Bioethics & Bioprinting Short Course Syllabus

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Introduction to the Short Course Syllabus

This seven-week short course was designed and piloted at Penn State in Spring 2025. It is intended as a one-credit (45 hour) college-level remote asynchronous interdisciplinary course.

Bioethics & Bioprinting Short Course Syllabus

**Course Description**

This short course will provide an introduction to 3D bioprinting technologies for regenerative medicine and critical consideration of the many ethical, legal, and social issues that correspond to the development and use of these technologies. Topics could include, for example, legal issues related to intellectual property, privacy rights, and personalized bioprinted organs, tissues, and body parts; ethical issues related to resolving physician-patient disagreements about use of natural vs fabricated organs and tissues in clinical care; regulatory gaps at the FDA for 3D bioprinting; and equity in the development and distribution of 3D bioprinted materials. This course is designed for students across different disciplines (including engineering, science, law, ethics, and other programs).

**Course Time and Location**

This is a remote asynchronous course that does not have a set time or physical classroom location.

**Course Objectives**

Upon successful completion of this course, you will be able to…

1. Define key bioprinting technologies and methods
2. Describe key bioethical principles and theories
3. Analyze bioethical issues involved with medical and non-medical bioprinting applications
4. Describe and interpret legal issues and regulatory frameworks for bioprinting technologies
5. Summarize societal and cultural implications of bioprinting technologies and applications

**Required Textbooks**

1. There is no required textbook. Required readings for this course are available online.
2. There are two optional textbooks suggested for more in-depth learning: (1) Ibrahim Ozbolat, *3D Bioprinting: Fundamentals, Principles and Applications*. Elsevier Academic Press (2017). eBook ISBN: 9780128030301 and (2) Yang Wu, Jerry Fuh, and Ibrahim Ozbolat. *3D Bioprinting in Tissue and Organ Regeneration*. Elsevier Academic Press (2023). eBook ISBN: 9780323859059

**Course Expectations**

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| **Activity** | **Percentage of Grade** |
| Class Engagement (7) | 35% |
| Written Assessments (2) | 20% |
| Quizzes (3) | 45% |

* Class engagement 350 points (35% of your overall grade)
  + You are expected to contribute to the discussion board each week of the 7-week session. Specific discussion prompts will be provided, and your engagement with each of these prompts and your classmates’ posts will be worth up to 50 points (or 5% of your overall grade) each week. Scoring criteria will involve timeliness, relevance to the prompt, and demonstrated effort.
* Essays 200 points (20% of your overall grade)
  + There are two required essays. Each is worth 100 points (or 10% of your overall grade)
  + Technical specifications for the essays:
    - Each essay must be between 500 and 1000 words in length
    - Each essay must be submitted online before the due date and time. If you have technical problems uploading your essay, you may email it to the instructor.
    - Writing should be refined (i.e., proofread your work) and free from typos, misspellings, punctuation errors, sentence fragments or run-ons, and other mechanical errors.
    - Organization of essay content should be clear and logical.
  + Prompts setting the substantive expectations for each essay will be provided separately.
* Quizzes 450 points (45% of your overall grade)
  + There are three quizzes to assess your learning. Each is worth 150 points (or 15% of your overall grade).
  + Quiz questions may be True/False, Fill-in-the-Blank, Matching, Multiple Choice, or short narrative styles.

**Schedule for Readings and Recorded Lectures**

The following schedule is tentative and will be adjusted at the instructor’s discretion. It is each student’s responsibility to keep up with changes announced in recorded lectures, notification emails, and/or course announcements. Updated versions of the syllabus will be posted. In addition to this content, each week features required viewing of posted recorded video content.

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| **Week** | **Topic** | **Required Readings** | **Discussion** | **Essay** | **Quiz** |
| 1 | Introduction to Bioprinting | Kačarević ŽP, Rider PM, Alkildani S, Retnasingh S, Smeets R, Jung O, Ivanišević Z, Barbeck M. An Introduction to 3D Bioprinting: Possibilities, Challenges and Future Aspects. Materials (Basel). 2018 Nov 6;11(11):2199. doi: 10.3390/ma11112199. PMID: 30404222; PMCID: PMC6266989. Available at <https://pmc.ncbi.nlm.nih.gov/articles/PMC6266989/> | Discussion Board Prompt #1 |  |  |
| 2 | Introduction to Bioethics | "Bioethics." Encyclopedia of Bioethics. *Encyclopedia.com.* (Last updated 08/13/2018) Available at <https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/bioethics> | Discussion Board Prompt #2 |  | Quiz #1 |
| 3 | Bioprinting Applications | Ozbolat IT, Peng W, Ozbolat V. Application areas of 3D bioprinting. Drug Discov Today. 2016 Aug;21(8):1257-71. doi: 10.1016/j.drudis.2016.04.006. Epub 2016 Apr 13. PMID: 27086009. | Discussion Board Prompt #3 | Essay #1 |  |
| 4 | Key Ethical Issues | Datta P, Cabrera LY, Ozbolat IT. Ethical challenges with 3D bioprinted tissues and organs. Trends Biotechnol. 2023 Jan;41(1):6-9. doi: 10.1016/j.tibtech.2022.08.012. Epub 2022 Sep 15. PMID: 36117024. | Discussion Board Prompt #4 |  | Quiz #2: |
| 5 | Legal and Regulatory Challenges | Gilbert F, O'Connell CD, Mladenovska T, Dodds S. Print Me an Organ? Ethical and Regulatory Issues Emerging from 3D Bioprinting in Medicine. Sci Eng Ethics. 2018 Feb;24(1):73-91. doi: 10.1007/s11948-017-9874-6. Epub 2017 Feb 9. PMID: 28185142. | Discussion Board Prompt #5 |  |  |
| 6 | Societal and Cultural Impacts | Mendoza MCO, Chico JCD, Ong AKS, Regayas RAM. Assessment of Health Values, Beliefs, Norms, and Behavior towards Consumption Intention of 3D-Bioprinted Meat. Foods. 2024 Aug 23;13(17):2662. doi: 10.3390/foods13172662. PMID: 39272426; PMCID: PMC11394225. Available at <https://pubmed.ncbi.nlm.nih.gov/39272426/> | Discussion Board Prompt #6 |  | Quiz #3: |
| 7 | Future Directions and Emerging Issues | Kim J, D A G, Debnath P, Saha P. Smart Multi-Responsive Biomaterials and Their Applications for 4D Bioprinting. Biomimetics (Basel). 2024 Aug 11;9(8):484. doi: 10.3390/biomimetics9080484. PMID: 39194463; PMCID: PMC11351532. Available at <https://pubmed.ncbi.nlm.nih.gov/39194463/>  Taylor S, Mueller E, Jones LR, Makela AV, Ashammakhi N. Translational Aspects of 3D and 4D Printing and Bioprinting. Adv Healthc Mater. 2024 Oct;13(27):e2400463. doi: 10.1002/adhm.202400463. Epub 2024 Jul 9. PMID: 38979857. | Discussion Board Prompt #7 | Essay #2 |  |