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# Planetary health education in the United States: four curricular models, one goal

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## ABSTRACT

Global environmental crises demand scaled-up investment in education about planetary health. We identified college and university programs in the United States that focus on the human-animal-ecosystem nexus by systematically searching the 2023–2024 catalogs of more than 1000 schools. We identified four frequently-used curricular models: (1) One Health programs offered by universities with veterinary and agriculture schools that emphasize zoonotic diseases, antimicrobial resistance, food safety, and wildlife conservation; (2) climate change and health (climate medicine) programs for graduate and professional students at large universities with medical and public health schools; (3) global environmental public health programs focused on pollution and other exposures; and (4) sustainability and health programs emphasizing food security, environmental justice, and other health issues that can be improved with ethical design and engineering. Highlighting the shared goals of these distinct academic models may help make planetary health a more visible area of teaching, research, and practice.

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## Introduction

There is now scientific consensus that humans are damaging Earth's natural systems by using radioactive materials, burning massive amounts of fossil fuels, making widespread alterations in land use, polluting waterways with microplastics and persistent organic pollutants, and doing other harmful actions with long-term consequences for environmental health (Intergovernmental Panel on Climate Change 2023). Some researchers have proposed that these changes are so significant that Earth has entered a new geological epoch dubbed the Anthropocene (Crutzen 2006; Lewis and Maslin 2015). As the adverse effects of climate change and extensive ecosystem degradation have become increasingly more evident, scholars from a variety of health-related fields, including veterinarians, wildlife ecologists, environmental health scientists, and human health specialists, have pushed for greater attention to the ways that human actions are damaging the planet as well as the ways that humans, animals, plants, and ecosystems are being adversely affected by environmental degradation.

Over the past decade, planetary health has emerged as one of the more prominent labels for research and practice that links human health and global environmental change (Seltenrich 2018).

For example, the Planetary Health Alliance (PHA), founded in 2016, counts more than 400 universities, research institutes, and other entities as members, and *The Lancet Planetary Health* began publishing articles in 2017. *The Lancet* defines Planetary Health as “the health of human civilization and the state of the natural systems on which it depends” (Horton et al. 2014; Whitmee et al. 2015). This relatively anthropocentric description is popular in medical and public health contexts, and it is sometimes capitalized to emphasize its specificity (Royal Netherlands Academy of Arts and Sciences KNAW 2023). PHA describes planetary health as “a solutions-oriented, trans-disciplinary field and social movement focused on analyzing and addressing the impacts of human disruptions to Earth’s natural system on human health and all life on Earth” (<https://www.planetaryhealthalliance.org/>), expanding the scope of planetary health to include harms to animals and other species in addition to humans (Faerron Guzmán and Potter 2021).

The distinctions between planetary health and other frameworks for understanding the health–environment nexus are blurry (Willettts et al. 2022). One Health arose about two decades ago from the disciplines of Conservation Medicine and EcoHealth, which themselves emerged in the mid-1990s, and it is built on the premise that the health of humans, domestic and wild animals, plants, and ecosystems is inextricably linked (Lerner and Berg 2017; Aguirre et al. 2019; Ruiz de Castañeda et al. 2023). Planetary Health tends to place less emphasis on animal health and the relationships between human and animal health than One Health does, but both fields agree that all living beings are interconnected. Climate change and health, alternatively called climate and health or climate medicine, tends to engage only peripherally with planetary health concerns that are not directly related to climate change, but that makes climate medicine more a subset of planetary health than a competitor (Lemery et al. 2020; Shea et al. 2020; Goshua et al. 2021; Arora et al. 2023). Global health, public health, environmental health, sustainable development, and many other academic and professional disciplines also all engage meaningfully with planetary health themes.

The term “planetary health” is not widely used in the names of educational programs at this time, at least not in the United States, but there are many types of degrees and other learning pathways that align with the PHA framing of planetary health as encompassing the interrelationships among human health, animal health, and ecosystem health in the context of environmental changes (Stone et al. 2018; Faerron Guzmán and Potter 2021; Faerron Guzmán et al. 2021; Redvers et al. 2023). If we consider Planetary Health, One Health, climate medicine, and a variety of related fields to be complementary ones founded on the same science and values and sharing goals for the wellbeing of people, other species, and the planet, then the educational landscape for planetary health – in the lowercase, as an encompassing term rather than the narrower capitalized version – can be described as complex but thriving at a diverse range of schools and universities. For this paper, we aimed to examine the full scope of degrees and other credit-bearing academic programs related to planetary health that are being offered by institutions of higher education in the United States as of the 2023–2024 academic year.

