Div. Surface & Corrosion Science, Dept. Chemistry
Div. Polymer Technology, Dept. Fibre and Polymer Technology

Biomedical materials, KD2300, ECTS 7.5 credits

The course consists of lectures, laboratory exercises, and a project task. The lecturers are Prof. Jinshan Pan (JP) at Div. Surface & Corrosion Science, Dept. Chemistry, and Prof. Ulrica Edlund (UE) at Div. Polymer Technology, Dept. Fibre and Polymer Technology. A guest lecturer, Dr. Anna Weissenrieder (AW), will give the first two lectures.

Course content

Various types of biomaterials for a wide range of biomedical applications; Fundamental structure-property relationships; Basic function and performance of passive and active implant materials; Physical, chemical, and mechanical aspects of bulk and surface properties of metallic, polymer and ceramic biomaterials; Principles of surface engineering and combination of different materials; Host-tissue response, blood compatibility, polymers for controlled drug release; Corrosion and degradation mechanisms of biomaterials; Selection of biomaterials based on function, biological environments, toxicity, and economic aspects; Examples of biomaterials and implant objects and devices; Current research trends and medical device regulation.

Intended learning outcomes

After completion of the course the student will be able to: i) Give examples of biomedical material applications, identify material properties that are critical for metallic, polymer, and ceramic biomaterials, and suggest a proper type of biomaterial for given applications; ii) Explain basic physical, chemical and mechanical processes that may occur on biomaterials in use, including corrosion and degradation reactions that occur for different biomaterials and their consequences; iii) Practically perform testing and property evaluations of common biomedical materials; iv) Present and evaluate a project and laboratory assignments orally and in writing.

Lectures

The lectures focus on the structure, function, and performance of various types of metallic, ceramic, and polymer biomaterials, and their mechanical, physical, and chemical properties, as well as the corrosion and degradation mechanisms of biomaterials in different applications. In addition to chosen chapters in the course book, the lectures also present current trends in biomaterial research. There is one extra pass after the polymer lectures, during which the teachers give a short summary of the lectures and answer questions from the students.

Laboratory exercise (compulsory)

There are two practical laboratory exercises, one about polymers and another about metal biomaterials. A short report (ca. 2 pages) should be submitted after each laboratory exercise. Plagiarism is not allowed. It is not allowed to use generative AI

tools in the writing of this report or to use text or text fragments generated by such tools.

Polymer exercise: The students will learn how to make hydrogel (a common polymeric biomaterial) and test some important properties of hydrogels by investigating their own hydrogel specimens. The polymer lab exercise will be done individually and tutored via Zoom on September 21. To be able to do this exercise, EACH STUDENT individually needs to pick up their personal hydrogel sample in advance. Hydrogel samples can be claimed at any of Ulrica's lectures (Sep. 8, 12, 15, and 20). Should a student for any reason not be present during any of these lectures, it is the student's responsibility to contact Ulrica, schedule a time, and pick up the sample from Ulrica's office.

Metal lab: The students (divided into small groups) will learn how to perform electrochemical (EC) measurements of metallic biomaterials (stainless steel and titanium) to evaluate and compare the corrosion resistance of the materials. The lab assistant, Dr. Xiaoqi Yue, will prepare the instruments, electrochemical cells and the samples, and also explain and assist the EC measurements. The metal lab excise will take place in our own EC lab (Teknikringen 34, room 602, floor 6), in four repeated lab sections, each student will only join one of the four sections. The students need to sign up on the list during Jinshan's lectures and read the references provided in the course homepage before the lab exercise.

Group project work (compulsory)

The students will work in groups of two persons. Each group will choose a real implantable biomedical device as the project topic (there is a list of proposed topics). The students' tasks are: to search, read, and summarize information about the functions of the device and materials used in the device. Each group will write a technical report (ca. 10 pages) including a description of the functions of the device, a discussion of the material properties critical for the application, potential risk for material failure, and suggestions for improvement or alternative materials. Plagiarism is not allowed. It is not allowed to use generative AI tools in the writing of this report or to use text or text fragments generated by such tools. For more information regarding plagiarism, the Policy for handling plagiarism in KTH education is available via this link:
https://www.kth.se/social/upload/529e4900f27654016...iarism%20in%20KTH%20education.pdf

At the two seminars, each group will make an oral presentation of their own project work, and give critical comments on other groups' project work.

