Course dates: February 21st to March 25th

Exam: 2019-03-25 Time: 09.00-13.00, Place: Östra Paviljongen
Re Exam: 2019-05-18 Time: 09.00-13.00, Place: Östra Paviljongen

Localities: Main Lecture room: Thymine (Building 6K)
Other Lecture rooms: Old Library and Guanine (Building 6K)
Laboratory: White & Blue (Building 6K)

Course Literature: See next page

Course Administrator: Ingela Nilsson, tel: 7852869
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Course Leader: Victoria Shingler, tel. 785 2534
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Course Assistants: Henrik Seibt henrik.seibt@umu.se (HS)
Sarp Bamyaci sarp.bamyaci@umu.se (SB)

Other Course Lecturers:
Gemma Atkinson (GA) Department of Molecular Biology
Matthew Francis (MF) Department of Molecular Biology
Martin Gullberg (MG) Department of Molecular Biology
Vasili Hauryliuk (VH) Department of Molecular Biology
Jörgen Johansson (JJ) Department of Molecular Biology
Per Stenberg (PS) Department of Ecology and Environmental Science

Course components: Lectures, laboratory exercises, discussion groups and associated problem solving classes.

Mandatory components: Laboratory classes and their associated report (including the peer review session). Discussion groups and associated scientific article written assignments are mandatory. Attendance at lectures and problem solving classes is, of course, highly recommended.

Please note that laboratory reports and preparation of written working material for discussion groups have strict deadlines.

Absence due to illness should immediately be reported to the course administrator.
Course Literature 5MO113:

1] Genetics: From Genes to Genomes (5th International edition)
   Leland H. Hartwell; Michael L. Goldberg; Janice A. Fischer; Leroy Hood; Charles F.

   Note: 4th Edition free download at: https://www.youtube.com/watch?v=8rKo5C4QCHY
   Check out animations on:
   http://highered.mcgraw-hill.com/sites/007352526x/student_view0/

   Most relevant Chapters for 5MO113
   Chapters  8: Gene Expression: the flow of information from DNA to RNA to protein
   Chapters 10: Genomes and proteomes
   Chapters 15: Gene regulation in prokaryotes
   Chapters 16: Gene regulation in eukaryotes

2] Additional important information is provided in lectures (including laboratory
   introductions), together with lecture handouts, reviews and the original articles for
   discussion groups.

3] Other useful information is provided by on-line resources [see 5MO112]

Learning Goals (FSR’s) 5MO113:

- Apply knowledge about the fundamental processes of the cellular macromolecular
  machinery (RNA-polymerase and ribosomes) and to explain how the functioning of the
  cellular macromolecular machinery is analysed and evaluated with respect to gene expression
  in bacterial and eukaryotic cells.

- Understand and can describe how the functioning of the cellular macromolecular machinery
  is regulated (e.g. by proteins and regulatory RNAs) in response to signals such as binding of
  ligands and covalent modifications.

- Understand and can explain how the activity of gene products can be modulated at the post-
  transcriptional level (e.g. by Riboswitches, regulatory RNAs, post-translational modifications
  and export).

- Understand and describe how regulatory circuits can used in gene expression system for
  biotechnological purposes.

- Be able to show knowledge and considerations in the design of gene-expression experiments
  and analyzing the resulting data.

- To show skill in both oral and written scientific communication in English
Overview of lectures, labs, discussion groups and PSCs 5MO113

**Lectures:**
1. Bacterial transcriptional regulation I (VS)
2. Bacterial transcriptional regulation II (VS)
3. External stimuli and gene regulation: Two-component systems (VS)
4. Signal sensing, regulatory logic, and synthetic regulatory devices (VS)
5. Transcriptional termination and attenuation (JJ)
6. Regulation of mRNA stability and function (JJ)
7. Bacterial translation and control of protein synthesis (GA)
8. Bacterial protein export systems (MF)
9. Global regulation and the “omics” (VS)
10. Protein expression systems: bacterial (VH or VS)
11. Eukaryotic transcriptional regulation (VS)
12. The eukaryotic ribosome and regulation of protein synthesis (GA)
13. Tool Box: for eukaryotic cells (MG)
14. Protein expression systems: eukaryotic (MG)
15. Transcriptomics and RNA sequencing (PS or VS)

**Laboratory exercises**

*Gene regulation lab with data interpretation*
Lab. 1 Reporter gene technology in gene regulation

*Protein expression labs*
Lab. 2 Protein expression analysis
Lab. 3 Dry Lab: Deletion & Protein expression data interpretation lab

**Discussion groups and problem solving classes (PSCs)**
Discussion groups and problem solving classes are designed to reinforce key concepts and to stimulate critical thinking that requires assimilation and interpretation of basic information given in the lectures.

