

# Biosensor Technology

Programme course

6 credits

Biosensorteknik

TFTB34

Valid from: 2021 Spring semester

**Determined by**

Board of Studies for Chemistry, Biology  
and Biotechnology

**Date determined**

2020-09-29

## Main field of study

Engineering Biology, Biomedical Engineering

## Course level

Second cycle

## Advancement level

A1X

## Course offered for

- Chemical Biology, M Sc in Engineering
- Engineering Biology, M Sc in Engineering

## Prerequisites

Biochemistry, General Chemistry, Basic Spectroscopy

## Intended learning outcomes

The course will give insights into the complexities involved in combining biological materials such as enzymes, antibodies and DNA with optical, electrochemical and other transducers to provide practical and easy-to-use systems. In order to integrate this knowledge and to introduce the importance of intellectual property protection, students will participate in practical classes and a group project on patent litigation at the end of the course.

The overall purpose of the course is to give the student a thorough understanding of the fundamentals and applications of biosensor technology together with an appreciation of its current and future impact on society.

Following the course, the student should be able to:

- design and construct a simple biosensor,
- use biosensors in the laboratory
- explain how biosensors are constructed and manufactured
- show how biosensors can be used to solve real analytical problems
- reflect on the patenting and commercialisation of a biosensor

## Course content

This course will provide a concise overview of biosensor technology and its application in healthcare, food safety, environmental monitoring and security. The lectures and practical exercises will focus on the construction, design and manufacture of biosensors, the principal and emerging materials and components used and three case studies of key devices. Lectures and a group project will examine some pivotal biosensor patents and an example of patent litigation. The course will conclude with a consideration of commercialisation routes, ethical issues and future perspectives.

Practical exercises will focus on enzyme electrodes, bioaffinity monitoring using two examples including the BIAcore and a site visit to see the printing facilities for biosensor production in Norrköping. The group project will study a patent litigation case and will culminate in a mock court battle.

The course will cover, an introduction to biosensors, applications of biosensors, transducers and sensor systems, bioreceptors and their immobilisation, synthetic receptors and nanomaterials for biosensors, design parameters for catalytic biosensors, design of affinity biosensors, microfluidics and arrays, glucose biosensors for diabetes, surface plasmon resonance for bioaffinity monitoring, electronic noses and tongues, patenting and litigation in the field of biosensors, commercialising biosensors, ethics and future prospects.

## Teaching and working methods

Lectures, practical exercises and a group assignment.

## Examination

LAB1	Laboratory work	1 credits	U, G
UPG1	Project assignment	1 credits	U, G
TEN2	Oral or written examination	4 credits	U, 3, 4, 5

The written examination will test the ability of the student to understand different biosensor technologies and concepts together with their practical application and commercialisation. During the practical laboratory exercises the student will be expected to construct and use enzyme electrodes for glucose measurement and to learn how to operate the BiaCore system for bioaffinity monitoring. The site visit will be used to assess observation skills and inquisitiveness. The group project will test the student's ability to work as part of a team to analyse a specific biosensor technology in detail, to present technical and commercial arguments and to individually reflect on the outcome.

## Grades

Four-grade scale, LiU, U, 3, 4, 5

## Other information

### About teaching and examination language

The teaching language is presented in the Overview tab for each course. The examination language relates to the teaching language as follows:

- If teaching language is Swedish, the course as a whole or in large parts, is taught in Swedish. Please note that although teaching language is Swedish, parts of the course could be given in English. Examination language is Swedish.
- If teaching language is Swedish/English, the course as a whole will be taught in English if students without prior knowledge of the Swedish language participate. Examination language is Swedish or English (depending on teaching language).
- If teaching language is English, the course as a whole is taught in English. Examination language is English.

### Other

The course is conducted in a manner where both men's and women's experience and knowledge are made visible and developed.

The planning and implementation of a course should correspond to the course syllabus. The course evaluation should therefore be conducted with the course syllabus as a starting point.