Examination (two parts)

1. Written exam at the end of the course. The results from the written exam will be graded (A, B, C, D, E, Fx, F) based on a system of 100 points, and ca. 50 points are required to pass the exam. For participating in the lectures and passing the written exam, the student gets 4.5 ECTS. The regulations for written exams apply to all students at KTH. Please, read carefully what you ought to know and follow: https://www.kth.se/en/student

Based on the recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with a documented disability. In order to ensure that the student receives support for an examination, they need to submit their complete application for support as soon as the need arises. The guideline for supportive measures in the examination of students with disabilities is found here: https://intra.kth.se/polopoly_fs/1.909914.1560175463!/Guideline%20for%20supportive%20measures%20in%20the%20examination%20of%20students%20with%20disabilities.pdf

2. The completion and passing of the lab and project work. For passing the laboratory exercises and the project work, the student gets 3 ECTS. The lectures, laboratory excises, and project work all will be helpful to get good results in the written exam. The passed laboratory exercises and the project work give bonus points between 5-10, which will be added to the points from the written exam to get the final points.

The whole course (7.5 ECTS) is completed when both of the two parts are completed. The total points will give the final grade for the whole course.

Schedule for lectures, laboratory exercises, and project presentations

Date	Time (room)	Topic (lecturer)
Tuesday 29/8	10-12 (K53)	Introduction - Biomaterials (AW)
Wednesday 30/8	15-17 (K53)	Titanium alloys (AW)
Friday 1/9	15-17 (K53)	Stainless steels (JP)
Tuesday 5/9	10-12 (M35)	Cobolt alloys (JP)
Wednesday 6/9	15-17 (K53)	Bioceramics/glasses (JP)
Friday 8/9	15-17 (B23)	Biological polymers (UE)
Tuesday 12/9	10-12 (FA31)	Biostable polymers (UE)
Friday 15/9	15-17 (M31)	Biodegradable polymers (UE)
Tuesday 19/9	10-12 (B23)	Modification/combination (JP)
Wednesday 20/9	15-17 (Q11)	Tissue engineering/drug delivery (UE)
Thursday 21/9	08-11 (on zoom)	Polymer exercise (UE)
Friday 22/9	15-17 (K53)	Material-tissue interaction (JP)
Tuesday 26/9	10-12 (B23)	Own study/project work
Wednesday 27/9	15-17 (K53)	Deterioration/corrosion (JP)
Thursday 28/9	08-10 (Q11)	Selection/testing/standard (JP)
Friday 29/9	15-18 (Metal lab)	Lab/Project work (JP/XY)
Monday 2/10	13-16 (Metal lab)	Lab/Project work (JP/XY)
Tuesday 3/10	09-12 (Metal lab)	Lab/Project work (JP/XY)
Wednesday 4/10	15-18 (Metal lab)	Lab/Project work (JP/XY)
Thursday 5/10	08-13	Own study/Project work
Friday 6/10	13-18	Own study/Project work
Monday 9/10	13-18	Own study/Project work
Tuesday 10/10	13-17 (K53)	Presentation of project work (JP)
Wednesday 11/10	13-17 (U1)	Presentation of project work (JP)

Exam schedule

Monday 23/10, 8-12 am, lecture room F1.

To be eligible for the exam, you must register on LADOK 'My Pages' before the deadline.
Re-exam: Tuesday, 19/12, 8-12, lecture room D33.

Course homepage

All information, announcements, and documents in this course will be available at KTH Canvas. The course Canvas room is KD2300 HT23 (50791).

Prerequisites

4H1065 Materials Science for Materials Design and Engineering, or equivalent.

Required reading

Selected chapters in "Biomaterials Science, An Introduction to Materials in Medicine", edited by B.D. Ratner, A.S. Hoffman, F.J. Schoen and J.E. Lemons. ISBN: 0125824637. 2nd edition, Academic Press (2004). There is a 3rd edition and a 4th edition of the book. Other lecture materials (hand-outs).

Requirements

Written exam (TEN, 4.5 ECTS). Lab/project (LAB: 3 ECTS).

Contact information

Course coordinator: Prof. Jinshan Pan (JP)
Examiners: Prof. Jinshan Pan and Prof. Ulrica Edlund (UE)
Guest Lecturer: Dr. Anna Weissenrieder (AW)
Metal lab assistant: Dr. Xiaoqi Yue (XY)

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Stockholm, August 2023.

Jinshan Pan, Ulrica Edlund