

## **JMB1050: Biological and Bioinspired Materials -- Fall 2024**

Institute of Biomedical Engineering  
Department of Materials Science & Engineering

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<b>Guest lecturers:</b>	Prof. Adele Changoor, MSH/MSE Prof. B. Ganss, Dentistry/BME Nadeen Meshry, Dentistry
<b>Weekly meeting:</b>	Wednesdays, 10am-12pm
<b>Location:</b>	MY 480

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### **Course Description:**

This course, offered jointly through BME and MSE, covers fundamental aspects of the formation, structure, and properties of natural materials, and the use of derived biological principles such as self-assembly and mineralization to design synthetic materials for a variety of applications. Examples are drawn from both structural and functional biomaterials, with emphasis on hybrid systems in which protein-mineral interactions play a key role, such as mineralized tissues and biological adhesives. Additional materials with remarkable mechanical, optical, and surface properties will be discussed. Advanced experimental methods for characterizing interfacial biological structures will be highlighted, along with materials synthesis strategies, and structure-property relationships in both biological and engineered materials.

### **Prerequisite:**

Students should have a physical sciences/engineering background and have some familiarity with basic concepts in biochemistry and cell biology.

### **Course format:**

The course material covers three main areas: (i) Biomineralization and composite materials; (ii) Bioinspired self-assembled materials; and (iii) Bioadhesion and biomimetic adhesives (see schedule for details). The course will be run as “guided journal club”/seminar, in which we will explore recent and/or seminal papers on various topics in these areas. Typically, the first hour of class will consist of a journal club presentation and discussion led by students. In the second hour, the instructor or guest lecturer will introduce a new topic to provide the conceptual basis and context for the next week’s topic. Readings will often be assigned as background in advance of the lecture.

**Marks distribution:**

Journal club presentation	25%	ongoing
Participation	15%	ongoing
Journal club assignments	10%	ongoing
Research Proposal pitch presentation	10%	November 13
Research Proposal letter of intent	10%	November 20
Research proposal	30%	December 4

**Journal club presentation**

Each student (singly or in pairs, depending on final course enrolment) will lead one journal club presentation and discussion during the course, based on recent literature that connects to the topic of the previous week's lecture. A survey will be made available in week one, and slots will be filled on a first-come, first-served basis. The length of each presentation and discussion will be 50 minutes.

While all students are expected to read the journal club article in advance, the presenters are expected to have an in-depth knowledge of the paper and both present the paper and lead a discussion. The presentation should summarize the major findings and significance of the paper, and also explain key background principles and important techniques. Significant criticisms, limitations, and/or future directions should be discussed where relevant. Given the limited time, it is not usually possible to cover all the results of the paper, but the presenters can work with the assumption that all students will have read the paper. Therefore, they can cover only important and/or tricky findings and spend more time on context and analysis.

The presentation should be designed to be interactive and encourage participation from the class.

**Participation**

Students are expected to attend and participate in both lectures and journal clubs, having read assigned readings or the journal club article. Please bring the journal club article with you to class, along with your notes, comments, or questions. In both lectures and journal clubs there will be plenty of opportunity for class discussion and questions. The participation mark will reflect both attendance and participation in class discussions during lectures, journal clubs and research proposal pitch presentations.

**Journal club assignments**

A short assignment will be posted in advance of each journal club presentation. These are designed to encourage students to read the articles prior to the journal club presentations. The assignments will be due prior to the start of the class in which the journal club article is being presented.

**Research proposal**

The final course assignment will consist of an original research proposal on a topic of the student's choosing, within the field of biological and bio-inspired materials. The topic need not be one that was covered in the course and should not be closely related to the student's

thesis topic. The proposal will follow the formatting requirements of an NSERC Discovery Grant and will be due on December 4 (submission via Quercus). Prior to submission of the proposal, a one page “letter of intent” is due on November 20 (submission via Quercus). The letter of intent should also follow NSERC format and should provide a summary of the proposed research topic, objectives, and significance. No late submissions will be accepted for either the letter of intent or full proposal.

During the November 13 class meeting, each student will present a short research proposal pitch to the class of ~5 min., followed by 5 min. of questions/discussion.

### **Use of Generative AI:**

Students may use GenAI tools as learning aids, e.g., literature searches or to summarize information from an article. These tools should be used in a manner similar to consulting library books, online sources, peers, or a tutor. These uses do not need to be cited or disclosed.

Unless otherwise stated, students may also use GenAI tools in completing course assignments in the limited ways described below:

It is permissible to use GenAI tools for creating an outline for an assignment or for generating graphics, in which case the use should be appropriately cited. All the ideas and words in the assignment must be original work produced by the individual student alone.

Please consult with the instructor if you are unsure about a particular use of GenAI.

### **Course schedule:**

#### **Week One – September 11**

Course introduction E. Sone

*\*Journal club schedule sign up posted this week*

#### **Week Two – September 18**

Lecture 1 – Principles of biomineralization E. Sone

#### **Week Three – September 25**

Journal club 1 – Biomineralization A. Obille

Lecture 2– Bone: Formation, structure, and properties E. Sone

#### **Week Four – October 2**

Journal club 2 – Bone Students

Lecture 3 – Mechanism of collagen mineralization E. Sone

#### **Week Five – October 9**

Journal club 3 – Collagen biomineralization Students

Lecture 4 – Bioinspired scaffolds and hydrogels for bone regeneration E. Sone

**Week Six – October 16**

Journal club 4 – Bone regeneration  
Lecture 5 – Enamel

Students  
B. Ganss

**Week Seven – October 23**

Journal club 5 – Enamel mimetic materials  
Lecture 6 – Cartilage structure, function and diseases

Students  
A. Changoor

**Week Eight – October 31**

Reading Week

**Week Nine – November 6**

Journal club 6 – Cartilage repair and regeneration  
Lecture 7 – Biological adhesion

Students  
A. Obille

**Week Ten – November 13**

Research Proposal Pitch Presentations

Students

**Week Eleven – November 20**

Journal club 7 – Bioadhesion  
Lecture 8 – DNA-based nanomaterials and mineralization  
*\*Research proposal letter of intent due*

Students  
N. Meshry

**Week Twelve – November 27**

Journal club 8 – DNA nanostructures

Students

**Week Thirteen – December 4**

*\*Research Proposal due*