Discussion group 1: Paradigms of bacterial transcriptional regulation (to VS)

*Dead-line for written material: 17.00 Feb 28th*

Discussion group 2: Transcriptional reporter genes and biosensors (to VS)

*Dead-line for written material: 12.00 March 6th*

Discussion group 3: Genetic switches in gene regulation (to VS)

*Dead-line for written material 17.00 March 12th*

PSC1: data interpretation - Genetic data and gene regulation (VS and assistants HS&SB)
PSC2: data interpretation - Bacterial regulatory circuitry (VS and assistants HS&SB)
PSC3: data interpretation - Signalling circuitry (VS and assistants HS&SB)
Overview of laboratory component of the course

Laboratory practical
Gene regulation lab with data interpretation
Lab. 1 Reporter gene technology in gene regulation

Protein expression labs
Lab. 2 Protein expression analysis
Lab. 3 Dry Lab: Deletion & Protein expression data interpretation lab

Introduction to the dry lab. The aim of the dry lab series incorporated into the practical part of this course is to introduce you (the student) to concepts and ways of thinking that are usually taught through a practical course in which you get your hands "wet".

The ability to manipulate and regulate genes and to express proteins is the cornerstone of molecular biology techniques. There are few aspects of modern biology that have not been affected by the advent of molecular biology in some way, including areas that might not be expected to have a "molecular" component. In addition to being important in basic research, molecular biology has had far reaching effects in medical, pharmaceutical, and agricultural industries, in forensics, and in many other areas of applied science and technology. However, given the time-frame of the course, it is not possible for us to introduce you practically to all of the molecular biology techniques used in analysis of gene regulation and expression, or even to undertake all steps in a given analysis. Dry labs are designed using authentic data to complement your “wet labs”, so that you can reach the more mentally stimulating part of any practical - the interpretation of genuine experimental results.

<table>
<thead>
<tr>
<th>Lab. 1: Reporter gene technology in gene regulation</th>
<th>Day 1 Feb 21(^{st}) (Introduction and patching) Day 2 Feb 22(^{nd}) (imaging, data plotting, and interpretation)</th>
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</thead>
<tbody>
<tr>
<td>Lab. 2: Protein expression analysis</td>
<td>Day 1 Feb 25(^{th}) (Introduction, and put up overnight cultures) Day 2 Feb 26(^{th}) (grow-up, induction, collection of pellets, and preparation of buffers for purification for day 3 Day 3 Feb 27(^{th}) (extracts, purification and gel running) Open office (assistants March 12(^{th})) for anyone who needs extra help.</td>
</tr>
<tr>
<td>Dry Lab. 3: Deletion &amp; Protein expression data interpretation</td>
<td>To be done during Lab 2 incubation/waiting times and private study times Open office Dry Lab 3 (assistants on March 6(^{th})) for anyone who did not manage it or needs extra help.</td>
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Dead-line for dry Lab 3 papers to assistants: March 7\(^{th}\) 17.00
Lab round-up: March 11\(^{th}\)
Dead-line for Lab 1-2 report: March 18\(^{th}\) 17.00
Dead-line for Lab 1-2 report after peer review: March 21\(^{st}\) 17.00
Weekly Course Time Table

Key deadline dates not to be missed 😊:

Discussion group 1: Paradigms of bacterial transcriptional regulation (VS)
(Dead-line for written material: 17.00 Feb 28th)

Discussion group 2: Transcriptional reporter genes and biosensors (VS)
(Dead-line for written material: 12.00 March 6th)

Discussion group 3: Genetic switches in gene regulation (VS)
(Dead-line for written material 17.00 March 12th)

Dry Lab 3 report: (Dead-line for written material 17.00 March 7th)

Lab 1-2 report: (Dead-line 1 for peer review: 17.00 March 18th)

Lab 1-2 report: (Dead-line 2 for corrected versions based on peer review: 17.00 March 21st)
Thursday Feb. 21st

09.00-09.30  Roll-Call & Introduction to the course (VS)
09.30-11.30  L1. Bacterial transcriptional regulation I (VS)
12.30-13.00  Introductions to the laboratory course &
              Discussion group 1 literature assignment (VS)
13.00--14.30  Lab safety - as in 5MO112 applies for 5MO113, reminder (HS & SB)
              Introduction to Lab. 1 & to keeping lab notes (HS & SB)
14.30--15.30  Lab. 1: Reporter gene technology in gene regulation (HS & SB)
              day 1 (plate patching)
              Thereafter Private study

Friday Feb. 22nd

Booking Guanine  08.00-12.00 meeting point & study for analysis
Booking Old library 12.30-16.30 for analysis
Booking Guanine  12.30-16.30 for analysis
Booking computers 20 12.30-16.30 for analysis

08.00-10.30  Lab. 1: day 2: time staggered development of reporter gene assay plates, and
              data crunching (with lab assistants at LAS4000)
              Groups 1 - 3: 08:00
              Groups 4 - 6: 08:30
              Groups 7 - 9: 09:00
              Groups 10 - 12: 09:30
              Groups 13 - 15: 10:00

10.30-12.30  L2. Bacterial transcriptional regulation II (VS)
Lunch

13.30-  Lab. 1: day 2 continued (with assistants in the Old library and Guanine)
Data analysis: Computers will be provided, or you can bring you own

(Students: be sure to check your answers to the specific questions and your plots of the data with the course assistants (HS & SB) before you leave.
It is important that you have this clear)

~17.00  (may be earlier, but your analysis decides....)
Use unscheduled time for private study, e.g. Discussion groups/Lab Reports etc

Monday Feb. 25th

09.00-11.00   L3. External stimuli and gene regulation: Two-component systems (VS)
Lunch

12.00-13.00   Introduction to Lab 2 and dry Lab 3: (HS & SB)

13.00-14.30   Lab. 2: T7 Expression Analysis (Day 1: set up overnight cultures)

14.30   private study [e.g. Discussion group 1 literature assignment]

Tuesday Feb. 26th

08.30-10.00   Lab. 2: day 2 (HS & SB; growth, induction, collection of pellets, and
Preparation of buffers for purification – day 3)

10.00-12.00   L4. Signal sensing, regulatory logic, and synthetic regulatory devices (VS)

13.00-17.00   Lab. 2: day 2 continued (HS & SB) [incubation times for Dry Lab 3 and
private study e.g. Discussion group 1 literature assignment]

Wednesday Feb 27th

Be prepared for a fairly long day!

08.30-17.00   Lab 2: day 3 (HS & SB; preparation of extracts, purification and running of
gels)
Note 1: gel de-staining can be done overnight if time gets short.
Note 2: use waiting times productively (e.g. for Dry Lab 3 and Discussion
group 1 literature assignment)

Thursday Feb 28th

11.00-13.00   L5. Transcriptional termination and attenuation (JJ)
Thereafter Private study for e.g. Discussion group 1 literature assignment

17.00   Dead-line for Discussion group 1 written material

Friday March 1st

09.00-11.00   L6. Regulation of mRNA stability and function (JJ)

12.00-16.00   Discussion group 1 (VS) and Discussion group 2 assignment (VS)
Private study for e.g. Discussion group 2 literature assignment
**WEEK 10 (WORKING WEEK 3 MARCH 4TH – 8TH)**

*Use unscheduled time for private study, e.g. Discussion groups/Lab Reports etc*

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td><strong>Monday</strong></td>
<td>March 4th</td>
<td>09.00</td>
<td>L7  Bacterial translation and control of protein synthesis (GA)</td>
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<td></td>
<td></td>
<td>12.00</td>
<td>L8  Bacterial protein export systems (MF)</td>
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<td>Private study</td>
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<tr>
<td><strong>Tuesday</strong></td>
<td>March 5th</td>
<td>09.00</td>
<td>L9  Global regulation and the “omics” (VS)</td>
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<td>Private study</td>
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<tr>
<td><strong>Wednesday</strong></td>
<td>March 6th</td>
<td>09.00</td>
<td>L10 Protein expression systems: bacterial (VH or VS) 09.00-11.00</td>
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</table>
|              |            | 12.00 | **Open office for Dry Labs 3**: Protein expression data interpretation lab (HS & SB)  
|              |            |       | *for anyone who did not manage it during Lab.2 incubations and waiting times, or needs some extra help.* |
|              |            |       | **12.00** Dead-line for Discussion group 2 written material               |
|              |            |       | Private study                                                            |
| **Thursday** | March 7th  | 09.00 | **Discussion group 2** (VS) and Discussion group 3 assignment (VS)        |
|              |            |       | Private study                                                            |
|              |            | 17.00 | **Dead-line for Dry Lab 3 written material (to course assistants HS & SB)** |
| **Friday**   | March 8th  | 09.00 | L15 Transcriptomics and RNA sequencing (PS)                              |
|              |            |       | Private study                                                            |
WEEK 11 (WORKING WEEK 4 MARCH 11th TO MARCH 15th)

Use unscheduled time for private study, e.g. Discussion groups/Lab Reports etc

**Monday March 11th**
09.00-11.00  **L11.** Eukaryotic transcriptional regulation (VS)

12.00-14:00  **Lab round-up (VS & MV)**
Private study e.g. for DG3 and dry lab 3 report

**Tuesday March 12th**
09.00-10.30  How to write up your **Lab material** (HS & SB)
10.30-12.00  **Open office for Labs 1 & 2 (HS & SB) for anyone who need extra help**

17.00  **Dead-line for Discussion group 3 written material (to VS)**

**Wednesday March 13th**
09.00-11.00  **L12.** The eukaryotic ribosome and regulation of protein synthesis (GA)
Private study for Lab reports etc

**Thursday March 14th**
09.00-14.00  **Discussion group 3 (VS)**
Private study e.g. for Lab report etc

**Friday March 15th**
09.00-11.30  **L13.** Tool Box: for eukaryotic cells (MG)
Private study for Lab reports etc
Use unscheduled time for private study, e.g. Lab Reports etc

Monday March 18th
09:00-11.30  L14. Protein expression systems: eukaryotic (MG)
  Private study e.g. Lab report 1-2 / Exam

17.00  Dead-line for Lab 1&2 written material
  (to be given in person to your designated peer reviewers:
  Group 1 ↔ Group 2;  Group 3 ↔ Group 4  Group 5 ↔ Group 6;
  Group 7 ↔ Group 8;  Group 9 ↔ Group 10;  Group 11 ↔ Group 12
  Group 13 ↔ Group 14;

NOTE: you will need a signed assessment form from your Peer assessor to be able to submit your final written material!

Tuesday March 19th
09.00-11.30  L13-15. Back up lecture time slot
  Private study

Wednesday March 20th
Private study:
12.00-17.00  Lab 1-2 material: Peer Assessment Discussion & correction (HS & SB)
  NOTE: here is where you should provide your written assessment of others and discuss you mutual assessments of each other’s written material. You will need a signed assessment form from your Peers to be able to submit your lab report material!

Thursday March 21st
Private study: Exam and/or Lab 1-2 report correction

17.00  Dead-line Lab 1-2 reports: resubmission after Peer Assessment & corrections to Assistants ALONG WITH A SIGNED PEER REVIEW FORM (submit to sarp.bamyaci.umu@analys.urkund.se)

Friday March 22nd
Private study:
12.00-15.00  Course Q and A session (VS and others) / course evaluation
  Private study

WEEK 13 (WORKING WEEK 6 MARCH 25TH-29TH)

Monday March 25th
Exam:  2019-03-25  Time: 09.00-13.00, Place: Östra Paviljongen
Re Exam:  2019-05-18  Time: 09.00-13.00, Place: Östra Paviljongen