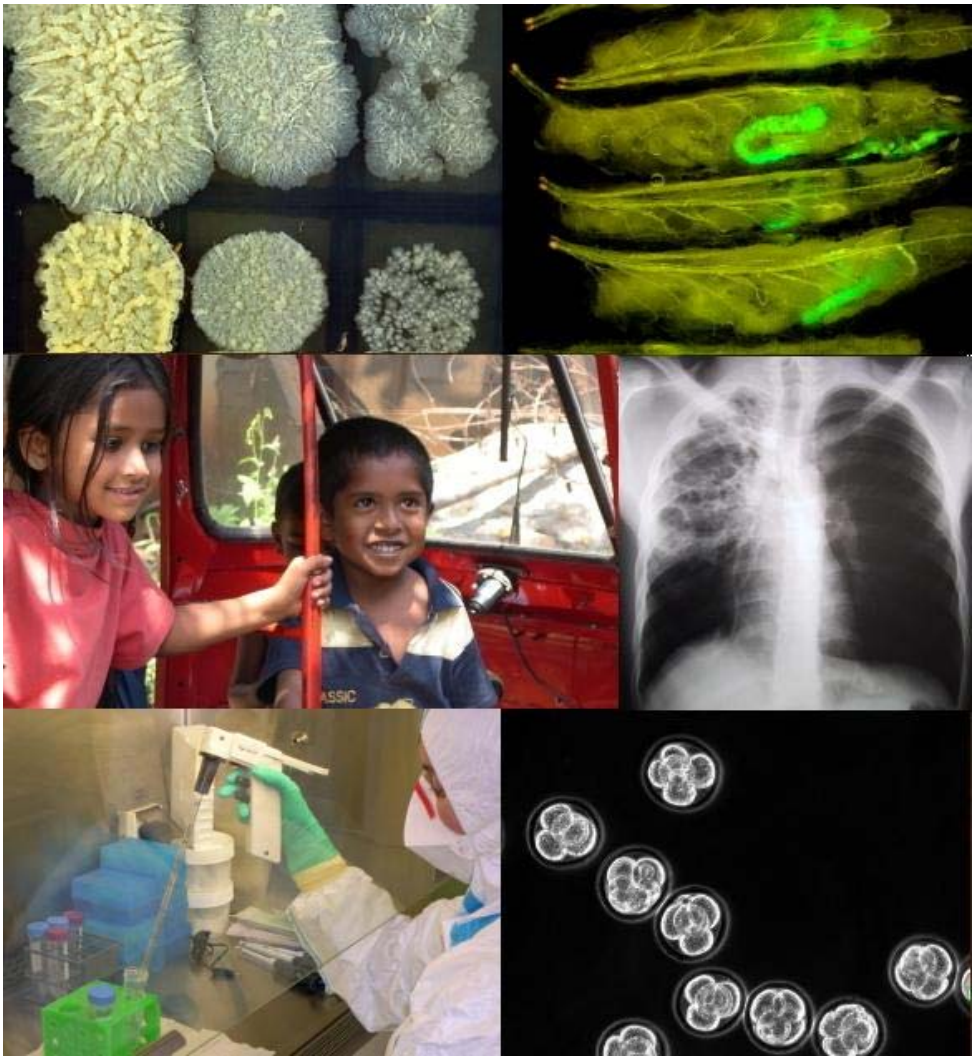
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

# Global Health Institute

## School of Life Sciences



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http://ghi.epfl.ch

# An introduction to the Global Health Institute at the EPFL (*Ecole Polytechnique Fédérale de Lausanne*)

Despite two centuries of economic and social progress, over 18 million human lives are still lost to infectious diseases every year according to the *The World Health Report* [1]. This is roughly one third of all deaths annually. Many of these diseases, which affect 90% of the world's population, can be prevented by vaccination or cured through drug treatment yet only 10% of the global biomedical research budget is devoted to tackling major causes of suffering and death, such as malaria, tuberculosis and HIV/AIDS. This imbalance is referred to as the 10-90 gap and, in an effort to redress the situation, the EPFL created the **Global Health Institute** (GHI) in 2006.

