth and variety of life they support, challenges faced, and WWF's ability to have a positive impact on them. The WWF website for student internships is included above.

## **UNIVERSITIES**

### **Berry College - Mount Berry, GA**

<http://www.berry.edu/academics/majors/onehealth/>

Berry College offers an undergraduate One Health Minor, one of only a few colleges to do so.

The Berry College website states:

One Health encourages transdisciplinary collaborations between numerous specialties ... and by understanding the contributions of each discipline and the techniques they bring to bear on such problems, the student of One Health gains a unique understanding of population health and its relationship to the environment, as well as how to assemble an effective One Health team.

The One Health minor requires three One Health Sciences (OHS) courses plus additional elective courses from a select list. The OHS courses provide the student with a conceptual framework for One Health, details into the techniques and methods used in investigations and research, and development and execution of their own research project.

This minor degree program would be useful to undergraduate students applying to medical or veterinary schools and those students interested in a career in a health care or environmental-related field will benefit by understanding the One Health approach.

### **Cornell University – Ithaca, NY**

<https://www2.vet.cornell.edu/departments/population-medicine-and-diagnostic-sciences/public-health-and-international-programs>

The mission statement of Cornell's College of Veterinary Medicine (CVM) specifically states:

We promote research ....to better inform the practice of medicine, public health and policy ... We seek to advance understanding of both animal and human health, foster open collaboration across disciplines ...

The CVM is "dedicated to advancing animal and human health through discovery-based research, the delivery of excellent clinical care, and continued vigilance against the spread of diseases". The traditional DVM program is offered as well as Master and PhD degrees, which include study in infectious disease epidemiology, biomedical and biological science, and food systems for global health.

The CVM also administers a Master of Public Health program, which takes a One Health approach to solving public health problems and recognizes that an interdisciplinary approach is needed to focus on the interrelationships between animals, humans and the environment. The MPH program involves cross-campus initiatives related to sustainability and international issues.

### **Duke University – Durham, NC**

<https://sites.globalhealth.duke.edu/dukeonehealth/trainingprogram/>

Duke University has an established interdisciplinary One Health team which serves as the base for the expanding Duke research portfolio in One Health. As part of these efforts, Duke University offers an annual One Health training program with a 9-credit format.

The objectives of the annual One Health Training are to introduce the concept of One Health problem solving - combining public health, veterinary health, and environmental health training; strengthen global surveillance; and consider interventions to reduce infectious disease public health threats. Course work involves epidemiology and virology (particularly influenza) training, along with how to achieve better collaborations between US governmental agencies and various ministries of health or agriculture. Participants are a diverse group of students who must be nominated by representatives from sponsoring organizations. A bachelor degree from an accredited college or university is required with a minimum GPA of 3.0 on a 4.0 scale, or the foreign equivalent to a US bachelor degree with similar grading criteria. The above link provides more information on the application process.

### **Fontbonne University – St. Louis, MO**

<https://www.fontbonne.edu/academics/departments/biological-and-physical-sciences-department/center-for-one-health/>

<https://www.fontbonne.edu/academics/departments/biological-and-physical-sciences-department/one-health-certificate/>

Fontbonne University's Biological and Physical Sciences Department offers a One Health Certificate, which was developed in partnership with the St. Louis Zoo's Institute of Conservation Medicine. Dr. Sharon Deem, Director of the ICM, states the Fontbonne program "offers a trans-disciplinary, holistic approach necessary to solve the 21<sup>st</sup> century challenges that increasingly threaten wildlife species survival, ecosystem sustainability and public health." The One Health program is described as:

One Health is a growing field combining human medicine, veterinary medicine and environmental conservation to study the interconnectedness of the world. As human and animal populations coexist in closer environments, the health and well-being of all become intertwined. Diseases like avian flu and epidemics like colony collapse in bee populations impact both animals and humans. One Health students will take a close look at the intersection of disease transmission, climate change, public health, animal health and more as they explore this increasingly critical field.

It is noteworthy that the program at Fontbonne is offered to undergraduates, while most other One Health programs are offered as part of graduate degree programs.

Fontbonne University partners with the Saint Louis Zoo Institute of Conservation Medicine

### **Michigan State University – East Lansing, MI**

<https://reg.msu.edu/AcademicPrograms/ProgramDetail.aspx?Program=5256>

<https://natsci.msu.edu/news-events/news/2016-08-new-study-abroad-course-conservation-medicine-in-new-zealand/>

Michigan State University has two programs focused on Conservation Medicine.

A Graduate Specialization in Fish and Wildlife Disease Ecology and Conservation Medicine is administered by the Department of Fisheries and Wildlife and the College of Agriculture and Natural Resources. This is available as an elective to master and doctoral students in the College of Veterinary Medicine, College of Agriculture and Natural Resources, and College of Natural Science.

The website states

The Specialization in Fish and Wildlife Disease Ecology and Conservation Medicine is designed to provide students with improved understanding of the likely consequences of increased contact between fish and wildlife, domestic animals and human populations for emergence and spread of infectious diseases. Students will gain a sound understanding of the basis of fish and wildlife disease, and an appreciation of the diagnostic and surveillance tools needed to move toward effective disease control among wild populations and ecosystems. Students will also obtain the skills that will enable them to work effectively within interdisciplinary and interagency teams to develop disease surveillance, control, and prevention plans.

Students may also compete for the annual Hal and Jean Glassen Conservation Medicine Fellowship given to a student pursuing graduate-level research related to the goals of this specialization.

The Department of Integrative Biology also offers a study abroad course in conservation medicine in New Zealand. This course considers the relationships between animal health, ecosystem/environmental health, and human health. "Human health depends on healthy ecosystems," said Jeanette McGuire, integrative biology assistant professor. "More than 75 percent of new and emerging diseases are zoonotic—they move between animals and humans. One in five diseases results from preventable environmental exposures. To solve complex problems such as health issues, researchers and medical professionals will need the skills, tools and background provided by an integrative approach to global health...."

### **Ohio State University – Columbus, OH**

<http://vet.osu.edu/education/veterinary-public-health-program>

The Ohio State College of Veterinary Medicine partners with the College of Public Health to offer a Veterinary Public Health specialization towards the Master of Public Health degree. The MPH-VPH degree was developed to provide students with the public health credentials to become leaders in zoonoses prevention and control programs around the world. This program recognizes that veterinary sciences are relevant to more than just animal health; they also play an important role in maintenance of the health of human populations. Because animals (pets, livestock, and wildlife) are the major source for the pathogens involved in zoonoses and foodborne illnesses, professionals trained in veterinary sciences are often the most qualified individuals to deal with these public health issues. Students will gain an understanding of the epidemiology and ecology of zoonotic and foodborne diseases in pet animal, livestock and human populations. Students also learn about animal population systems, including the roles of companion and food-producing animals in society, food production and distribution systems, food safety and food security and intervention strategies. The program is open to veterinarians, as well as other professionals, including students with science backgrounds interested in public health.

The Ohio State College of Veterinary Medicine partners with the Columbus Zoo and Aquarium.

### **Tufts University – Medford, MA**

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

<https://www.warnell.uga.edu/master-science-conservation-medicine>

Tufts University Cummings School of Veterinary Medicine has a Center for Conservation Medicine (CCM). The CCM mission is “to advance the health of animals, people and the environment through professional training, research and service to communities around the globe, utilizing a conservation medicine approach.”

The CCM provides opportunities for students to participate in global initiatives concerning animal, human, and ecosystem health through three programs:

A Master of Science in Conservation Medicine (MCM) is a multi-disciplinary program designed to examine the relationships between environmental, animal, and human health. The program confronts the disciplinary gaps that obscure the broad view of “One Health” and seeks graduate students from a variety of fields including veterinarians, natural and social scientists, engineers, public health and medical professionals, lawyers, policy and wildlife professionals, and others interested in applying their expertise to conservation medicine issues. This program includes a collaboration with the University of Georgia – Warnell School of Forestry & Natural Resources- Master of Science in Conservation Medicine,

The Wildlife Conservation Medicine (WCM) Signature Opportunity is designed to teach the clinical skills required for the medical care and management of wildlife, and to develop an understanding of the habits of wild animals and the environmental conditions in which they live. The Tufts Wildlife Clinic is the federally designated wildlife care and rehabilitation center for the New England region and offers opportunities for students to learn about wildlife and habitat preservation. The Clinic also serves as the basis for research and monitoring programs, including zoonoses and bioindicators of environmental change.

The International Veterinary Medicine (IVM) Signature Opportunity supports global veterinary medical practices and issues of environmental, animal, and public health. The opportunity includes work toward community-based solutions to problems that threaten sustainable agriculture and environmental integrity. Students learn to apply their veterinary knowledge to understand the ecology, sociology, and economics of developing or developed countries through field research. A Post Graduate Certificate Program in IVM is available.

### **University of Arizona**

<https://publichealth.arizona.edu/departments/epi-bio/one-health-program>

The University of Arizona College of Public Health offers a Master of Public Health (MPH) in One Health. The One Health program includes faculty from over a dozen departments at the University of Arizona and focuses on an integrated assessment of health issues through the consideration of human, animal, and environmental aspects to address complex disease systems. The program emphasizes integrated thinking to identify critical linkages among human, animal, and environmental systems, how to target them for intervention, monitoring to recognize sentinel events, and data to detect and prevent public health events.

Students with undergraduate degrees in various biological or physical sciences, anthropology, global health and others can be successful in this Master degree program. The program gives students the opportunity to acquire a deeper understanding of public health methodologies while exposing them to partnerships that are crucial to successful programs including microbiology, animal sciences, natural resources, climate change, and water use.

**University of California, Davis – Davis, CA**

<http://www.vetmed.ucdavis.edu/mpvm/>

<http://www.vetmed.ucdavis.edu/onehealth/about/project.cfm>

The University of California, Davis offers a Master of Preventive Veterinary Medicine (MPVM) degree program to veterinarians and other medical professionals. The program curriculum includes statistics, epidemiology, and implementation of research, along with animal/human health leadership, ecosystem health, and infectious disease epidemiology. Electives include disease ecology, zoonoses, and risk analysis, among others.

The Veterinary School has a One Health Project, the goal of which is to “prepare a new generation of veterinary practitioners ... in a broad arena that includes not only traditional animal medicine, but also public health and ecosystem conservation.” The One Health Project notes that veterinarians already work at the interface of human, animal and environmental health. The unique challenges facing the world today mean that practitioners of the future must be prepared to think and strategize with their science colleagues, create team solutions, and problem-solve as a global unit on behalf of the changing planet.

**University of Florida – Gainesville, FL**

<http://research.vetmed.ufl.edu/one-health-2/uf-rising-global-health-initiative/>

<https://wildlife.forensics.med.ufl.edu/programs/courses/conservation-medicine/>

<http://research.vetmed.ufl.edu/one-health-2/educational-opportunities-in-one-health/>

The University of Florida has multiple programs related to Conservation Medicine/One Health. The College of Public Health & Health Professions and the College of Veterinary Medicine jointly offer a DVM-MPH degree for students interested in veterinary public health. This program provides a foundation for students wishing to pursue public health positions in research, government, international health, and private industry. Public health-trained veterinarians are uniquely qualified to address and meet the needs of emerging diseases, food system problems, and respond to acts of bioterrorism. The College of Public Health & Health Professions also offers a Certificate of One Health through the distance-learning program for non-degree seeking students, which typically takes one year to complete.

The PhD in Public Health with a One Health concentration is a research-oriented health degree that emphasizes working across public health, veterinary health, and environmental health disciplines to tackle difficult health problems. This program is designed to bridge the gap between various areas of animal, plant, and human health to improve the well-being of all species.

The University also offers a Graduate Certificate in Wildlife Forensic Sciences and Conservation, which examines the links between climate, habitat and land use, emergence and re-emergence of infectious disease, parasites, environmental contaminants, and the maintenance of biodiversity as an indicator of the ecohealth of a community. This program will discuss conservation with wildlife forensic science using a transdisciplinary approach. Forensics, as it relates to issues of wildlife crime, the illegal wildlife trade, and the consumption and trade of bushmeat; ecotoxicology as it relates to forensics and the use of plants to harm humans, livestock, or wildlife; and applied techniques in conservation as it relates to the forensic sciences will all be discussed.

**University of Georgia – Athens, GA**

<http://vet.uga.edu/academic-affairs/international-program/>

The University of Georgia College of Veterinary Medicine has an International Program to help students understand the inter-relatedness of animal health globally and make meaningful contributions to international veterinary medicine. The College offers a Certificate in International Veterinary Medicine (CIVM) in the form of an externship for professional students. The certificate program is interdisciplinary and familiarizes students with issues and opportunities in this field, including international animal and public health concepts.

**University of Illinois – Champaign, IL**

<http://vetmed.illinois.edu/college-organization/center-for-one-health-illinois/>

<http://vetmed.illinois.edu/education/doctor-veterinary-medicine-degree/dvm-master-public-health-degree/>

The University of Illinois College of Veterinary Medicine includes The Center for One Health Illinois, which focuses on fostering human, animal, and ecosystem health through the three broadly defined areas of education, research, and public outreach. The website describes these areas as

- *Education:* To educate a new cadre of health professionals who understand the determinants and contributing factors affecting human, animal, and ecosystem health (One Health), and how public health policy is developed and affects the health of all three
- *Research:* To understand disease processes that occur at the interface of human and animal activities and their effects on the environment
- *Outreach:* To improve our society's preparedness and response to natural and intentional exposures of biological, chemical, and physical agents

The College of Veterinary Medicine offers a dual DVM/MPH degree in conjunction with School of Public Health.

The Center for One Health partners with the Conservation Medicine Center of Chicago, the School of Public Health, and the Zoology Pathology Program. The College of Veterinary Medicine partners with the Brookfield Zoo and the Shedd Aquarium

### **University of Minnesota – Minneapolis, MN**

<https://www.vetmed.umn.edu/centers-programs/global-one-health-initiative>

<https://www.vetmed.umn.edu/centers-programs/global-one-health-initiative/one-health-systems-mapping-and-analysis-resource-toolkit>

<http://www.sph.umn.edu/academics/dual-joint-degrees/veterinary-medicine/>

The University of Minnesota has two distinct programs related to One Health.

The College of Veterinary Medicine has a Global One Health Initiative which partners with other organizations to create “innovative solutions to tackle complex problems crossing human, animal and environmental health”. Students can obtain a dual DVM/MPH degree. As described on the College of Veterinary Medicine website:

The college embraces the “One Health” concept, which aims to transform new knowledge into better health for animals, people, and the environment. The college also plays an important role in the health of the community by assuring food safety, conducting biomedical research, preventing zoonotic diseases, and ... protection of Minnesota’s wildlife natural resource

The University of Minnesota leads a cooperative agreement with U.S. Agency for International Development (USAID) called the One Health Workforce project. This project focuses on creating a global workforce that is prepared to predict, detect, and respond to infectious disease outbreaks, and to create a new kind of health professional with the practical skills and knowledge needed to address the multi-sectoral nature of emerging infectious disease threats. The One Health Systems Mapping and Analysis Resource Toolkit (OH-SMART) is an interactive mapping process fostering improved cross-agency interactions for comprehensive, systematic One Health approaches to infectious disease threats. The University of Minnesota, in collaboration with the U.S. Department of Agriculture (USDA) One Health Coordination Center, has piloted OH-SMART in the United States.

### **University of Missouri – Columbia, MO**

<https://mizzouadvantage.missouri.edu/medicine/>

<https://healthprofessions.missouri.edu/mpH/mpH-degree/dual-degrees/mpHdvm-doctor-veterinary-medicine/>

<https://healthprofessions.missouri.edu/mpH/mpH-degree/emphasis-areas/>

The University of Missouri College of Veterinary Medicine does not have a conservation medicine program per se although two degree options are available that focus on animal and human health. A dual MPH/DVM degree is available although students must be admitted to the College of Veterinary Medicine and the Master of Public Health programs independently. A Master of Public Health degree with a focus on Veterinary Public Health is also available from the School of Health Professions. Students in this emphasis area receive training in zoonotic disease prevention, food safety and other emerging issues in animal and human health.

Mizzou provides grant funding for MPH/DVM students to participate in internships with the St. Louis Zoo ICM program.

### **University of Washington – Seattle, WA**

<https://globalhealth.washington.edu/education-training/undergraduate-minor>

<https://globalhealth.washington.edu/education-training/graduate-certificates/global-health>

<http://deohs.washington.edu/cohr/graduate-certificate-one-health>

The University of Washington School of Public Health has two departments that have a One Health approach. The Department of Global Health offers a Global Health minor to undergraduates and a Graduate Certificate in Global Health. The undergraduate minor is available to undergraduates from all majors and discipline. The Graduate Certificate curriculum emphasizes the sociopolitical, economic, and geographic factors that, in addition to biomedical factors, have an impact on health in developing countries. The University also offers a Master of Public Health, which provides interdisciplinary studies in global health.

The Department of Environmental and Occupational Health Sciences has a Center for One Health Research. The mission of the Center is to “investigate the health linkages between humans, animals, and their shared environments; including zoonoses, comparative clinical medicine, animals as sentinels, animal worker health, food safety, and .... develop innovative strategies for healthy coexistence between humans and animals in sustainable local and global ecosystems.” Areas of research include zoonotic infectious diseases, animals as "sentinels", surveillance of Emerging Diseases, and One Health Communication and Collaboration. The Center offers a Graduate Certificate in One Health. Specific areas of emphasis include zoonotic diseases, the human animal bond, integrated approaches to human, animal, and environmental risk and outcome data, and human animal medicine (including clinical comparative medicine).

### **Washington University – St. Louis, MO**

<https://onehealth.wustl.edu/>

<https://brownschool.wustl.edu/Academics/Master-of-Public-Health/Pages/Global-Health-Specialization.aspx>

Washington University School of Medicine has a growing focus area on One Health. The School of Medicine is working with the Saint Louis Zoo’s Institute for Conservation Medicine (ICM), Saint Louis University, and the University of Missouri-Columbia veterinary school. In 2016, Washington University students formed One Health at WUSM, and numerous One Health events have taken place including a seminar titled “The Big Bet: How Linking Human and Veterinary Medicine Improves Health Across Species”.

Among other joint efforts, School of Medicine and zoo researchers are collaborating to study viruses in lemurs faced with habitat destruction and extinction. “The increase in interactions between humans and wildlife can lead to more infectious diseases in both,” said Dr. Sharon Deem, Director of the St. Louis Zoo ICM. “As importantly, animals may act as reservoirs or sentinels of diseases for humans. It requires physicians, veterinarians and scientists to work together to solve the global health challenges that we will face in our generation.”

The Brown School of Social Work offers a Master of Public Health degree, which includes four areas of specialization, one of which is Global Health. The current description of the Global Health specialization is focused only on human health issues; however, there is growing interest in bringing the One Health concept into this program.

### **Murdoch University – Perth, Australia**

<http://www.murdoch.edu.au/School-of-Veterinary-and-Life-Sciences/Our-courses/Postgraduate/Conservation-Medicine/Master-of-Wildlife-Health-and-Conservation/>  
<http://www.murdoch.edu.au/School-of-Veterinary-and-Life-Sciences/Our-courses/Postgraduate/Conservation-Medicine/BSc-DVM-Degree/>  
<http://www.murdoch.edu.au/School-of-Veterinary-and-Life-Sciences/Our-courses/Postgraduate/Conservation-Medicine/Master-of-Veterinary-Studies-in-Conservation-Medicine/>

Murdoch University School of Veterinary & Life Sciences offers a five-year BSc/DVM program in which undergraduate students can participate in conservation medicine field trips to South Africa and New Zealand that are organized by staff in the Conservation Medicine Program. These field trips provide students with an immersion experience in the fields of wildlife and conservation medicine. Fifth year students can select Advanced Topics in Wildlife, Zoological and Conservation Medicine as a focus area.