## Materials and methods

We used a variety of methods to identify tertiary educational programs in the United States that relate to planetary health. First, we systematically searched the catalogs of the more than 800 colleges and universities that are members of the American Association of Colleges and Universities (AAC&U) and offer bachelor’s and/or higher degrees. Second, we searched the websites of all doctoral universities with Carnegie Classifications indicating very high research activity that were not already included in the AAC&U search (American Council on Education 2021). Third, we used internet search engines to look for programs at additional schools. We considered educational programs to be related to planetary health if they met three criteria: (1) they engaged meaningfully with human health, (2) they engaged meaningfully with climate change, environmental health, ecology, ecosystems, and/or other environmental domains, and (3) they had a global scale rather than being limited in focus primarily to domestic or local issues or having an exclusive focus on

health in lower-income countries. We did not limit our search to pre-selected program names. Instead, we used generous inclusion criteria to search for programs related to climate change and health, climate medicine, conservation medicine, EcoHealth, environmental health, GeoHealth, global change biology, global environmental public health, human ecology, One Health, planetary health, planetary medicine, sustainability and health, and any similar areas.

Bachelor's, master's, and doctoral degrees, concentrations, and tracks and credit-bearing secondary programs such as certificates and minors were eligible for inclusion in our list of relevant programs. We excluded programs that were not credit-bearing, such as the diploma in Climate Medicine offered at the Anschutz Medical Campus of the University of Colorado, the online graduate certificate in Climate Change and Health offered by Yale University, and short courses that are offered to clinical health professionals as continuing education (Asaduzzaman et al. 2022). We also excluded environmental science, environmental engineering, environmental studies, and sustainability programs that did not have a named specialty track in health because these programs generally lack human health content in their curricula, and we excluded health and society, health science degrees, and other programs focused on human health that did not have a named specialty track in environment, climate, or sustainability because these programs generally lack environmental science content in their curricula.

For each eligible program, we copied all the text from the program homepage and the university catalog or bulletin about key features, learning outcomes, required and elective courses, course descriptions, and other relevant information into a document file that served as our data for qualitative analysis. We used an inductive coding process to highlight all words and phrases in the file that were related to the environment or health. We then grouped those *in vivo* codes into dozens of descriptive codes (such as food, interconnectedness, justice, migration, resilience, urbanization, and zoonoses) that were applied in subsequent rounds of coding and thematic analysis. We also assigned each required course to one curricular domain (such as One Health, climatology, ecology, epidemiologic methods, and communication). After examining which codes and required curricular elements tended to cluster together within individual programs, we identified four themes that represented distinct educational models: One Health, climate change and health, global environmental public health, and sustainability and health.

## Results

We identified more than 60 programs that met our eligibility criteria. Slightly more than half of these programs were at the graduate level, most of which were concentrations, certificates, or minors. The remainder were at the undergraduate level, and these were split nearly evenly between minors (or certificates) and concentrations within majors. Most of these programs aligned with one of four educational models revealed by our qualitative analysis process (Table 1).

### **One Health**

We identified about 30 One Health programs, and these were split evenly between the undergraduate and graduate levels. One Health programs are offered at a mix of national and regional universities, especially ones with veterinary schools and/or agriculture programs. Undergraduate programs in One Health include a mix of minors and certificates (such as the ones offered by Berry College, Fontbonne University, Pennsylvania State University, University of Arizona, University of Delaware, University of Georgia, and University of Tennessee), concentrations or tracks associated with majors in other fields (such as the ones housed within anthropology at Boise State University, biology at Calvin University and Old Dominion University, oceanography at Texas A&M University, and public health at University of Arizona), and majors specifically in One Health (like Auburn University's B.S. in Public and One Health and Fontbonne's B.S. in One Health). Graduate education in One Health offers a similarly diverse

**Table 1.** Comparison of four models for planetary health education at colleges and universities in the United States in 2023–2024: one health, climate change and health, global environmental public health, and sustainability and health.

	One Health	Climate Change and Health	Global Environmental Public Health	Sustainability and Health
Main focus	Shared health issues of humans, domestic animals, and wildlife that arise due to local or global environmental changes	Human health issues that are becoming more prevalent due to climate change and will necessitate mitigation, adaptation, and health system responsiveness	Community- through global-level environmental and ecological exposures that threaten the health of human populations	Health issues related to natural and built environments that can be improved with ethical design and engineering
Examples of featured health issues	<ul style="list-style-type: none"> <li>• Zoonotic diseases</li> <li>• Antimicrobial resistance</li> <li>• Food safety</li> </ul>	<ul style="list-style-type: none"> <li>• Vector-borne infections</li> <li>• Chronic respiratory diseases</li> <li>• Migrant health</li> </ul>	<ul style="list-style-type: none"> <li>• Air pollution</li> <li>• Water pollution</li> <li>• Pesticide exposure</li> </ul>	<ul style="list-style-type: none"> <li>• Food security</li> <li>• Water management</li> <li>• Environmental justice</li> </ul>
Frequently required course areas	<ul style="list-style-type: none"> <li>• One Health</li> <li>• Infectious diseases</li> </ul>	<ul style="list-style-type: none"> <li>• Climate and health</li> <li>• Epidemiological methods</li> </ul>	<ul style="list-style-type: none"> <li>• Environmental health</li> <li>• Toxicology</li> </ul>	<ul style="list-style-type: none"> <li>• Introduction to sustainability</li> <li>• Health and the built environment</li> </ul>
Educational level(s)	Undergraduate and graduate	Mostly at the graduate/professional level	Mostly at the undergraduate level	Mostly at the undergraduate level
Primary types of institutions	Large universities with agricultural and/ or veterinary schools	Large universities with both medical and public health schools	Universities with public health programs	Universities with engineering programs

mix of minors and certificates (such as the ones offered by Auburn University, the Ohio State University, University of Arizona, University of Florida, University of Maine, University of Tennessee, and University of Washington), concentrations in One Health associated with other degree programs (such as the M.P.H. concentrations in One Health offered by University of Arizona and University of Pennsylvania, the University of Florida's M.H.S. in Environmental and Global Health with a concentration in One Health and Ph.D. in Public Health with a concentration in One Health, and Old Dominion's M.S. in Biology with a concentration in One Health and Ph.D. in Biomedical Sciences with a concentration in One Health), and degrees specifically in One Health (like the Master's in One Health from the University of Alaska Fairbanks, which offers concentrations in Community Advocacy and Biomedicine, and the Ph.D. in One Health Sciences at Texas Tech University). There are also a few programs in areas outside of One Health that have a similar focus on intersections among human, animal, and ecosystems, such as the M.S. in Conservation Medicine at Tufts University (Kaufman et al. 2008).

The websites of One Health programs consistently define the field as having a holistic focus on the interconnectedness of human, animal, and environmental health, which aligns with the values identified by the One Health High-Level Expert Panel (OHHLEP 2022; Yasobant et al. 2022). Their program descriptions tend to focus on zoonotic infectious diseases, emerging infectious diseases with pandemic potential, and antimicrobial resistance. Some programs supplement their emphases on infectious diseases with concerns about food safety, food security, and other health and nutritional issues that are likely to be affected by climate change. One Health programs typically require courses on One Health principles and infectious diseases. These are sometimes supplemented with courses on communication, environmental health, and ecology.

### ***Climate change and health***

We identified more than a dozen programs related to climate change and health (CCH), all of which were offered by large universities that have medical schools and Carnegie classifications indicating very high research productivity. Almost all these programs are offered at the graduate level. Some are minors and certificates (like the graduate minors offered by University of Minnesota and University of Washington, the graduate certificate offered by Johns Hopkins University, or the minors specifically for M.P.H. students at Boston University and Emory University), some are concentrations (like the M.P.H. concentrations at Columbia University, George Washington University, and Yale University and the concentrations within Boston University's M.S. in Population Health Research and Columbia's Environmental Health Sciences Ph.D. program), and some are standalone programs (like University of Miami's M.S. in Climate and Health and the Colorado School of Public Health's Ph.D. in Climate and Human Health that is offered at UC Denver's Anschutz Medical Campus). Few undergraduate programs focus on climate and health (like the B.S. in Public Health concentration in Climate and Environmental Sciences at the University of California, San Diego).

CCH programs tend to emphasize the ways that climate-related events like extreme temperatures, extreme precipitation, sea level rise, and biodiversity loss are likely to cause poor air and water quality, crop failures and food insecurity, mass displacement and migration, and a variety of health problems in human populations in the coming decades, including ones related to vector-borne, foodborne, and waterborne infectious diseases; respiratory diseases and allergies; violent conflicts; and mental health disorders (Myers 2017). These emerging problems are paired with options for mitigation and adaptation. Environmental and climate justice is often featured as a core value for the field. These foci align with the recommended CCH competencies developed by the Global Consortium on Climate and Health Education and other groups (Patrick et al. 2011; Limaye et al. 2020; Association of Schools and Programs of Public Health 2022; Global Consortium on Climate and Health Education 2023).

Most CCH programs require an introductory course on CCH that focuses on the anthropogenic causes of disruptions to Earth's natural systems and the adverse impacts of climate change on human health. Based on our review of the descriptions and syllabi of CCH courses, these courses typically examine the science of climate change and the causes of it; describe the many ways that extreme temperatures and precipitation, worsening air and water quality, reduced agricultural and aquacultural productivity, sea level rise, expanded geographic ranges for vectors, and other environmental stressors adversely affect human health; and discuss the mitigation, adaptation, and communication strategies available to try to reduce the burden of climate change on human populations in the coming decades. In addition to courses on climate change science, many CCH programs require courses about the epidemiological methods that are used to track changes in the health and risk status of human populations over time. Some CCH programs also require introductory courses in public health, global health, or environmental health.

### **Global environmental public health**

Most environmental health degrees offered by public health programs touch on planetary health themes but place a much greater emphasis on traditional areas of environmental health, such as air and water quality, waste management, food safety, toxicology, and occupational and industrial health. Many environmental health, occupational health, toxicology, and public health programs do not overtly include Earth systems, climate change, global warming, disaster preparedness and response, or other planetary health priorities in their curricula (Shea et al. 2020; Arora et al. 2023). However, a growing number of undergraduate and graduate programs in environmental health do emphasize the harms that humans impose on Earth's systems rather than just examining the hazards that environments pose to human health (Seltenrich 2018). For example, this bidirectional model is used by the B.A. in Environmental Studies concentration in Environmental and Human Health at Northeastern University, the B.S. in Environmental Health and Sustainability at Illinois State University, the B.S. in Environmental Science: Environmental Health at Loyola University Chicago, the B.S. in Global Environmental Sciences concentration in Environmental Health Sciences at the University of Hawai'i at Mānoa, the M.P.H. in Global Environmental Health at Old Dominion University, and the M.P.H. in Environmental Systems and Human Health at Portland State University. These programs require coursework in traditional areas of environmental health (like toxicology and radiation biology) and add an emphasis on climate change and anthropogenic drivers of environmental change to their curricula.

### **Sustainability and health**

Sustainability studies programs are offered by environmental science and environmental studies departments, engineering schools, and interdisciplinary units (Liu 2011; O'Byrne et al. 2015). Educational programs related to sustainability teach learners to understand complex environmental problems and to design and implement ecofriendly solutions for environmental challenges at the local and larger levels (Evans 2019). Generic degrees and certificates in sustainability that do not have a specific emphasis on human health do not meet the criteria to be classified as planetary health programs (Evans 2019; Friedman et al. 2020; Guidotti 2021). However, there are several schools with programs specifically on health and sustainability that emphasize design and engineering interventions that can improve human health as well as the health of natural and built environments.

Some programs weave together environmental health and sustainability studies, such as Nevada State University's minor in Environmental Health and Sustainability and B.S. in Human Health Sciences with a concentration in Environmental Health and Sustainability, Eastern Kentucky University's B.S. in Environmental Health Science and Sustainability, and Johns Hopkins University's M.P.H. concentration in Global Environmental Sustainability and Health and Ph.D. in Environmental Health concentration in Environmental Sustainability, Resilience, and Health. Some sustainability and health programs highlight

engineering solutions, like the University of North Carolina at Chapel Hill's undergraduate minor in Engineering for Environmental Change, Climate, and Health; University of Nevada Las Vegas's undergraduate minor in Sustainability and Health, which requires courses on urban planning and on sustainability in civil and environmental engineering; and University of San Diego's online M.S. in Engineering, Sustainability, and Health that is open to professionals in a diversity of fields, not just engineering. A few programs that do not use the word sustainability in their titles highlight it in their required courses, like University of Southern California's B.A. and B.S. in Environmental Science and Health, which require courses on water and soil sustainability, energy and air sustainability, global environmental politics, and other sustainability issues.

The descriptions of sustainability and health programs tend to highlight issues like food security, water management, and environmental justice rather than human diseases, and their required coursework focuses on actions for resilient ecosystems and sustainable development. Some of these programs emphasize the rights of nature as a counterpoint to the anthropocentrism of some other planetary health education models (Ip 2023).

### **Planetary health**

Only a few educational programs in the United States use “planetary health” in their names, and these programs tend to align with one of the four educational models identified through our qualitative analysis rather than being distinctly “planetary.” Dominican University of California offers an undergraduate minor in Planetary Health that emphasizes climate change, George Mason University's M.S. in Environmental Science and Policy program offers a concentration in Conservation Medicine and Planetary Health that highlights One Health principles, SUNY Downstate Health Sciences University offers a 5-course Advanced Certificate in Climate Change and Planetary Health that has a climate medicine focus, the City University of New York has a Ph.D. in Environmental and Planetary Health Sciences with a global environmental public health focus, and Brown University offers an unstructured concentration in Planetary Health within the A. B. in Health and Human Biology program that can be tailored to individual interests. The most frequently required courses across these programs are environmental health, environmental science, climate change, epidemiology, and ecology.

### **Discussion**

Our review of educational programs across the United States identified four prominent models for teaching about the health–environment nexus: One Health, climate change and health, global environmental public health, and sustainability and health. We are aware that there is some territoriality when it comes to education in this area due to the models arising from disciplines that tend to compete for students, resources, and attention. Our goal with this analysis is not to propose that schools and programs abandon their unique disciplinary lenses and move toward teaching standardized, generic curricula. We hope that greater awareness of these models will enable program directors and faculty to be bolder about highlighting the curricular approaches that make their programs distinct.

Each of the four major models has significant strengths associated with its disciplinary framings as well as some aspects of health in the Anthropocene that receive limited coverage. One Health programs arose mainly from veterinary science and the wildlife conservation movement, so they emphasize animal health and the relationships between human and animal health more than the other models, and they typically do not require coursework specifically focused on climate change or other planetary boundaries (Richardson et al. 2023). Climate and health programs are typically housed at large universities with medical schools, and they emphasize human health problems but give limited attention to ecosystem and animal health. Global environmental public health programs emphasize ecosystem and human health, but they may focus more on practical responses to local concerns than on the policy solutions required for international and global environmental



crises. Sustainability and health programs, which are often hosted by schools with engineering and design programs, emphasize ecosystem health and climate change, but they sometimes lack coverage of specific human health concerns. Awareness of curricular gaps is valuable for programs using any of the four models as well as those using less frequently employed approaches.

All educational programs related to planetary health would benefit from making the full spectrum of health challenges related to all of the established planetary boundaries – biodiversity loss, climate change, microplastics and other pollutants, stratospheric ozone depletion, atmospheric aerosol loading, ocean acidification, and freshwater and land system changes (Richardson et al. 2023) – more visible on their websites and in their curricula. Many programs appear to focus primarily on one domain – with One Health especially concerned about biodiversity loss, climate medicine about climate change, environmental health about pollutants, and so on – but it is important for learners to understand how all the planetary boundaries are linked to human, animal, and ecosystem health.

Educational programs using any of the four models featured in this analysis may also benefit from engagement with the PHA's Planetary Health Education Framework (PHEF), which was developed through an international collaborative effort and promotes systems thinking, equity, social justice, movement building, and systems change (Stone et al. 2018; Faerron Guzmán and Potter 2021; Faerron Guzmán et al. 2021). The PHEF is intended to be useful across countries, and it provides significant flexibility for teaching the key planetary health concepts and themes in diverse contexts. Rather than calling for the creation of special Planetary Health degrees, it promotes interprofessional efforts to understand and respond to global environmental changes, using planetary health as an umbrella term for initiatives that build on the interconnectedness of human, animal, and ecosystem health and their collective dependence on healthy Earth systems (Redvers et al. 2023).

Because each country's education system is distinct, we opted to focus this paper only on educational programs in the United States. However, our preliminary research suggests that other countries have a similar pattern of different disciplines taking distinct approaches to educating about planetary health concepts. We did not conduct a comprehensive search of all institutions in the United States, so we may have missed programs at schools that are not AAC&U members and do not have very high research activity Carnegie Classifications. We may have omitted programs at searched schools that had not updated their websites or catalogs to present their most current educational offerings. We may also have misclassified some programs, inadvertently overlooking some degrees and secondary programs that meet our criteria. However, our goal was not to count all eligible programs but to look for educational trends as of the 2023–2024 academic year, and this approach allowed us to do that reasonably well.

All the programs our search identified are committed to achieving a healthier and more just and sustainable future for humans, animals, and the planet. The ability of higher education to contribute meaningfully to solving complex global environmental health challenges through teaching, research, community outreach, and professional practice is dependent on collective willingness to build bridges rather than retreating to academic siloes or creating additional disciplines that address similar problems with different lenses. This shared goal can be achieved when educational programs focused on the health-environment nexus introduce the full spectrum of global environmental health issues, equip their students with advanced knowledge and skills in selected areas of planetary health, and prepare them to participate in transdisciplinary, interprofessional collaborations.

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## References

- One Health High-Level Panel (OHHLEP), Adisasmito WB, Almuhairei S, Behravesh CB, Bilibogui P, Bukachi SA, Casas N, Becerra NC, Charron DF, Chaudhary A, et al. 2022. One health: a new definition for a sustainable and healthy future. *PLoS Pathog.* 18(6):e1010537. doi: [10.1371/journal.ppat.1010537](https://doi.org/10.1371/journal.ppat.1010537).
- Aguirre AA, Basu N, Kahn LH, Morin XK, Echaubard P, Wilcox BA, Beasley VR. 2019. Transdisciplinary and social-ecological health frameworks: novel approaches to emerging parasitic and vector-borne diseases. *Parasite Epidemiol Control.* 3:e00084. doi: [10.1016/j.parepi.2019.e00084](https://doi.org/10.1016/j.parepi.2019.e00084).
- American Council on Education. 2021. Carnegie classifications of institutions of higher education. Washington, DC: ACE.
- Arora M, Comrie AC, Ernst KE. 2023. Assessing climate and health curriculum in graduate public health education in the United States. *Front Public Health.* 11:1124379. doi: [10.3389/fpubh.2023.1124379](https://doi.org/10.3389/fpubh.2023.1124379).
- Asaduzzaman M, Ara R, Afrin S, Meiring JE, Saif-Ur-Rahman KM. 2022. Planetary health education and capacity building for healthcare professionals in a global context: current opportunities, gaps and future directions. *Int J Environ Res Public Health.* 19:11786. doi: [10.3390/ijerph191811786](https://doi.org/10.3390/ijerph191811786).
- Association of Schools and Programs of Public Health. 2022. Climate change and health: a public health education toolkit. Washington, DC: ASPPH.
- Crutzen PJ. 2006. The “anthropocene”. In: Ehlers E, and Krafft T, editors. *Earth system science in the anthropocene*. Berlin: Springer; pp. 13–18.
- Evans TE. 2019. Competencies and pedagogies for sustainability education: a roadmap for sustainability studies program development in colleges and universities. *Sustainability.* 11:5526. doi: [10.3390/su11195526](https://doi.org/10.3390/su11195526).
- Faerron Guzmán CA, Aguirre AA, Astle B, Barros E, Bayles B, Chimbari M, El-Abbadi N, Evert J, Hackett F, Howard C, et al. 2021. A framework to guide planetary health education. *Lancet Planet Health.* 5(5):e253–254. doi: [10.1016/S2542-5196\(21\)00110-8](https://doi.org/10.1016/S2542-5196(21)00110-8).
- Faerron Guzmán CA, Potter T, editors. 2021. *The planetary health education framework*. Boston, MA: Planetary Health Alliance.
- Friedman EJ, Adkins S, Guidotti TL. 2020. Foundational health content in environmental studies, sciences, and sustainability education: report of a workshop. *J Environ Stud Sci.* 10:327–333. doi: [10.1007/s13412-020-00604-x](https://doi.org/10.1007/s13412-020-00604-x).
- Global Consortium on Climate and Health Education. 2023. *Climate and health core concepts for health professionals*. New York: GCCHE.
- Goshua A, Gomez J, Erny B, Burke M, Luby S, Sokolow S, LaBeaud D, Auerbach P, Gisondi MA, Nadeau K. 2021. Addressing climate change and its effects on human health: a call to action for medical schools. *Acad Med.* 96(3):324–328. doi: [10.1097/ACM.0000000000003861](https://doi.org/10.1097/ACM.0000000000003861).
- Guidotti TL. 2021. What do public health professionals need to know about ecosystems and sustainability? *Arch Environ Occup Health.* 76(5):241–242. doi: [10.1080/19338244.2021.1944468](https://doi.org/10.1080/19338244.2021.1944468).
- Horton R, Beaglehole R, Bonita R, Raeburn J, McKee M, Wall S. 2014. From planetary to public health: a manifesto. *Lancet.* 383(9920):847. doi: [10.1016/S0140-6736\(14\)60409-8](https://doi.org/10.1016/S0140-6736(14)60409-8).
- Intergovernmental Panel on Climate Change. 2023. *Climate change 2023: synthesis report. Contribution of working groups I, II and III to the sixth assessment report of the Intergovernmental Panel on climate change*. Geneva: IPCC. doi: [10.59327/IPCC/AR6-9789291691647](https://doi.org/10.59327/IPCC/AR6-9789291691647).
- Ip EC. 2023. From the right to a healthy planet to the planetary right to health. *Lancet Planet Health.* 7(2):e104–105. doi: [10.1016/S2542-5196\(22\)00337-0](https://doi.org/10.1016/S2542-5196(22)00337-0).
- Kaufman GE, Epstein JH, Paul-Murphy J, Modrall JD. 2008. Designing graduate training programs in conservation medicine: producing the right professionals with the right tools. *EcoHealth.* 5:519–527. doi: [10.1007/s10393-008-0208-7](https://doi.org/10.1007/s10393-008-0208-7).
- Lemery J, Balbus J, Sorensen C, Rublee C, Dresser C, Balsari S, Calvello Hynes E. 2020. Training climate and public health leaders in climate and health. *Health Aff.* 39(12):2189–2196. doi: [10.1377/hlthaff.2020.01186](https://doi.org/10.1377/hlthaff.2020.01186).
- Lerner H, Berg C. 2017. A comparison of three holistic approaches to health: one health, EcoHealth, and planetary health. *Front Vet Sci.* 4:163. doi: [10.3389/fvets.2017.00163](https://doi.org/10.3389/fvets.2017.00163).
- Lewis SL, Maslin MA. 2015. Defining the Anthropocene. *Nature.* 519:171–180. doi: [10.1038/nature14258](https://doi.org/10.1038/nature14258).
- Limaye VS, Grabow ML, Stull VJ, Patz JA. 2020. Developing a definition of climate and health literacy. *Health Aff.* 39(12):2182–2188. doi: [10.1377/hlthaff.2020.01116](https://doi.org/10.1377/hlthaff.2020.01116).

- Liu L. 2011. Where in the world of sustainability education is US geography? *J Geog Higher Educ.* 35(2):245–263. doi: [10.1080/03098265.2010.548086](https://doi.org/10.1080/03098265.2010.548086).
- Myers SS. 2017. Planetary health: protecting human health on a rapidly changing planet. *Lancet.* 390(10114):2860–2868. doi: [10.1016/S0140-6736\(17\)32846-5](https://doi.org/10.1016/S0140-6736(17)32846-5).
- O’Byrne D, Dripps W, Nicholas KA. 2015. Teaching and learning sustainability: an assessment of the curriculum content and structure of sustainability degree programs in higher education. *Sustainability Sci.* 10(1):43–59. doi: [10.1007/s11625-014-0251-y](https://doi.org/10.1007/s11625-014-0251-y).
- Patrick R, Capetola T, Townsend M, Nuttman S. 2011. Health promotion and climate change: exploring the core competencies required for action. *Health Promot Int.* 27(4):475–485. doi: [10.1093/heapro/dar055](https://doi.org/10.1093/heapro/dar055).
- Redvers N, Faerron Guzmán CA, Parkes MW. 2023. Towards an educational praxis for planetary health: a call for transformative, inclusive, and integrative approaches for learning and relearning in the anthropocene. *Lancet Planet Health.* 7(1):e77–85. doi: [10.1016/S2542-5196\(22\)00332-1](https://doi.org/10.1016/S2542-5196(22)00332-1).
- Richardson K, Steffen W, Lucht W, Bendtsen J, Cornell SE, Donges JF, Drüke M, Fetzer I, Bala G, von Bloh W, et al. 2023. Earth beyond six of nine planetary boundaries. *Sci Adv.* 9(37):eadh2458. doi: [10.1126/sciadv.adh2458](https://doi.org/10.1126/sciadv.adh2458).
- Royal Netherlands Academy of Arts and Sciences (KNAW). 2023. Planetary health: an emerging field to be developed. Amsterdam: KNAW.
- Ruiz de Castañeda R, Villers J, Faerron Guzmán CA, Eslanloo T, de Paula N, Machalaba C, Zinsstag J, Utzinger J, Flahault A, Bolon I. 2023. One health and planetary health research: leveraging differences to grow together. *Lancet Planet Health.* 7(2):e109–111. doi: [10.1016/S2542-5196\(23\)00002-5](https://doi.org/10.1016/S2542-5196(23)00002-5).
- Seltenrich N. 2018. Down to earth: the emerging field of planetary health. *Environ Health Persp.* 126(7):072001. doi: [10.1289/EHP2374](https://doi.org/10.1289/EHP2374).
- Shea B, Knowlton K, Shaman J. 2020. Assessment of climate-health curricula at international health professions schools. *JAMA Netw Open.* 3(5):e206609. doi: [10.1001/jamanetworkopen2020.6609](https://doi.org/10.1001/jamanetworkopen2020.6609).
- Stone SB, Myers SS, Golden CD, Planetary Health Education Brainstorm Group. 2018. Cross-cutting principles for planetary health education. *Lancet Planet Health.* 2(5):e192–193. doi: [10.1016/S2542-5196\(18\)30022-6](https://doi.org/10.1016/S2542-5196(18)30022-6).
- Whitmee S, Haines A, Beyrer C, Boltz F, Capon AG, Ferreira de Souza Dias B, Ezeh A, Frumkin H, Gong P, Head P, et al. 2015. Safeguarding human health in the Anthropocene epoch: report of the Rockefeller Foundation–*Lancet* Commission on planetary health. *Lancet.* 386(10007):1973–2028. doi: [10.1016/S0140-6736\(15\)60901-1](https://doi.org/10.1016/S0140-6736(15)60901-1).
- Willets E, Bansard J, Kohler P, Bettelli P, Rosen T, Schröder M, Grant L. 2022. Health in the global environmental agenda: a policy guide. Winnipeg, MB: International Institute for Sustainable Development.
- Yasobant S, Daptardar M, Kurup KK, Panwar D, Bongcac M, De Los Santos MY, Guinto RR, Saxena D, Tiwari S. 2022. One (vis-à-vis planetary, eco) health: a landscape analysis of educational programs. *Public Health Chall.* 1: e24. doi: [10.1002/puh2.24](https://doi.org/10.1002/puh2.24).