The mission of the GHI is to contribute to the understanding, diagnosis, prevention and treatment of infectious diseases by performing world-class research, and providing training and tuition of the highest possible standard. Building on studies of basic biological mechanisms, employed by pathogens and their hosts, the GHI portfolio extends to challenging areas of translational research like drug discovery and vaccine development. A major strength of this initiative is the unique environment provided by the EPFL, a world leader in the fields of (bio)engineering, physical sciences, nanotechnologies and informatics.

[1] *The World Health Report,* World Health Organization (2004), Geneva

**Prof. Stewart T. Cole FRS**
**Director of the Global Health Institute**

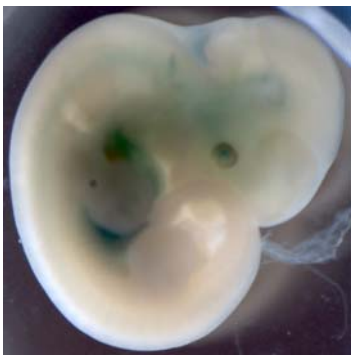
## Infection biology

A special feature of the GHI is its world-class expertise in molecular and cellular microbiology, and these modern disciplines underpin infectious disease research, which is often referred to as infection biology. Multidisciplinary approaches are being applied to crucial world health issues, including tuberculosis and HIV/AIDS, and these take advantage of the Biomolecular Screening Platform with its fully automated screening facility and collections of drug-like compounds.

**Tuberculosis.** Most bacterial infections wax and wane in a matter of days or weeks, but tuberculosis (TB) persists for the lifetime of the host. The World Health Organization estimates that nearly one-third of the global human population is currently infected with the TB bacterium in latent form, while eight million new cases and two million deaths occur each year. Existing interventions are inadequate to address this pervasive threat to global health with multidrug resistance becoming increasingly common. The development of new and more effective interventions to prevent and treat TB will hinge on an improved understanding of the molecular underpinnings of TB persistence and pathogenesis. Towards this goal, the GHI is studying the persistence mechanisms and identifying and developing new drug targets and strategies for anti-TB therapy, in partnership with our colleagues in the pharmaceutical industry.

**Toxin-mediated diseases.** Many bacteria, such as those responsible for food- and water-borne diseases, produce toxins, toxic molecules that incapacitate or kill mammalian cells. Consequently, understanding the molecular and cellular mode of action of various toxins will help in the prevention and treatment of these infectious diseases. To this aim, we are investigating the membrane insertion of pore-forming toxins, and the molecular mechanisms of anthrax toxin endocytosis and Systemic Hyalinosis in humans.

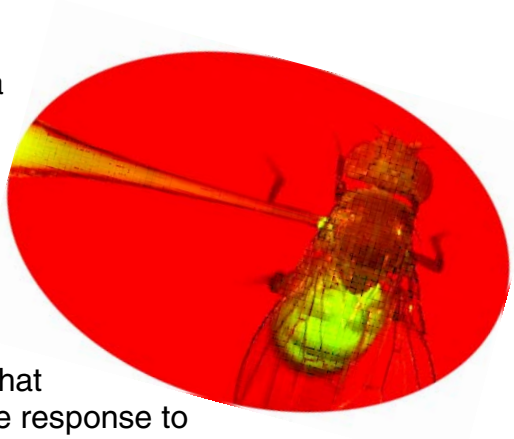
**HIV/AIDS and other retroviral diseases.** Retroelements include both lethal invaders such as the human immunodeficiency virus (HIV) and the hepatitis B virus (HBV), and endogenous retroviruses and retrotransposons that drive human genome evolution. The goals of our work are to shed light on diseases caused by these groups of viruses and to uncover new avenues for therapeutic interventions; to gain insights into evolutionary processes that shape mammalin genomes and to exploit retroelement-derived gene transfer systems for experimental and therapeutic purposes. In particular, lentiviral vectors are being used for the genetic treatment of lympho-hematopoietic disorders, like chronic granulomatous disease, via stem cell-based gene transfer.