A Master of Veterinary Studies (Conservation Medicine) is also offered through distance education or at the Perth Campus to veterinarian residents in Australia or overseas. The Master of Veterinary Studies (Conservation Medicine) will provide veterinarians with training and expertise, which can be applied in private practice, zoos and wildlife conservation projects.

The University also offers a postgraduate Master of Wildlife Health and Conservation that offers training in techniques and research methods necessary to answer complex questions related to wildlife health in contemporary biodiversity conservation. Focus is on understanding the need and opportunities for transdisciplinary partnerships and on the One Health approach.

Murdoch University collaborates with the Perth Zoo.

### **Ross University School of Veterinary Medicine – St. Kitts, West Indies**

<http://veterinary.rossu.edu/postgraduate/msc-one-health.html>

Ross University School of Veterinary Medicine takes a One Health approach to understanding and reducing zoonoses. Zoonoses and other diseases affecting livestock production and health can have serious impacts on the economic growth, health and food security, and alleviation of poverty in tropical and resource constrained countries.

Ross offers a Master of Science in One Health (MSc One Health) degree program to equip veterinarians, animal scientists, medical and biological scientists with an in-depth understanding of the principles of, and issues associated with, One Health. The program has 1-year, 2-year and 3-year options and is open to students with professional veterinary degrees as well as those with professional medical qualifications and bachelor degrees in biological, biomedical, environmental or ecological sciences.

The program provides graduates the background and experience to assess, investigate and manage animal health and zoonotic disease risks, to design and execute targeted research in animal health, and to manage veterinary intervention in the control and prevention of animal disease. Within the program, the student will have had the opportunity to focus on an area of

interest, such as area disease control, vector borne diseases, zoonotic infections, or conservation medicine. The taught portion of the degree is through distance learning and the research project is completed in St. Kitts and Nevis or other locations as appropriate, under the supervision of a RUSVM faculty member.

**University of Calgary – Calgary, Canada**

<https://vet.ucalgary.ca/home/ecosystem-public-health>

The University of Calgary’s veterinary program includes public and ecosystem health, wildlife and conservation medicine, professional and communication skills, research skills and comparative medicine. Four areas of emphasis are available: production animal health, ecosystem and public health, investigative medicine, and equine health.

The Department of Ecosystem & Public Health examines current and emerging issues at the interface of human health, animal health, and the environment. While the terms Conservation Medicine and/or One Health are not used, the disciplines represented in the department include ecosystem health, public health, epidemiology and disease surveillance, toxicology and pathology, population health, wildlife diseases and zoonoses, conservation medicine, microbiology and parasitology, risk assessment, and animal health policy. Graduate programs include research relevant to animal health, disease, and welfare, and its relation to human health. All of these focus areas fit within the conservation medicine and/or One Health approach.

**University of Edinburgh - Scotland, UK**

<https://www.ed.ac.uk/vet/studying/postgraduate/taught-programmes/one-health/about>

The University of Edinburgh Royal (Dick) School of Veterinary Studies offers a One Health program that includes a Certificate, a Diploma, and a Master of Science in One Health. The program is structured to allow progression via Certificate, Diploma, and Master of Science; however, a student can finish at the Certificate or Diploma. The aim of the One Health program is to provide veterinary and medical professionals, and graduates in other related disciplines, such as life sciences and ecosystem health, with the skills to work in a One Health interdisciplinary framework that recognizes the interrelatedness of human, animal, and environmental health. Among other aims, the program will allow students to:

- Understand emerging disease dynamics,
- Learn to reduce negative effects of interactions between animal, human, and ecosystem health,
- Understand how a One Health approach can be applied to practical situations, and
- Identify gaps or challenges in implementing One Health surveillance programs at the national, regional and global level.

