School for International Training | 1 Kipling Road, PO Box 676 | Brattleboro, VT 05302-0676 USA
Tel 888 272-7881 | Fax 802 258-3296 | studyabroad.sit.edu

Biotechnology and Healthcare Futures

IPBH-3030 (3 credits)

India: Public Health

This syllabus is representative of a typical semester. Because courses develop and change over time to take advantage of unique learning opportunities, actual course content varies from semester to semester.

Course Description

Biotechnology plays a crucial role in enabling global health by integrating biomedical sciences and the use of technological innovation to prevent infectious and non-infectious diseases, improve diagnosis tools and treatment, and maintain the quality of life in general through the development of vaccines and therapeutic interventions. The applications of biotechnologies such as molecular epidemiology, genomic surveillance, and bioinformatics enable the early detection and monitoring of disease outbreaks, improving preparedness and response strategies as witnessed in the recent Covid-19 pandemic. At the same time, biotechnology in global health contexts supports equitable access to essential health technologies, facilitates the production of affordable vaccines and medicines, and enhances food and environmental safety. These are all critical determinants of population health that contribute to sustainable health systems by fostering innovations in personalized medicine, regenerative therapies, and public health genomics. These applications raise important ethical, regulatory, and equity considerations, especially in low- and middle-income countries like India.

This course will offer students an understanding of how biotechnology affects global and public health vis-à-vis critically evaluating the scientific advancements related to health policy, availability, affordability and accessibility, and social justice.

Learning Outcomes

Upon completion of the course, students will be able to:

- Explain the contribution and role of biotechnology to global and public health through disease prevention, diagnosis, and treatment.
- List various biotechnological tools, such as genomics, bioinformatics, and molecular epidemiology, and their roles in addressing global health challenges.
- Analyze how biotechnology enables equitable access to medicines, vaccines, and sustainable healthcare systems.
- Synthesize the ethical and regulatory issues that arise from applying biotechnology in the local social and cultural contexts.

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- Understand legal, control and regulator policies and practices in biotechnical research and development in India.

Language of Instruction
This course is taught in English, but students will be introduced to local terminology and contextual understandings related to biotechnology and public health. Students will learn from local experts through lectures, hands-on workshops, and site visits to research centers and labs, hospitals, biotech companies, drug research and development regulatory and control bodies, and advocacy and community organizations in India and Thailand. These experiential components will enable students to critically engage with real-world applications of biotechnology in advancing global and public health.

Instructional Methods
SIT's teaching and learning philosophy is grounded in the experiential learning theory developed by Kolb (1984; 2015) and informed by various scholars, such as Dewey, Piaget, Lewin, among others. Experiential learning theory recognizes that learning is an active process that is not confined to the formal curriculum; "knowledge is created through the transformation of experience" (Kolb, 2015, p. 49). Learning involves both content and process. Learning is holistic and happens through various life experiences upon which students draw to generate new ways of knowing and being. Learning involves a community and is a lifelong endeavor. Learning is transformational. The suggested four step-cycle of a *concrete experience*, *reflective observation*, *abstract conceptualization*, and *active experimentation* embedded in the experiential learning model is not linear and might not always happen in that specific order, as any learning is highly context dependent. These stages of taking part in a shared experience; reflecting on that experience by describing and interpreting it; challenging their own assumptions and beliefs to generate new knowledge; and ultimately applying new knowledge, awareness, skills, and attitudes in a variety of situations and contexts are important for students to engage in to become empowered lifelong learners.

Required Texts

Department of Biotechnology, Ministry of Science & Technology, Government of India. (2020). National Biotechnology Development Strategy [2020-2025] [Report]

https://dbtindia.gov.in/sites/default/files/uploadfiles/Draft%20National%20Biotechnology%20Development%20Strategy%202020-25.pdf

Madhuri CK (2024) Biotechnology for Global Health: Addressing Challenges with Innovative Solutions. J Biotechnol Biomater, 14: 394.

Assignments and Evaluation

Assignment Descriptions and Grading Criteria

1. **Mapping the global health connection with Biotechnology. (20%)**

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Write a short reflection in 400-500 words or create a 5 to 10 minute podcast by using one or two examples of how biotechnology contributes to global or public health through disease prevention, diagnosis, or treatment. Discuss how these examples reflect broader goals of improving population health and quality of life. The evaluation parameters include conceptual clarity, depth of understanding through relevant examples, and the coherence and structure of the arguments**.**

2. **Bioteconlogy-Equity and Access in health: Country Case Analysis (25 %)**

The student will examine how biotechnology influences equitable access to medicines, vaccines, or diagnostic tools in India (500–600 words). Discuss in detail at least one policy or program that supports or limits such access, and analyze the associated legal, ethical, or regulatory implications. The students are expected to use classroom discussion, site visit observations, and discussions while analyzing the policy, integrating ethical and equity considerations by using credible and evidence-based resources.