**More diseases.** As part of the GHI's programmed expansion, other scientists are being recruited to establish research groups dedicated to malaria, pneumococcal pneumonia and viral influenza, in addition to emerging diseases.

## Infection immunology

The GHI is an important component of the recently established Swiss Institute for Vaccine Research and, as such, is active in the areas of innate and adaptive immunity, which are both important for preventing disease. Microbial infections are characterised by a continual, dramatic interplay between pathogen and host: pathogens exploit an array of host cell functions during infection and their hosts respond with efficient immune responses. Innate immunity is employed by the host as its firstline of defence against infection, and the underlying mechanisms are conserved from insects to humans. Adaptive, or acquired immunity, involves the induction of immunological memory and improved understanding of this process is crucial for vaccine development.



**Innate immunity.** *Drosophila,* the fruitfly, provides a powerful model system for dissecting innate host defence mechanisms. In response to an immune challenge, the fat body of this insect produces a battery of small peptides with antifungal and antibacterial activities. Two signalling pathways, Imd and Toll, control the expression of antimicrobial peptide-encoding genes in *Drosophila* and share striking similarities with the Toll-Like Receptor and Tumor Necrosis Factor $\alpha$ cascades, that regulate immune activity in vertebrates. The innate immune response to HIV in humans is also the subject of investigation since improved understanding could lead to new ways of preventing infection.

**Adaptive immunity.** A better vaccine than BCG is required to prevent TB, and GHI investigators are currently exploring new means of achieving this objective. One of the key challenges in TB vaccine development is the ability of the TB bacterium to persist, indefinitely, in the face of acquired immunity. With the goal of developing more effective immunization strategies, GHI investigators are seeking to elucidate the molecular mechanisms that allow the TB bacterium to evade and counter the adaptive immune response. Other targets for vaccine development include HIV/AIDS and hepatitis C while immunodiagnostic approaches are being pursued for leprosy and TB.

## Partnerships and funding

The GHI is actively collaborating with the Swiss Tropical Institute and other national institutions, numerous laboratories in Europe, the USA and, importantly, the developing world. In addition to financial support from the Swiss Federal Government, GHI investigators receive funding from the Bill and Melinda Gates Foundation, European Community, Howard Hughes, NIH, SNSF, WHO, …

## Teaching and training

### Undergraduate studies – http://ssv.epfl.ch

The Life Sciences curriculum aims at educating a new generation of engineers who can master the technical and scientific skills needed for studying life and developing the biomedical technologies of tomorrow. This educational program is unique in Switzerland and Europe.

- **Bachelor's program (3 years)**
- **Master's program (2 years)**

### Graduate studies – http://phd.epfl.ch

Graduate programs comprise a combination of coursework, laboratory based research, in-house seminars, and national or international conferences. GHI students can chose between two doctoral programs:

New

- **The International PhD Program in Molecular Biology of Cancer and Infection** provides training and research opportunities to motivated graduate students in key areas of modern biology. The program is run jointly by the GHI and the Swiss Institute for Experimental Cancer Research (ISREC) thus providing a stimulating interdisciplinary scientific environment. Highly qualified applicants worldwide are chosen twice a year through a competitive selection procedure
  **http://www.international-phd.ch/**

- **The Doctoral Program in Biotechnology and Bioengineering** aims at providing doctoral students with the education necessary to be leaders in the fast-growing industrial and academic biotechnology and bioengineering sectors, i.e. a depth of knowledge and competence in their specific research area as well as a breadth of knowledge in biology, bioengineering and biotechnology. These program themes include**:** genomics and proteomics, biomolecular engineering and biomaterials, stem cell biotechnology, cell and process engineering, biochemical engineering, orthopaedic engineering, biomechanics, biorheology, mechanobiology, cell biophysics, computational biology, biomedical imaging as well as molecular, cell and tissue engineering
  **http://phd.epfl.ch/edbb**