Syllabus

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| **Name of course** | Sustainable Materials |  |
| **Instructor emails** | Dr. David Kaplan, [David.kaplan@tufts.edu](mailto:David.kaplan@tufts.edu)  Dr. Logan Morton, [logan.morton@tufts.edu](mailto:logan.morton@tufts.edu)  Dr. Lauren Blake, [lauren.blake@tufts.edu](mailto:lauren.blake@tufts.edu)  Dr. Sanjana Gopalakrishnan, [Sanjana.gopalakrishnan@tufts.edu](mailto:Sanjana.gopalakrishnan@tufts.edu)  Dr. Artem Arkhangelskiy, [Artem.arkhangelskiy@tufts.edu](mailto:Artem.arkhangelskiy@tufts.edu)  Dr. Reddhy Mahle, [reddhy.mahle@tufts.edu](mailto:reddhy.mahle@tufts.edu) |  |
| **Course number** | BME 0193 Special Topics-Sustainable Materials |  |
| **Credit hours** | 3 |  |
| **Responsible departments** | Biomedical Engineering |  |
| **Prerequisites** | Introductory chemistry and biology |  |
| **Academic term** | Fall 2024 |  |
| **Dates of course** | September 3 – December 9, 2024 |  |
| **Class meeting time** | Mon/Wed 3-4:15 pm |  |
| **Classroom** | Room 136 Science & Technology Center |  |
| **Course description** | In this course, you will gain an understanding of materials utilized in consumer products and everyday life from an environmental sustainability, human health, and global impact perspective. ‘Sustainable Materials’ will provide context to what we use today for plastics and other materials, and how the needs and directions for such use are changing toward more sustainable alternatives – including the motivations, methods and progress.  We will look at materials as a microcosm of needs on the planet and how we can actively participate in the solutions. The course will include fundamental knowledge (e.g., mechanisms of synthesis and characterization, sources of materials, processing methods, mechanisms of breakdown, re-use of materials), new and emerging strategies in the field, methods to assess sustainability, and future needs and visions.  It will also include discussions on how sustainable materials fit within lifecycle analyses, cover current news and views on the topic, emerging solutions, and include projects to address new ideas. |  |
| **Learning outcomes: Upon successful completion of this course, students should be able to:** | ●   Understanding of sustainable materials in detail, but also in terms of context or holistic terms  ●   Apply the components of sustainability, life cycle analysis  ●   Assess scalability potential for novel material manufacturing solutions  ●   Understand recombinant and regenerated approaches for harvesting biopolymers, pros and cons  ●   Understand the pros and cons of using different incumbent materials and what problems need solving | |
| **Grading scale** | A: 90-100  B: 80-89  C: 70-79  D: 60-69  F: 59 and below | |
| **Attendance requirements** | Attendance is highly recommended and part of the grade | |
| **Teaching arrangement and method of instruction** | * Lecture * Hands-on lab demonstration * Participation during class discussion * Guest lectures * Oral presentations * Group project * Written summary * Take home exams | |
| **Assessment Criteria** | * **Class participation and attendance** (9%) * **Homework (6)** (31%) * **Midterm presentation** – (25%) – halfway update for the final class project. Will entail a written portion (1-2 pages) as well as a 5 minute in-class presentation with your project group. We hope that this will be helpful in ironing out issues before the final presentations. * **Class project** – team (35%) – 20-minute presentations. Some ideas will be provided, but the thought is that the students will dig their teeth into something they are passionate about and present on how it could impact currently utilized materials to improve sustainability. | |
| **Suggested Reading Material** | [**Leather-like material biofabrication using fungi**](https://doi.org/10.1038/s41893-020-00606-1) Mitchell Jones, et al. *Nature Sustainability.* 2021.  [**State of the Industry Report: Next-Gen Materials**](https://materialinnovation.org/reports/state-of-the-industry-report-next-gen-materials/) Elaine Siu. *Material Innovation Initiative Report*. 2021.  **Fiber-Based Biopolymer Processing as a Route toward Sustainability** Chunmei Li et al., Advanced Materials, 2021    Online Materials of note:  <https://sustainability.tufts.edu/>  <https://ecochain.com/blog/life-cycle-assessment-lca-guide/>  [MIT course: How to Build (Almost) Anything](https://ocw.mit.edu/courses/mas-863-how-to-make-almost-anything-fall-2002/)  <https://www.media.mit.edu/courses/htgaa/>  [NC State Sustainable Materials and Technology courses](https://catalog.ncsu.edu/course-descriptions/smt/) | |
| **Late Policy** | For in class presentations and participation no late submissions will be accepted.  For assignments, 20% will be deducted per day after the due date. | |
| **Academic Integrity** | Students are responsible for creating an atmosphere of integrity and honesty in all assignments, class discussions, research conducted, and other academic work.  This is accomplished by:   * Learning and using proper scholarly procedures; * Scrupulously following directions and asking for clarification when needed; and * Engaging with course material fully and meeting the spirit of the assignment.   Academic misconduct is inimical to academic integrity and violates a core value of Tufts University.  Accordingly, faculty and students are prohibited from engaging in academic misconduct.  Academic misconduct includes cheating, plagiarism, inappropriate collaboration, academic dishonesty, research misconduct, and facilitating the academic misconduct of another.  Academic misconduct can occur with the intent to deceive or by disregarding proper scholarly procedures.  Please review the [Academic Misconduct policy](https://students.tufts.edu/community-standards/student-code-conduct/policies-regarding-student-behavior) in the Code of Conduct. We also encourage you to review the information below about the parameters of scholarly work to consider how to best meet University expectations. | |
| **Public access to class information** | All course information, presentations, projects, and assignments may be shared as examples in subsequent courses both within and outside of Tufts. If you have any questions about this policy please reach out and we would be happy to discuss. | |