**University of Liverpool – Liverpool, UK**

<https://www.liverpool.ac.uk/study/undergraduate/courses/veterinary-conservation-medicine-intercalated-honours-bsc/>

The University of Liverpool offers a Bachelor of Science degree in Veterinary Conservation Medicine. This undergraduate, one-year intercalated honours degree course is for students interested in the veterinary aspects of conservation. The course focuses on current concepts in conservation biology and a range of current issues at the interface between wildlife conservation and the health and welfare of animals in the wild and in zoos. An individually tailored research project will constitute a significant part of the course.

The University collaborates with the Chester Zoo.

**University of London – London, UK**

<https://www.rvc.ac.uk/study/postgraduate/one-health>

<https://www.rvc.ac.uk/study/postgraduate/wild-animal-health>

The University of London Royal Veterinary College (RVC), in conjunction with the London School of Hygiene and Tropical Medicine, offers a post graduate (PG) Diploma and a Master of Science in One Health (Infectious Diseases). As noted on the website, the One Health approach recognizes the relationship between health and disease at the human, animal, and environment interfaces and promotes a “whole of society” treatment of health hazards and a systemic change of perspective in the management of risk. The One Health degree programs provide a comprehensive foundation on the principles of diseases in the context of socio-ecological systems, global health and food safety, and knowledge and skills in relation to One Health methodologies, transdisciplinary interactions, and in using a systems approach. This program is open to students with a background in public health, veterinary sciences, animal or biological sciences, social and environmental sciences, ecology, and wildlife health.

The RVC also offers an Master of Science in Wild Animal Health (conservation medicine) for qualified veterinarians. Emerging infectious diseases are recognized as a serious hazard, both for wild animal species and for the domestic animal and human populations that interact with them. In addition, a large number of wild animal species are kept in captivity – in zoos and in laboratories – which has led to an increased demand for specialist skills and knowledge. The MSc in Wild Animal Health is a postgraduate veterinary science program taught jointly by the RVC, University of London and the Zoological Society of London. This MSc program equips veterinarians with an in-depth knowledge of the management of wild animals and the epidemiology, treatment and control of wild animal diseases.

### **Global Health at the Human Animal Ecosystem Interface (Online Course through Coursera)**

<https://www.coursera.org/learn/global-health-human-animal-ecosystem>

The University of Geneva, Institute Pasteur, University of Montreal and Centre Virchow-Villermé/University Paris Descartes have partnered to create this 8-week (3-4 hours per week) on-line course. The course covers major and current Global Health Challenges at the Human-Animal-Ecosystem Interface: zoonotic emerging infections (e.g. Ebola, MERS, Avian Influenza), antimicrobial resistance, neglected tropical diseases (e.g. rabies, zoonotic TB), snakebite, and other human-animal conflicts. Concepts from the field of epidemiology, social anthropology, disease ecology, veterinary sciences, and global health policy are presented along with broad approaches such as One Health, Eco-Health and Planetary Health. Innovative tools and frameworks used to study and tackle some of these global health challenges of the Sustainable Development Goals era will also be discussed.

### **One Health (Online Course through FutureLearn)**

<https://www.futurelearn.com/courses/one-health>

This One Health course, offered in conjunction with the University of Basel, is a 6-week online course (5 hours per week) which explores how One Health works in practice, bringing together different scientific perspectives. Topics covered include:

- Transdisciplinary process that can solve a One Health problem
- Shortfalls resulting from poor communication between human doctors and veterinarians
- Social-ecological perspectives for the improvement of human and animal well-being
- Fundamental principles of cross-sector human and animal health economics
- Prevention of diseases from livestock to human via food
- Principles of disease transmission dynamics between humans and animals, and
- Interpretation of vaccination coverage data.

The basic version of this course is free; however, an upgraded version is also available which includes a Certificate of Achievement.