



## Course syllabus

Faculty of Health and Life Sciences

Department of Chemistry and Biomedical Sciences

2XN501 Introduktion till naturvetenskaplig forskningsmetodik, 15 högskolepoäng

Introduction to Research Methodology in the Natural Sciences, 15 credits

### **Main field of study**

Biology, Biomedical Science, Physics, Chemistry, Mathematics, Environmental Science

### **Subject Group**

Other Subjects within Natural Science

### **Level of classification**

First Level

### **Progression**

G2F

### **Date of Ratification**

Approved by Faculty of Health and Life Sciences 2015-03-02

The course syllabus is valid from autumn semester 2015

### **Prerequisites**

60 credits in a subject within the Natural Sciences.

## Objectives

The aim of the course is that the student shall gain solid knowledge and skills in research methodology. The course consists of 6 modules.

When the student has completed module 1 (Vetenskapsteori och forskningsmetodik – Philosophy of science and research methods – see below), the student should be able to:

- give a summary of the most common current theories in philosophy of science and their historical development;
- identify and verbalize a scientific problem related to earlier studies/at a basic level;
- provide suggestions for the treatment of a given problem in a scientific way;
- give arguments for the selection of a particular method for the application/problem in question; and
- make a critical assessment of scientific work done by other students/scientists

When the student has completed module 2 (Forskningsetik – Research ethics – see below), the student should be able to:

- discuss theories in ethics and their relationship to research-based ethical problems;
- discuss the importance of the individual's opinion in the handling of ethical issues;
- discuss the relationship between the scientist and the society with regard to ethics;
- give an account of the contents of GLP (Good Laboratory Practice); and
- give an account of ethical rules and laws for indexes and data-bases

When the student has completed module 3 (Litteratursökning – Literature searching – see below), the student should be able to:

- select suitable literature databases for a given query;
- formulate search queries based on logical operators; and
- perform literature searches in databases containing material from the field of natural sciences.

When the student has completed module 4 (Laboratoriesäkerhet – Laboratory safety – see below), the student should be able to:

- give an account for the laws and regulations with relevance for laboratory work;
- give first aid; and
- perform a risk evaluation with relevance for laboratory work
- give an account of the responsibility people have for laboratory work and its impact on the environment and society.

When the student has completed module 5 (Kvantitativ forskningsmetodik inom naturvetenskap - Quantitative research methodology in the natural sciences – see below), the student should be able to:

- perform statistical tests (tests of significance, t-test, F-test, Grubbs test, ANOVA, chi-2-test);
- make a determination of the confidence interval;
- carry out simple and multiple linear regression;
- plan and optimize experimental studies using statistical methods;
- evaluate experimental data using statistical methods;
- select, implement and interpret a statistical procedure that gives a solution to a scientific problem and
- use statistical terms in both written and spoken language.

When the student has completed module 6 (Muntlig presentationsteknik, Oral presentation skills, see below), the student should be able to:

- give an account for fundamental concepts and theories with relevance for the planning and the realization of both scientific and popular oral presentations;
- individually prepare and carry out both scientific and popular oral presentations;

- give arguments for the choices the student makes in connection with his/her oral presentations;
- make critical evaluations of oral presentations made by other students on subjects in science or popular science and
- reflect on his/her presentation skills.

## Content

MODULE 1 Philosophy of science and introduction to research methods, 3 hp

### Contents

Current theories in philosophy of science and

their historical development.

The research process, from identification of a problem, formulation of a problem and selection of method to implementation and presentation of results.

Different scientific methods and approaches.

Discussion and dissection of scientific works.

MODULE 2 Research ethics, 3 hp

### Contents

Opinions, theories of ethics and the system of norms.

Research ethics and associated regulations: is there good and bad research?

GLP (Good Laboratory Practice), including the importance of and the demands for documentation, interpretation/presentation/publication of research results

The scientist and the society – who owns the research results?

Regulations and norms: the influence of research on the society.

MODULE 3 Literature searching, 1,5 hp

### Contents

The structure of the scientific literature.

Search logistics (e.g. Boolean operators).

Databases and their contents (BIOSIS, Chemical Abstracts/CAS-online, Medline, Physics abstracts, Science Citation Index and other relevant databases available at Lnu).

Practical training in the use of databases that are relevant for research in the natural sciences.

MODULE 4 Laboratory safety, 3 hp

### Contents

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Laws and regulations relevant for laboratory work.

Laws and local regulations concerning work involving chemicals, genetically modified organisms, infectious material and radio-isotopes as well as the responsibility people have for laboratory work and its impact on the environment and society.

First aid.

Risk evaluation of experimental work in relation to the individual and society, including laws and local regulations.

MODULE 5 Quantitative research methodology in the natural sciences, 3 hp

Contents

Statistical tests and experiments.

Significance tests, t-test, F-test, Grubbs test, ANOVA, chi-2-test

Confidence interval.

Simple and multiple linear regression analysis.

Planning of experiments and optimization.

MODULE 6 Oral presentation skills, 1,5 hp

Contents

Theoretical and practical aspects relating to preparation, implementation and evaluation of oral presentations, focusing on the student's field of study or research.

During the course, the following elements will be discussed in relation to scientific and popular oral presentations:

The communication process

The preparation process

Resources

Realization of oral presentations.

Critical assessment and evaluation of oral presentations.

The module is based on learning by experience. The student is expected to reflect, based on feedback on the student's and the other participants' performance, on different parts in the module.

### Type of Instruction

The instruction may consist of lectures, computer laboratory sessions, exercise sessions, seminars led by tutor and project work. Participation in computer laboratory sessions, seminars and exercises is compulsory; which parts that are compulsory should be stated in the course schedule.

### Examination

The course is assessed with the grades A, B, C, D, E, Fx or F.

The grade A constitutes the highest grade on the scale and the remaining grades follow in descending order where the grade E is the lowest grade on the scale that will result in a pass. The grade F means that the student's performance is assessed as fail.

Examination of each module is either done continuously (active participation by the student in designated module components) or through a test in the end of a module. These tests may consist of; an oral and/or written exam; an oral and/or written account of projects; or practical tests (e.g. video or audio recordings). An additional opportunity to take part in a test is given within six semester-weeks. The number of examination instances is limited to five.

On the modules one of the grades from A to F should be given. The theoretical and practical parts, respectively, will be assessed in their entirety. The grade for the course as a whole will be a proportional scaling of the grades in all modules.

The assessment criteria for the grade Pass is stated in the Objectives (see above).

### Course Evaluation

After each module an oral evaluation shall be carried out. The results of the oral evaluations shall be the focus of a discussion between students and teachers. The examiner of the course shall be present during these discussions.

A written evaluation shall be completed in the end of the course. The results of the written evaluation shall be compiled in a course report, which is filed in the institutional archives. The results of the written evaluation, and any actions taken, should be communicated to the programme coordinator, and presented to the students when the course is given again.

### Other

The course is generally taught in English but may be taught in Swedish if only students fluent in Swedish participate in the course.

Grade criteria for the A–F scale are communicated to the student through a special document. The student is to be informed about the grade criteria for the course by the start of the course at the latest.

### Required Reading and Additional Study Material

#### Required reading

MODULE 1 (Philosophy of science and introduction to research methods)

- Chalmers, A.F. (2013) *What is this thing called Science?* 4th rev. edition, Open University Press, 316 pp.) ISBN 9780335262786.

- Kumar, R. (2014) *Research Methodology – a step-by-step guide for beginners.* 4th rev. edition, London: Sage Publications (442 pp.) ISBN 9781446269978.

MODULE 2 (Research ethics)

- Macrina, Francis L. (2005). *Scientific integrity : text and cases in responsible conduct of research.* Washington, DC: American Society of Microbiology (402 p.) ISBN 1-55581-318-6

MODULE 3 (Literature searching)

- Compendium: Wikman, Susanne *Literature searching* (provided by course coordinator)

MODULE 4 (Laboratory safety)

- Compendia and manuals provided by course coordinator
- Material available on the internet.

MODULE 5 (Quantitative research methodology in the natural sciences)

- Miller, J. (2010) *Statistics and Chemometrics for Analytical Chemistry.* 6th edition. Prentice Hall, (296 s.), ISBN 9780273730422.

MODULE 6 (Oral presentation skills)

- Compendia provided by course coordinator.

- One of the books listed below is chosen after consultation with the course coordinator. Literature not mentioned below may be chosen after consultation with the course coordinator.
- Alley, Michael (2003). *The craft of scientific presentations. Critical steps to succeed and critical errors to avoid.* Springer [Electronic resource]
- Billingham, Jo (2003). *Giving presentations.* Oxford: Oxford University Press (144 p.) ISBN: 0-19-860681-8
- Davis, Martha (2005). *Scientific papers and presentations.* San Diego, Calif.: Academic Press (356 p.) ISBN: 0-12-088424-0
- Ehrenborg, Jöns & Mattock, John (2001). *Powerful presentations.* London: Kogan Page.
- Jay, Antony (2000). *Effective presentation.* London: Prentice Hall (159 p.) ISBN 0-273-64498-X
- Kenny, Peter (1982). *A handbook of public speaking for scientists and engineers.* Bristol: Hilger (181 p.) ISBN 0-85274-553-2
- Malmfors, Birgitta, Garnsworthy, Phil & Grossman, Michael (2004). *Writing and presenting scientific papers.* Nottingham: Nottingham University Press (153 p.) ISBN 1-897676-12-3
- Templeton, Melody & Sparks FitzGerald, Suzanne (1999). *Schaum's quick guide to great presentations.* London: McGraw-Hill (190 p.) ISBN 0-07-022061-1

#### **Additional study material**

##### MODULE 1 (Philosophy of science and introduction to research methods)

- Cover, J. A. & Curd, Martin (eds.) (1998) *Philosophy of Science: The Central Issues.* New York: W.W. Norton & Company, Inc. (1349 p.) ISBN 0-393-97175-9
- Rosenberg, Alex (2000). *Philosophy of Science: A Contemporary Introduction.* London: Routledge (191 p.) ISBN: 0-415-15281-X (E-book available via the university library)
- Gower, Barry (1996). *Scientific Method: An historical and philosophical introduction.* London: Routledge (276 p.) ISBN: 0-415-12282-1 (E-book available via the university library)
- Henry, John (2002). *The Scientific Revolution and the Origins of Modern Science.* Basingstoke: Palgrave (160 p.) ISBN: 0-333-96090-4 (E-book available via the university library)
- Baird, Davis (2004). *Thing Knowledge: A Philosophy of Scientific Instruments.* Berkeley, Calif.: University of California Press (273 p.) ISBN: 0-520-23249-6 (E-book available via the university library)
- Bell, Judith (2005) *Doing your research project: a guide for first-time researchers in education, health and social science.* Maidenhead: Open University Press (267 p.) ISBN: 0-335-21504-1 ISBN: 978-0-335-21504-1 (ISBN-13)
- Hempel, Carl G. (1966) *Philosophy of Natural Science (Foundations of Philosophy)* Prentice Hall (168 p.) ISBN-10: 0136638236 ISBN-13: 978-0136638230

##### MODULE 2 (Research ethics)

###### Examples of extension literature:

- Hansson, Mats G. (ed.) (1999) *Good conduct in research: an extract from the Swedish parliamentary investigation into research ethics 1999.* Stockholm: Swedish Council for Planning and Coordination of Research (Forskningsrådsnämnden) (FRN).
- Beauchamp, Tom L. & Childress, James F. (2001) *Principles of biomedical ethics.* New York: Oxford University Press (454 p.) ISBN 978-0-19-514332-4
- Berg, Kåre & Tranøy, Knut Erik (eds.) (1983). *Research ethics.* New York: Alan R. Liss, Inc. (413 p.) ISBN 0-8451-0128-5
- Broad, William & Wade, Nicholas (1985). *Betrayers of the truth: fraud and deceit in science.* Oxford: Oxford University Press (256 p.) ISBN: 0-19-281889-9.
- Elliott, Deni & Stern, Judy E. (eds.) (1997). *Research ethics: a reader.* Hanover, NH: University Press of New England for the Institute for the Study of Applied and Professional Ethics at Dartmouth College. (319 p.) ISBN: 0-87451-797-4.
- Elzinga, Aant (ed.) (1990). *In science we trust? Moral and political issues of science in*

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- society. Lund: Lund University Press (392 p.) ISBN 91-7966-129-7
- Erwin, Edwin, Gendin, Sidney & Kleiman, Lowell (eds.) (1994). *Ethical issues in scientific research: an anthology*. New York: Garland (413 p.) ISBN 0-8153-1790-5
  - Loue, Sana (2000). *Textbook of research ethics: theory and practice*. New York: Kluwer Academic/Plenum Publishers (255 p.) ISBN 0-306-46448-9
  - Resnik, David B. (1998). *The ethics of science: An introduction*. New York: Routledge (221 p.) ISBN 0-415-16698-5
  - Shrader-Frechette, Kristin S. (1994). *Ethics of scientific research*. Lanham, MD: Rowman & Littlefield (243 p.) ISBN 0-8476-7940-3 (hft)
  - Stevenson, Leslie (2000). *The many faces of science: an introduction to scientists, values, and society*. Boulder, CO: Westview Press (290 p.) ISBN 0-8133-6551-1
  - Centre for Research Ethics (1997-- ) *Studies in bioethics and research ethics*. Uppsala : Acta Universitatis Upsaliensis (AUU) : Uppsala University Library, 1997- (series ISSN 1402-3148)
  - The Royal Society of Arts and Sciences in Gothenburg, Centre for Research Ethics (1991-). *Studies in research ethics*. Göteborg: Centre for Research Ethics, The Royal Society of Arts and Sciences in Gothenburg [Centrum för forskningsetik, Kungl. Vetenskaps- och vitterhetssamhället i Göteborg] Series, ISSN 1102-0458
  - Welin, Stellan (ed.) (1993). *Scientific responsibility and public control: proceedings from a workshop 10-11 August 1992*. Göteborg: Centrum för forskningsetik, Vetenskaps- och vitterhetssamhället, ISBN 91-971672-1-5