## Department

Institutionen för fysik, kemi och biologi

## Director of Studies or equivalent

Magnus Boman

## Examiner

Wing Cheung Mak

## Course website and other links

<http://www.ifm.liu.se/edu/coursescms/tftb34>

## Education components

Preliminary scheduled hours: 56 h

Recommended self-study hours: 104 h

## Course literature

YouTube Video: Biosensors: An Introduction by Anthony Turner:  
<http://www.youtube.com/watch?v=KChAkSAizCw> Turner, A.P.F. (2013).  
Biosensors: sense and sensibility. *Chemical Society Reviews* 42 (8), 3184-3196.  
OPEN ACCESS: <http://xlink.rsc.org/?doi=C3CS35528D> Newman, J.D. and  
Turner, A.P.F. (2005). Home blood glucose biosensors: a commercial perspective.  
*Biosensors and Bioelectronics* 20, 2435-2453. (available online in LiU) Handbook  
of Biosensors and Biochips; Robert S. Marks, Christopher R. Lowe, David C.  
Cullen, Howard H. Weetall, Isao Karube, (2007) Wiley (available as e-book in  
LiU) Chemical sensors and biosensors; Brian R. Eggins (2002) Wiley (available in  
LiU library) US Patent: 5,436,161 - Matrix coating for sensing surfaces capable of  
selective biomolecular interactions, to be used in biosensor systems. Biacore AB.:  
[http://www.google.com/patents/US5436161?](http://www.google.com/patents/US5436161?dq=Patent+US+5,436,161&hl=en&sa=X&ei=HSf5UZjuLYLPtAbzm4GQDg&ved=oCDQQ6AEwAA)  
[dq=Patent+US+5,436,161&hl=en&sa=X&ei=HSf5UZjuLYLPtAbzm4GQDg&ved=oCDQQ6AEwAA](http://www.google.com/patents/US5436161?dq=Patent+US+5,436,161&hl=en&sa=X&ei=HSf5UZjuLYLPtAbzm4GQDg&ved=oCDQQ6AEwAA)  
Reviews and articles in the Elsevier journal *Biosensors and Bioelectronics*  
(available online in LiU): [www.elsevier.com/locate/bios](http://www.elsevier.com/locate/bios) Biosensors and  
Bioelectronics Centre website: [www.ifm.liu.se/biosensors](http://www.ifm.liu.se/biosensors) PDF files of lectures  
and accompanying material.

## Common rules

### Course syllabus

A syllabus must be established for each course. The syllabus specifies the aim and contents of the course, and the prior knowledge that a student must have in order to be able to benefit from the course.

### Timetabling

Courses are timetabled after a decision has been made for this course concerning its assignment to a timetable module.

### Interrupting a course

The vice-chancellor's decision concerning regulations for registration, deregistration and reporting results (Dnr LiU-2015-01241) states that interruptions in study are to be recorded in Ladok. Thus, all students who do not participate in a course for which they have registered must record the interruption, such that the registration on the course can be removed. Deregistration from a course is carried out using a web-based form: <https://www.lith.liu.se/for-studenter/kurskomplettering?l=en>.

### Cancelled courses

Courses with few participants (fewer than 10) may be cancelled or organised in a manner that differs from that stated in the course syllabus. The Dean is to deliberate and decide whether a course is to be cancelled or changed from the course syllabus.

### Guidelines relating to examinations and examiners

For details, see Guidelines for education and examination for first-cycle and second-cycle education at Linköping University, Dnr LiU-2019-00920 (<http://stydokument.liu.se/Regelsamling/VisaBeslut/917592>).

An examiner must be employed as a teacher at LiU according to the LiU Regulations for Appointments, Dnr LiU-2017-03931 (<https://stydokument.liu.se/Regelsamling/VisaBeslut/622784>). For courses in second-cycle, the following teachers can be appointed as examiner: Professor (including Adjunct and Visiting Professor), Associate Professor (including Adjunct), Senior Lecturer (including Adjunct and Visiting Senior Lecturer), Research Fellow, or Postdoc. For courses in first-cycle, Assistant Lecturer (including Adjunct and Visiting Assistant Lecturer) can also be appointed as examiner in addition to those listed for second-cycle courses. In exceptional cases, a Part-time Lecturer can also be appointed as an examiner at both first- and second cycle, see Delegation of authority for the Board of Faculty of Science and Engineering.

## Forms of examination

### Principles for examination

Written and oral examinations and digital and computer-based examinations are held at least three times a year: once immediately after the end of the course, once in August, and once (usually) in one of the re-examination periods. Examinations held at other times are to follow a decision of the board of studies.

Principles for examination scheduling for courses that follow the study periods:

- courses given in VT1 are examined for the first time in March, with re-examination in June and August
- courses given in VT2 are examined for the first time in May, with re-examination in August and October
- courses given in HT1 are examined for the first time in October, with re-examination in January and August
- courses given in HT2 are examined for the first time in January, with re-examination in March and in August.

The examination schedule is based on the structure of timetable modules, but there may be deviations from this, mainly in the case of courses that are studied and examined for several programmes and in lower grades (i.e. 1 and 2).

Examinations for courses that the board of studies has decided are to be held in alternate years are held three times during the school year in which the course is given according to the principles stated above.

Examinations for courses that are cancelled or rescheduled such that they are not given in one or several years are held three times during the year that immediately follows the course, with examination scheduling that corresponds to the scheduling that was in force before the course was cancelled or rescheduled.

When a course is given for the last time, the regular examination and two re-examinations will be offered. Thereafter, examinations are phased out by offering three examinations during the following academic year at the same times as the examinations in any substitute course. If there is no substitute course, three examinations will be offered during re-examination periods during the following academic year. Other examination times are decided by the board of studies. In all cases above, the examination is also offered one more time during the academic year after the following, unless the board of studies decides otherwise.

If a course is given during several periods of the year (for programmes, or on different occasions for different programmes) the board or boards of studies determine together the scheduling and frequency of re-examination occasions.