**Syllabus Schedule *(subject to change):***

***Sep 4- Overview*** *-* definitions, coverage, topics, rationale, the future *(David Kaplan)*

***Sep 9, 11 - Historical perspective*** – where we started, where we are, how we got here, waste, landfills, micro/nano plastics *(Lauren Blake and Logan Morton)*

***September 11: Assignment #1:*** Envisioning Sustainability Through Art

***Sep 16, 18 - Challenges and opportunities* –** what are the issues and problems today, what are the paths forward to solve these challenges *(Logan Morton and Lauren Blake)*

***September 18: Project checkpoint #1:*** Pick your groups and pick your problem

***Sep 23, 25 - Old polymers with new perspectives and approaches*** (alt proteins, new methods, new solvents, chemistry, etc.) – cellulose, chitin/chitosan, keratin, silk, collagen *(Logan Morton and Sanjana Gopalakrishnan)*

***September 25: Assignment #2:*** Exploring Emerging Polymers for Sustainable Materials

***Sep 30 - Emerging concepts – Chemical modification of biomaterials*** (*Sanjana Gopalakrishnan)*

***Oct 2 – Sustainable materials for textiles guest lecture*** *(Sydney Gladman)*

***October 2: Project checkpoint #2:*** Send one slide introduction to your project—will be reviewed by the team to ensure that it is a reasonable selection.

***Oct 7 - Sustainable materials for food and agriculture*** *(Lauren Blake)*

***Oct 9, 16 – Emerging concepts – modern advancements in biopolymers and Engineered Living Materials*** *(Sanjana Gopalakrishnan and Reddhy Mahle)*

***October 9: Assignment #3:*** Surface Modification for Sustainable Materials: Enhancing Functionality and Performance

***October 16: Project checkpoint #3:*** Written portion of the midterm presentation (1-2 Pages)

***Oct 21, 23 - Case studies + midterm*** *(Logan Morton and students)*

***October 23: No assignment, just midterm presentations***

***Oct 28 - Manufacturing Considerations for Sustainable Materials****(Lauren Blake)*

***Oct 30: SCOBY Leather Show and Tell and in-class hands-on alginate fiber wet-spinning demo*** *(Lauren Blake)*

***October 30:  Assignment #4: Grow SCOBY in weeks prior and design a SCOBY leather product. Upload 1 slide about your design strategy, challenges and wins***

***Nov 4, 6 - Sustainable Materials Management*** *(Artem Arkhangelskiy)*

***November 6: Project checkpoint #4: Literature review—collect resources to support your proposed sustainable material. Delve into the research. What are some things you had not thought about yet? (minimum 5 articles)***

***Nov 13 - Sustainable materials for healthcare*** *(Sanjana Gopalakrishnan)*

***November 13: Assignment #5:*** Materials Management and Life Cycle Analysis of Emerging Polymers

***Nov 18, 20 – State of the Kaplan lab – where you can get involved in sustainable materials right here at Tufts***

***November 20: Project checkpoint #5: Materials management and life cycle analysis for your proposed project***

***Nov 25 - W*hat we need, how do we get there, circular approaches** *(David Kaplan)*

***Nov 27, - No class due to Thanksgiving Holiday***

***Dec 2, 4, 9 - Final presentations (students)***

***Student Resources:***

**Accommodations for Students with Disabilities:**Tufts University values the diversity of our students, staff, and faculty and recognizes the important contribution each student makes to our unique community. Tufts is committed to providing equal access and support to all qualified students through the provision of reasonable accommodations so that each student may fully participate in the Tufts experience. If you have a disability that requires reasonable accommodations, please contact the StAAR Center (formerly Student Accessibility Services) at [StaarCenter@tufts.edu](mailto:StaarCenter@tufts.edu) or 617-627-4539 to make an appointment with an accessibility representative to determine appropriate accommodations. Please be aware that accommodations cannot be enacted retroactively, making timeliness a critical aspect for their provision.

**Academic Support at the StAAR Center:**The StAAR Center (formerly the Academic Resource Center and Student Accessibility Services) offers a variety of resources to all students (both undergraduate and graduate) in the Schools of Arts and Science, Engineering, the SMFA and Fletcher; services are free to all enrolled students. Students may make an appointment to work on any writing-related project or assignment, attend subject tutoring in a variety of disciplines, or meet with an academic coach to hone fundamental academic skills like time management or overcoming procrastination. Students can make an appointment for any of these services by visiting the [StAAR Center](https://go.tufts.edu/StAARcenter" \o "https://students.tufts.edu/staar-center" \t "_blank) website ([go.tufts.edu/StAARCenter](https://go.tufts.edu/StAARCenter)).

**Mental Health Support:** As a student, there may be times when personal stressors or emotional difficulties interfere with your academic performance or well-being. The Counseling and Mental Health Service (CMHS) provides confidential consultation, brief counseling, and urgent care at no cost for all Tufts undergraduates as well as for graduate students who have paid the student health fee. To make an appointment, call 617-627-3360. Please visit the [CMHS](https://go.tufts.edu/Counseling) website ([go.tufts.edu/Counseling](http://go.tufts.edu/Counseling)) to learn more about their services and resources.