3. **Influence of biotechnology, Innovation, and development in Global Health Systems (45%)**

The student will write a research-based paper (in 1200-1300 words) that compares how biotechnology is shaping health systems in India. Focus on one key thematic area—such as vaccine development, genomic surveillance, or bioinformatics—and examine its scientific, ethical, and policy dimensions. Analyze how local regulations, cultural contexts, and global health governance structures influence innovation and equitable access to biotechnology. The paper will be evaluated on its depth of research, analytical rigor, integration of theoretical and empirical perspectives, originality of argument, clarity of structure, quality, and proper citation from reliable and credible sources.

4. Participation (10%)

This includes active involvement in lectures, readings, discussions and excursions using the following criteria:

- Attendance - promptness to class and positive presence in class.
- Active Listening - paying attention in class and during field excursions, asking appropriate questions, showing interest and enthusiasm (this includes body language), entertaining contradictory perspectives, taking notes.
- Involvement in Class Discussions - either in small or large groups, sharing knowledge. This means challenging yourself to speak up if you usually don't, and also means allowing others to speak if you are a person who tends to dominate class discussions.
- Group Accountability – positive participation in the group during field excursions and classes; not keeping others waiting.

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- Displaying Respect – culturally appropriate interaction with hosts, SIT program staff, SIT lecturers and communities.]

Assessment

1. Mapping the global health connection with Biotechnology-20%
2. Biotechnology-Equity and Access in health: Country Case Analysis-25
3. Influence of biotechnology, Innovation, and development in Global Health Systems-45%
4. Participation - 10%

Attendance and Participation

Due to the nature of SIT Study Abroad programs, and the importance of student and instructor contributions in each and every class session, attendance at all classes and for all program excursions is required. Criteria for evaluation of student performance include attendance and participation in program activities. Students must fully participate in all program components and courses. Students may not voluntarily opt out of required program activities. Valid reasons for absence – such as illness – must be discussed with the academic director or other designated staff person. Absences impact academic performance, may impact grades, and could result in dismissal from the program.

Late Assignments

SIT Study Abroad programs integrate traditional classroom lectures and discussion with field-based experiences, site visits and debriefs. The curriculum is designed to build on itself and progress to the culmination (projects, ISP, case studies, internship, etc.). It is critical that students complete assignments in a timely manner to continue to benefit from the sequences in assignments, reflections and experiences throughout the program.
Example: Students may request a justified extension for one paper/assignment during the semester. Requests must be made in writing and at least 12 hours before the posted due date and time. If reason for request is accepted, an extension of up to one week may be granted at that time. Any further requests for extensions will not be granted. Students who fail to submit the assignment within the extension period will receive an 'F' for the assignment.

Grading Scale

94-100%	A
90-93%	A-
87-89%	B+
84-86%	B
80-83%	B-
77-79%	C+
74-76%	C
70-73%	C-

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67-69% D+
64-66% D
below 64 F

Program Expectations

- Show up prepared. Be on time, have your readings completed and points in mind for discussion or clarification. Complying with these elements raises the level of class discussion for everyone.
- Have assignments completed on schedule, printed, and done accordingly to the specified requirements. This will help ensure that your assignments are returned in a timely manner.
- Ask questions in class. Engage the lecturer. These are often very busy professionals who are doing us an honor by coming to speak.
- Comply with academic integrity policies (no plagiarism or cheating, nothing unethical).
- Respect differences of opinion (classmates', lecturers, local constituents engaged with on the visits). You are not expected to agree with everything you hear, but you are expected to listen across difference and consider other perspectives with respect.
- Storing Your Work: Keep several copies of your work as back up and keep one copy accessible to you through an online forum, such as an attachment in your email, the course learning management system, or cloud-based storage. This way your work will always be available to despite technical issues. Lost files, deleted drives, or computer crashes are not excuses for late, missing work.
- Personal Technology Use: Cell phones and other personal electronics can be used for taking notes and other class activities. Off-task usage is not acceptable. You may be marked as absent for habitually using them for something other than classroom activities.
- Course Communication: Course documents and assignments will be posted on the learning management system, Canvas. Although the course calendar provides a broad overview and the general sequence of work and assignments for the course, what we accomplish in class will vary, and revisions to the calendar will be posted at the course site. You will need to check the course site regularly. You are responsible for letting me know about any network-related problems that prevent you from accessing or submitting assignments.
- Content Considerations: Some texts and activities you will encounter in this course delve into sensitive topics that may be emotionally and intellectually challenging. Our classroom is a space where we can engage with challenging ideas, question assumptions, and navigate difficult topics with respect and maturity. As possible, I will flag content and activities that are especially graphic or intense, so we are prepared to address them soberly and sensitively. If you are struggling to keep up with the work or participate in the course because of the nature of the content and activities, you should speak with me and/or seek help from counseling services.
- Classroom recording policy: To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance

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written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use.

SIT Policies and Resources

Please refer to the SIT Study Abroad Handbook and the Policies section of the SIT website for all academic and student affairs policies. Students are accountable for complying with all published policies. Of particular relevance to this course are the policies regarding: academic integrity, Family Educational Rights and Privacy Act (FERPA), research and ethics in field study and internships, late assignments, academic status, academic appeals, diversity and disability, sexual harassment and misconduct, and the student code of conduct.

Please refer to the SIT Study Abroad Handbook and SIT website for information on important resources and services provided through our central administration in Vermont, such as Library resources and research support, Accessibility Services, Counseling Services, Title IX information, and Equity, Diversity, and Inclusion resources.

Course Schedule

**Please be aware that topics and excursions may vary to take advantage of any emerging events, to accommodate changes in our lecturers' availability, and to respect any changes that would affect student safety. Students will be notified if this occurs*

Module 1: Foundations of Biotechnology in Global Health

Session 1: Introduction to Biotechnology and Global Health Interface
The session will overview how biotechnology intersects with global health by driving innovations in disease prevention, diagnostics, and treatment. Students will orient themselves to various biotechnological tools that contribute to addressing global health challenges and how scientific advances shape health systems, policy, and equity in India.

Required Readings:
Chin, C. D. (2008). Biotechnology for Global Health: Solutions for the developing world. *Consilience*, *1*, 1–12. https://doi.org/10.7916/d8np24t0

Department of Biotechnology. (n.d.). National Biotechnology Development Strategy. In *National Biotechnology Development Strategy*. https://dbtindia.gov.in/sites/default/files/NBDS_March%202021.pdf

Session 2: Biological Foundations of Biotechnology
This session introduces the core biological principles that underpin modern biotechnology, including genetics, molecular biology, and cellular processes. Students will explore how DNA, RNA, proteins, and cellular mechanisms form the basis for biotechnological innovations used in diagnostics, therapeutics, and public health.

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Required Reading:
DEPARTMENT OF BIOTECHNOLOGY. (n.d.). Concepts in biotechnology [excerpts]. In *DEPARTMENT OF BIOTECHNOLOGY*.
https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBB2103.pdf

Module 2:Tools Transforming Global Health- Technology and Innovation
This module provides a comprehensive examination of the principal biotechnological instruments that are revolutionizing modern global and public health practices. It introduces students to the scientific foundations and practical applications of genomics, including DNA sequencing, genetic mapping, and a critical field that integrates computational tools and biological data to analyze genomic sequences, model disease patterns, and support data-driven health innovations. These tools improve detection, diagnosis, and planning of treatments for diseases, as well as monitor health in communities, giving students a basic understanding of the scientific advancements that support today's global health systems.

Session 3: Pathological Diagnostics and Disease Detection Technologies: Prevention and Cure
The session will examine the role of pathological diagnostics and modern disease detection technologies in supporting early prevention and effective treatment. Students will explore core diagnostic methods, their applications in identifying disease at various stages, and their importance in guiding timely medical interventions.

Require Reading:
Karkosh, D. F. K., Mohammed, N. H. A., Ahmed, R. M. H., Ahmed, R. M. H., & Sada, F. a. Z. R. A. (2025). Advanced Pathological Diagnostics, Microbiology, and Medical Bacteriology: exploring innovations in disease detection and microbial advances. In *Bright Sky Publications eBooks*. https://doi.org/10.62906/bs.book.304

Excursions: The session will take place at a pathology lab to get hands on experience after the lecture.

Session 4: Radiological Diagnostics and Disease Detection Technologies-Prevention and Cure
This session will take place at a radiology lab to get hands-on experience after the theory session. Students will learn about radiology including imaging technologies such as X-ray, CT, RMI, and ulrasound that enable non-intrusive diagnosis and monitoring of disease.

Required Reading:

Zartashea, N. F. (2023). Revolutionizing disease diagnosis: The role of deep learning in medical imaging and radiology. *International Journal of Science and Research Archive*, *10*(1), 1175–1185. https://doi.org/10.30574/ijsra.2023.10.1.0707

Session 5: Vaccines and Therapeutics — Scientific Basis and Global Impact

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This session will provide an overview of the scientific principles behind vaccines and therapeutic interventions, examining how they prevent and treat disease. After the session, students will be able to understand key vaccine platforms and treatment modalities while considering their influence on global health outcomes, equity, and disease control in the Indian context.

Required Reading:
Bandaru, R., Rout, S. R., Kamble, O. S., Samal, S. K., Gorain, B., Sahebkar, A., Ahmed, F. J., Kesharwani, P., & Dandela, R. (2022). Clinical progress of therapeutics and vaccines: Rising hope against COVID-19 treatment. *Process Biochemistry*, *118*, 154–170. https://doi.org/10.1016/j.procbio.2022.04.011

Recommended Readings:
1. Bloom, B. R., & Widdus, R. (1998). Vaccine visions and their global impact. *Nature Medicine*, *4*(S5), 480–484. https://doi.org/10.1038/nm0598supp-480
2. Kumar, P., & Sharma, P. (2019). Role of Vaccines on Human Health-A Review. *SSR Institute of International Journal of Life Sciences*, *5*(1), 2122–2125. https://doi.org/10.21276/ssr-iijls.2019.5.1.1

Field visit: The session will take place at National Institute of Immunology, New Delhi to get hands-on experience after the theory session.

Session 6: Emerging Biotechnological Tools and Global Health Innovation
The session will introduce the scientific foundations of various vaccines and therapeutic interventions and will explore how immunology, molecular biology, and biotechnology contribute to preventing and treating disease in India. Students will learn about different vaccine platforms, such as mRNA, viral vector, and protein-based vaccines, as well as key therapeutic strategies used to manage infectious and noncommunicable conditions in India. Through global and local perspectives, the session will cover how these vaccine technologies shape public health outcomes, reduce disease burden, and influence global health.

Required Reading:
De Lima, R. C., & Quaresma, J. a. S. (2025). Emerging technologies transforming the future of global biosecurity. *Frontiers in Digital Health*, *7*, 1622123. https://doi.org/10.3389/fdgth.2025.1622123

Session 7: Digital and Data-Driven Technologies in Public Health Transformation
The digital innovations and data-driven tools are reshaping public health practices and health system performance worldwide. The session will explore the role and use of artificial intelligence, machine learning, digital epidemiology, and mobile health platforms in disease surveillance, service delivery, and health communication. This session will discuss how data-driven approaches can enhance public health decision-making, enhance research, and improve access to quality care.

Required Reading:

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Zandi, D., & Kuzmanovic, A. (2021). *Global strategy on digital health 2020-2025*. https://www.who.int/docs/default-source/documents/gs4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf

Module 3: Design Thinking for Global Impact- Engineering in Health
This module will introduce the core principles of design thinking as a human-centered approach that enables innovative solutions through the use of biotechnology to address global health challenges. The module will also delve into how design thinking contributes to the development of scalable, user-centered, and environmentally resilient waste-management solutions.

Session 8: Principles of Design Thinking in Global Health Innovation
It This session will discuss various stages of the design-thinking process, such as empathy, problem definition, ideation, prototyping, and testing, and how each stage supports the creation of context-appropriate, accessible, and sustainable health solutions.

Required Reading:
Srinivas, G. (2021). Healthcare innovation and design thinking. *Karnataka Pediatric Journal*, *36*, 87–93. https://doi.org/10.25259/kpj_14_2021

Session 9: Biodesign for Waste Sustainability: Microbial Solutions and System Innovation
This session explores how biodesign and biotechnology offer innovative pathways for sustainable waste management with microbial systems and engineered biological processes, especially in a megacity like Delhi. It will also explore how microbial resistance in hospital settings poses a major challenge to hospital management and hazardous waste management in India.

Field visit: Visit the hospital waste management unit and waste management treatment plant to understand the processes and discuss operational insights with administrators and practitioners.

Session 10: Digital and Data-Driven Technologies in Public Health Transformation
In this session, students will learn about applications such as digital epidemiology, AI-assisted diagnostics, and mobile and telehealth platforms. These innovations enhance disease surveillance, service delivery, and decision-making. It will also highlight key challenges, including data privacy and digital inequities, that influence the effectiveness of technology in global health contexts.

Required Reading:
Xu, X., Zhang, Y., Wang, Y., Zhao, C., Zhang, Y., & Xie, X. (2025). Impact of regional digital transformation on public health: an empirical analysis based on 31 provinces in China. *BMC Public Health*, *25*(1), 2485. https://doi.org/10.1186/s12889-025-23670-8

Field visit:

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The session will be held at the Integrated Disease Surveillance Program in Delhi, followed by observing various tools and technologies used by the data storage and disease surveillance units in Delhi and how they are responding to various needs and emergencies.

Module 4: Biotechnology, Reproductive Medicine, and the Question of Cultural Dimensions of Biotechnology

This module examines how biotechnology is transforming reproductive medicine through advances in assisted reproductive technologies, genetic screening, and fertility preservation. Students will understand the scientific principles that underpin these innovations, consider their implications for reproductive health, access, and ethics, and learn how biotechnological developments are reshaping reproductive care in diverse cultural and global health contexts.

Session 11: Biotechnology in Reproductive Health and Assisted Technologies

The session will introduce the role of biotechnology in advancing reproductive health through assisted reproductive technologies such as In-vitro fertilization (IVF), Intrauterine Insemination (IUI), genetic screening, and cryopreservation. The students will learn how innovations address infertility, improve maternal health outcomes, and shape reproductive choices. it will lead to a discussion about emerging ethical and access-related considerations within diverse global health contexts. This module will also explore how cultural beliefs, social values, and community norms shape the acceptance, use, and governance of biotechnological solutions and innovations. The module will highlight the importance of culturally informed approaches to ensure equitable, responsible, and context-sensitive applications of biotechnology in global health**.**

Required Readings:

Choudhary, K. K., Kavya, K. M., Jerome, A., & Sharma, R. K. (2016). Advances in reproductive biotechnologies. *Veterinary World*, *9*(4), 388–395. https://doi.org/10.14202/vetworld.2016.388-395

Silvia, T., Ivana, Š., Mária, M., & Mirka, R. (2022). Biotechnology in the process of assisted reproduction. In *Elsevier eBooks* (pp. 143–161). https://doi.org/10.1016/b978-0-323-90042-3.15002-9

Field visit: The session will be conducted at IVF clinic to get hands-on learning by visiting various sections of the hospital dealing in myriad aspects of IVF-IUISession 12: Ethics, Policy, and the Future of Reproductive Biotechnology

in this session, students enagage with the ethical, legal, and policy dimensions shaping the development and use of reproductive biotechnologies. The focus is on debates and deliberations surrounding genetic modification, embryo research, cross-border reproductive care, and equitable access, and how regulatory frameworks and emerging innovations influence the future direction of reproductive biotechnology in local and global health contexts.

Required Reading:

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Sarbasheva, M., Khamchiev, K., & Isaeva, P. (2024). Biotechnology and the Green Future of Reproductive Health: Innovations for an environmentally Sustainable approach. *BIO Web of Conferences*, *140*, 05001. https://doi.org/10.1051/bioconf/202414005001

Session 13: Localization of Global Biotechnology – Negotiating Culture, solutions and, Innovation
The global biotechnological solutions and innovations are adapting and assimilating the diverse cultural contexts to ensure relevance, acceptance, and equity, especially in public health. The session will further explore how local beliefs, community practices, and social dynamics influence the implementation of various solutions and drive innovation in biotechnology. It will also develop an understanding of how the negotiation between global innovation and local realities advances effective and ethical health interventions.

Required Readings:
Cooke, P. (2002). Biotechnology clusters as regional, sectoral innovation systems. *International Regional Science Review*, *25*(1), 8–37. https://doi.org/10.1177/016001760202500102

Thorsteinsdóttir, H., Ray, M., Kapoor, A., & Daar, A. S. (2011). Health biotechnology innovation on a global stage. *Nature reviews. Microbiology*, *9*(2), 137–143. https://doi.org/10.1038/nrmicro2492

Field visit: Visit Regional Centre for Biotechnology (RCB), Faridabad, New Delhi Territory Region to interact with students and faculty to learn about activities and culture of research and development.

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