### Retakes of other forms of examination

Regulations concerning retakes of other forms of examination than written examinations and digital and computer-based examinations are given in the LiU guidelines for examinations and examiners, <http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592>.

### Registration for examination

Until January 31 2021, the following applies according to previous guidelines: In order to take an written, digital or computer-based examination student must register in advance at the Student Portal during the registration period, which opens 30 days before the date of the examination and closes 10 days before it. Candidates are informed of the location of the examination by email, four days in advance. Students who have not registered for an examination run the risk of being refused admittance to the examination, if space is not available.

From February 1 2021, new guidelines applies for registration for written, digital or computer-based examination, Dnr LiU-2020-02033 (<https://stydokument.liu.se/Regelsamling/VisaBeslut/622682>).

Symbols used in the examination registration system:

- \*\* denotes that the examination is being given for the penultimate time.
- \* denotes that the examination is being given for the last time.

### Code of conduct for students during examinations

Details are given in a decision in the university's rule book:  
<http://stydokument.liu.se/Regelsamling/VisaBeslut/622682>.

### Retakes for higher grade

Students at the Institute of Technology at LiU have the right to retake written examinations and digital and computer-based examinations in an attempt to achieve a higher grade. This is valid for all examination components with code "TEN", "DIT" and "DAT". The same right may not be exercised for other examination components, unless otherwise specified in the course syllabus.

A retake is not possible on courses that are included in an issued degree diploma.

### Grades

The grades that are preferably to be used are Fail (U), Pass (3), Pass not without distinction (4) and Pass with distinction (5).

- Grades U, 3, 4, 5 are to be awarded for courses that have written or digital examinations.
- Grades Fail (U) and Pass (G) may be awarded for courses with a large degree of practical components such as laboratory work, project work and group work.
- Grades Fail (U) and Pass (G) are to be used for degree projects and other independent work.

### Examination components

The following examination components and associated module codes are used at the Faculty of Science and Engineering:

- Grades U, 3, 4, 5 are to be awarded for written examinations (TEN) and



digital examinations (DIT).

- Examination components for which the grades Fail (U) and Pass (G) may be awarded are laboratory work (LAB), project work (PRA), preparatory written examination (KTR), digital preparatory written examination (DIK), oral examination (MUN), computer-based examination (DAT), home assignment (HEM), and assignment (UPG).
- Students receive grades either Fail (U) or Pass (G) for other examination components in which the examination criteria are satisfied principally through active attendance such as tutorial group (BAS) or examination item (MOM).
- Grades Fail (U) and Pass (G) are to be used for the examination components Opposition (OPPO) and Attendance at thesis presentation (AUSK) (i.e. part of the degree project).

In general, the following applies:

- Mandatory course components must be scored and given a module code.
- Examination components that are not scored, cannot be mandatory. Hence, it is voluntary to participate in these examinations, and the voluntariness must be clearly stated. Additionally, if there are any associated conditions to the examination component, these must be clearly stated as well.
- For courses with more than one examination component with grades U,3,4,5, it shall be clearly stated how the final grade is weighted.

For mandatory components, the following applies: If special circumstances prevail, and if it is possible with consideration of the nature of the compulsory component, the examiner may decide to replace the compulsory component with another equivalent component. (In accordance with the LiU Guidelines for education and examination for first-cycle and second-cycle education at Linköping University, <http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592>).

For written examinations, the following applies: If the LiU coordinator for students with disabilities has granted a student the right to an adapted examination for a written examination in an examination hall, the student has the right to it. If the coordinator has instead recommended for the student an adapted examination or alternative form of examination, the examiner may grant this if the examiner assesses that it is possible, based on consideration of the course objectives. (In accordance with the LiU Guidelines for education and examination for first-cycle and second-cycle education at Linköping University, <http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592>).

### **Reporting of examination results**

The examination results for a student are reported at the relevant department.

### **Plagiarism**

For examinations that involve the writing of reports, in cases in which it can be assumed that the student has had access to other sources (such as during project work, writing essays, etc.), the material submitted must be prepared in accordance

with principles for acceptable practice when referring to sources (references or quotations for which the source is specified) when the text, images, ideas, data, etc. of other people are used. It is also to be made clear whether the author has reused his or her own text, images, ideas, data, etc. from previous examinations, such as degree projects, project reports, etc. (this is sometimes known as “self-plagiarism”).

A failure to specify such sources may be regarded as attempted deception during examination.

### **Attempts to cheat**

In the event of a suspected attempt by a student to cheat during an examination, or when study performance is to be assessed as specified in Chapter 10 of the Higher Education Ordinance, the examiner is to report this to the disciplinary board of the university. Possible consequences for the student are suspension from study and a formal warning. More information is available at <https://www.student.liu.se/studenttjanster/lagar-regler-rattigheter?l=en>.

### **Regulations (apply to LiU in its entirety)**

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU’s rule book for education at first-cycle and second-cycle levels is available at [http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning\\_pa\\_grund-\\_och\\_avancerad\\_niva](http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva).